The Technique of SPECIAL EFFECTS in Television

Bernard Wilkie

THE TECHNIQUE OF SPECIAL EFFECTS IN TELEVIS

By BERNARD WILKIE

This is a unique work: both pioneering and astonishingly comprehensive. In television, the term special effects does embrace a far wider range of activities than in the film world. This book covers it all—from the popping champagne cork to bullet and bomb effects, collapsing floors, animated captions, and such "normal" happenings as ringing telephones, boiling kettles, smoky atmosphere and dripping gutters.

The continuous shooting of television demands specially designed effects, while many film methods become unusable because they would limit the TV director's freedom of movement—and would also be too time-consuming and too expensive.

The problems of those engaged in providing large scale or dramatic effects sequences on a small budget are handled practically, and optical tricks which can effect considerable economies when only small studios and a limited number of cameras are available, are explained. Attention is also given to rules of conduct and procedure for those engaged in dangerous sequences. The treatment is detailed, giving full descriptions of equipment, working principles and type of effect obtained.

BERNARD WILKIE is the senior designer of a large section in BBC-Television concerned entirely with visual effects and special props, and during fifteen years as an effects man he has been responsible for thousands of effects sequences.

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THE TECHNIQUE OF

SPECIAL EFFECTS IN TELEVISION

By

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CONTENTS

PREFACE

ALTHOUGH still a young industry, television has built up an impressive amount of operational technique. Forced originally by lack of time and money to improvise, it has quickly converted improvisation into expertise, developing economies and know-how on a scale unrivalled in other entertainment media. Owing much to the theatre and the film industry, it has nevertheless invented its own procedures and technology.

This is particularly true in the case of special effects, where the designers have endeavoured to emulate their counterparts in the film world while working not on one or two major films a year but on dozens of shows per month. Furthermore, they have had to concern themselves with subjects not usually associated with special effects. Ranging from electronics to sculpture, these extracurricular activities have established the effects men as the accepted purveyors of innumerable items and services unobtainable elsewhere in the television organization.

Many of their ideas and methods might be classed as trade secrets, but in publishing these I share the belief of most of my colleagues that a free interchange of information must serve to improve the quality of the medium.

Several of the devices and techniques outlined are my own inventions. Many more have been devised by persons known and unknown. I am grateful to these people for making my job (and this book) possible. I hope that publication of our combined efforts will make things easier for those who will follow in our footsteps and stimulate others searching for solutions to problems in the fascinating field of television special effects.

ACKNOWLEDGMENTS

I WISH to thank those organizations and individuals who have allowed me to publish photographs and details of their materials, processes, and equipment. I am also grateful to those TV companies and film makers who have permitted me to use photographs of their productions. In this respect I am particularly grateful for the co-operation I have received from The British Broadcasting Corporation.

My thanks also to those who have taken the trouble to read through the various chapters and give me their expert advice, especially ANTHONY LIAS for his editorial help, and to PETER LOGAN, who drew the illustrations.

INTRODUCTION

ANY attempt to define the role of the special-effects worker in television is bound to be frustrated by the fact that in television the term "special effects" embraces a large number of different activities. This is because television itself differs fundamentally from the other entertainment media. The engineer who uses certain electronic equipment to transform the picture is supplying special effects. The man who devises a special prop is also understood to be providing an effect: so is the chap who spreads a carpet of "dry ice" for a dream sequence, and the film cameraman who by employing certain optical tricks creates a ghost effect or double image.

Nature of television effects

In the theatre and the film industry the term special effects means something both positive and tangible. On the stage the designer responsible for a splendid transformation scene or a burning building could justifiably be credited with the special effects, while in the film industry the same credit would be given to those responsible for sinking ships or creating vast and dramatic battle scenes. These are, in short, the sort of scenes that most people visualize when they read the words "special effects". Small wonder, then, that night after night millions of people watching television are totally unaware of the fact that special effects are included in programmes not even remotely connected with grandiose scenes or extravagant staging.

The milk saucepan that boils over at the precise moment in the action, the smoky atmosphere in a night-club, the rain dripping from a gutter—all these would pass without notice as being perfectly normal happenings. And this is how it should be. Within the context of the scene they *are* normal, but during the preparation of the programme someone has had to engineer these items—and that "someone" is quite likely to have been a special effects man.

This book sets out to explain as many of these effects or types of effects as possible.

Peculiarity of television methods

Television is a complex medium. Not only does it make film in exactly the same fashion as the movie industry (television film studios have become an essential adjunct of the larger TV companies) but it also operates in the same way as the live theatre. In the electronic studios it is quite usual to stage dramas where scenes are struck during the performance and where, although the output is recorded for later transmission, the programme is to all intents and purposes a live show. This applies particularly to those shows played before a studio audience. Some programmes are transmitted live while others are recorded on film or on videotape. Sometimes they are a combination of all three.

In addition to these different ways of recording or transmitting shows, studio programmes can also be integrated with scenes and events from distant locations via mobile television unit hook-ups.

All the factors mentioned so far are sufficient to set television well apart from the theatre and the movies, but an even more significant difference between TV and the older media lies in the use of the electronic cameras themselves. The movie director constructs his film shot by shot, whereas the TV director records continuous action. This difference in approach affects the sort of trickery available to each director.

The movie man can plan each shot with deliberation, assessing the value of each technique. Faced with a scene which does not suit him, he might well decide to alter it by utilizing a glass matte process. With this he can exclude unwelcome buildings or add new dimensions to existing landscapes. With enough time and labour he can carefully establish continuity, making sure that each change of viewpoint shows similar exclusions and additions, even though this means employing many more painstaking glass matte shots.

The television director works in a different way. He may have several electronic cameras available to him at any moment, each able to move freely in any direction—to pan, track, and zoom at will. Almost any sort of shot from any viewpoint can be his within seconds of asking. This freedom of movement does not accord with the setting up of elaborate optical effects. The emphasis is therefore on entirely different types of effects. Anything that limits the director's freedom of movement must prove unpopular, and this single fact accounts for the almost total disuse of certain methods and techniques which are considered essential to the movie maker.

Another factor which determines the TV director's choice of technique is, of course, the time factor. There are enormous differences in the time scales of the two media. The TV director must telescope into minutes something that might take days in the movie studio. Only something that is absolutely essential will be allowed to rob him of precious time, and no long-winded method is likely to find favour with him. Consequently there is no reference in this book to such processes as the Schufftan system or other similar methods which have proved so successful in the making of films. They have not, and presumably never will, find a place in modern television practice.

Departmental responsibility

As television has grown it has been found that those departments responsible for the design and supply of the various constituents of TV programmes have become more and more specialized. This is a natural trend which can be paralleled in most large business organizations. Carpenters, painters, prop-men all have their particular areas of responsibility, and as the amount of work increases, so each section finds that it must concentrate more on its own particular sphere of activity and less on the others. This means that an independent section able to operate with a very broad mandate is essential to ensure the supply of those items unobtainable from the other sections. This, then, is the special effects section of television.

Some TV organizations find it necessary to have such a section as an integral part of their design department, while others rely upon the services of the various specialized outside contractors. Both these methods work, but for the larger organization an internal section fully equipped to design and make most of the special items is economic common sense (although the section itself will inevitably have to use the services of some outside contractors).

In the television organization there are departments responsible for the design and making of the scenery, the supplying and the hiring of properties, the lighting of studios, the wardrobe, the make-up, and so on and so forth. All these departments are quite naturally fully occupied with their day-to-day commitments. The property department may be dealing with thousands of items a day. Called upon to search for a particular item, a property buyer might have to spend hours of precious time. Therefore if the effects section is able to deal with some of these special requests it is quite likely to save the company money, and in many cases ensure that a production is able to screen something that might otherwise have been unobtainable.

Role of effects designer

The value of a special effects section lies not so much in its adaptability or its ability to make models or props quickly and cheaply, but in the fact that it knows both the correct techniques and the limitations of television. This is something which makes it more convenient to have an internal section than to rely wholly on outside contractors. It also means that where a number of different effects are to be combined in one programme there is a central source of responsibility in the person of the effects designer.

In assessing the role of the TV effects man it is, of course, impossible to ignore comparisons with the film industry. The film man has better facilities, more money and more time, and generally enjoys more freedom to concentrate on one thing at any given moment. The TV man, dealing with smaller items and less elaborate practical work, may have to cover several shows concurrently. Nevertheless, he has the compensation that his work is extremely varied and, furthermore, he is likely to have a considerable measure of individual responsibility.

The effects designer has to decide how any particular effect shall be carried out, and as there are many different ways of achieving the same results, he must necessarily work very closely with the production unit in order that they are both fully aware of all the factors involved. Although it is possible to make and supply many special props and devices from only the briefest details, special effects proper must receive the fullest evaluation before being included in a programme.

Making effects convincing

It is trite to say that a bad effect can ruin a scene or even a programme, but nevertheless it is a fact that can bear some examination. A bad effect may be bad for one of two reasons: it can fail because it was badly made or operated, or it can fail because it did not fit into the programme. The first reason need not be discussed, because the effect of a prop which fails to work is obvious. The second reason is far less easy to define. An effect may be well thought up and well executed, but fail to appear convincing. Sometimes this is because it is poorly conceived and sometimes because it is not properly used. On these occasions visual effects which should pass without drawing attention to themselves suddenly appear as intrusions.

One example of this is when consecutive shots present the same thing in different forms. Assume a scene is to show a full-sized sentry-box which for some reason or other is to blow up. If the next shot shows the sentry-box as a model which is then exploded the difference between the real thing and the model robs the sequence of its full potential. The model of the sentry-box may have been very well made and excellently exploded, but the immediate switch from one to the other shows all sorts of discrepancies. The finish, the texture, the lighting all differ, even if only a little, but this is quite enough to expose the substitution. The answer in such a situation is to ensure that no direct comparison is possible between the two; and this can usually be achieved by inserting as many cut-away shots or other sequences between the real item and the model as will ensure that the memory of the one is dimmed before the appearance of the other.

It is unfortunate in this respect that the designer of visual effects often has a very tough job to make his stuff appear convincing. Consider the use of sound effects, for example. It is much easier to make convincing sound effects, because these need not occur *within* the picture. Visual effects, on the other hand, must obviously be *seen!* With sound effects, the buzz of conversation, the noise of battle, or even the closing of an unseen door, all create an immediate and convincing illusion of something taking place. The whine and crash of a mortar shell landing near by is accepted without question. But if the explosion is accompanied by a little jet of sawdust in the centre of frame the drama changes to high comedy.

Essential effects

There are effects without which the scene itself would have to be rewritten if not actually excluded. Sometimes these are complex and time-taking set-ups and sometimes simple little tricks, but however achieved they are essential to the programme.

It is interesting to examine three examples of this kind of effect. First, a train which was wrecked by saboteurs; secondly, a tree stump which was blown out of the ground; and lastly, an incendiary bomb which was brought under control by a small group of firefighters. These three were all essential to their respective programmes and could not be played off-stage, and yet they all had to be faked for different reasons.

In the first example the train had to appear to crash without actual derailment (no enormous film budgets here!). The scene had to develop from a long shot of the approaching train to a close-up of the exploding charge in front of the wheels and, finally, to a shot of the train toppling over.

It was arranged as follows. After the straightforward shots of the travelling train and the exploding charge the train was returned to its starting point up the line. Next the camera was placed alongside the line, looking down the track—but on this occasion the camera was tilted at an angle of 45°. The line and ground on either side was then dressed with small trees and shrubs tilted at the same angle as the camera. The result of this was that the shrubbery appeared to be *upright*. Consequently when the train was driven up the line, brushing aside the foliage, it was presumed to be leaning over. In fact, it appeared to be on its side crashing through the forest! The picture did not, of course, include any ground or the track.

In the second example the tree stump simulated an occurrence which is commonly practised on farmland when, after a tree has been cut down, the stump is blown out of the ground. It was filmed on location in an area where it would have been quite permissible to film the real thing. This would not have sufficed, however, because both the explosion and the actor who was playing the part of the explosive worker were required to appear in the same shot. To have filmed the tree stump while holding the actor in frame *and* in safety would have meant that the tree stump would have been too far away. So a special effect was called for.

A property stump made from expanded polystyrene with a central core of timber was lowered into a prepared hole in the ground, in the bottom of which was positioned a steel mortar. The wooden core of the property stump terminated in a spigot below the "roots" and was made so that it fitted into the mortar, which contained a charge of gunpowder. Two ground maroons were placed close to the tree stump, one in front and one behind. The final preparation was a covering of peat, loose earth, and grass, sprinkled around the base of the stump to simulate natural ground.

Having lit the fuse, the actor retired to his prearranged mark and the tree was blasted into the air by the effects man—who, with his leads and firing box, was positioned out of shot. The mortar blew the stump about nine feet into the air; being made of light, rigid foam plastic, it required only a small charge. The two maroons placed front and back completed the effect by flinging the peat and earth into the air. It looked exactly like the real thing and yet was so controlled that a person ten feet away would have been perfectly safe.

The only accident on this occasion occurred earlier in the day when a passing lorry driver, seeing a man carrying a huge tree stump on his shoulder, drove his vehicle into a roadside hedge!

The third example, the incendiary bomb, concerned an incident which was supposed to take place in a church hall. The bomb, which had fallen through the roof, was to be seen lying on a small pile of rubble on the floor of the building. The floor in this case was the floor of the studio, and as it was impossible under these circumstances to supply gas to the property bomb (which was positioned right in the middle of the acting area), it was decided to superimpose the effect of flames from another source.

The "bomb" was made from Perspex and had an internal quartz–iodine lamp to give the effect of the intense glow associated with this type of incendiary device. The flames were provided by gas jets rigged on a sheet of black painted asbestos and situated elsewhere in the studio. When the time came for the bomb to fire, the two pictures, seen by different cameras, were combined in a shot which showed the glowing bomb on the studio floor, burning with three-foot flames. This superimposition protected both the floor and the actors who had to extinguish the fire.

Importance of safety precautions

It may seem at times that the author is unduly preoccupied with safety, but effects concerned with fire, smoke, and explosives in films and television have produced a number of quite serious accidents and an even greater number of unrecorded incidents. Two current newspaper cuttings illustrate this. The first reads: "Last night more than 200 extras ran screaming as flames destroyed the Rome studios in minutes. The fire was believed to have been caused by a smoke bomb which ignited paper flowers in a casino set. It took 150 firemen four hours to fight the blaze, but the entire million-pound set was destroyed." The second cutting, which refers to a singer who was badly burned in Munich, says: ". . . his face and neck are covered with severe burns, a lot of his hair has been burned off and a skin graft may be necessary on his right hand . . .

this happened when a technician who was to replenish some foreground flames poured spirit from a bottle."

Even when every sensible precaution has been taken it is still possible for unforeseen accidents to happen, and it is essential that this fact is continually borne in mind. The lives of actors, stuntmen, and fellow technicians often depend on the code of practice adopted by the effects man. It is particularly important that his judgment is not influenced by other people—something which can often happen when an actor (who through professional pride, or desire to give of his best for the sake of the show) offers to submit to something which the effects man considers hazardous. If the actor is willing to do it and the director is prepared to let him the effects man will find himself in the unhappy position of appearing over-cautious. These occasions call for considerable tact, but the responsibility is ultimately the effects man's, and it is of paramount importance that he maintains an unblemished safety record. It is an unfortunate fact that while all those shows that go without a hitch are soon forgotten, the occasions when things do go wrong are remembered and retold as noteworthy anecdotes.

Directors and producers may often ask for improved or modified effects during the course of the action. Feeling that they are not getting what they originally visualized, they sometimes request that an effect be done in some other fashion. This is another difficult situation for the effects man, who will naturally want to rise to the occasion and give the results that he is being asked to produce. It may mean that his original planning will have to be scrapped in order to achieve the revised effect. When this happens accidents can result. The golden rule whenever something dangerous must have last-minute modifications is that the action should be suspended while the new effect is tried out in conditions of safety.

Keeping up appearances

One of the most embarrassing things that an effects man has to contend with is the fact that every actor, technician, prop-man, and bystander knows how any given effect should be achieved. Furthermore, these people never hesitate to give the unfortunate effects man the benefit of their advice. He has to listen patiently while they suggest a method which he has already discarded as being impractical. He then has to explain tactfully (or otherwise) why such a method would be of little use, at which point they will promptly suggest another!

Special effects work is seldom scientific, and the effects man is therefore at some disadvantage. Where others are supported in their labours by complicated machines and elaborate techniques, the TV effects man often has to carry out his work armed only with some simple device such as a homely mousetrap.

He should therefore take pains to make his equipment as professional as possible. In fact, there is no harm in actually dressing it up. A special effects man's reputation can depend very much on the image he presents, and this is more important than many people might consider. The effects man who fumbles in his pocket for a battery to set off an explosion is less likely to engender confidence than the man who carefully sets up a practically-made firing device. Even the humble mousetrap seems much more impressive if mounted in a metal box. This is an attitude of mind, but those who adopt it soon find that it encourages good workmanship and sound practice. It is, for example, quite possible to get rid of spent pyrotechnics by kicking them into the bushes, but the man who collects them in a steel container labelled "Special Effects Section" is likely to gain greater respect.

Essential tools and equipment

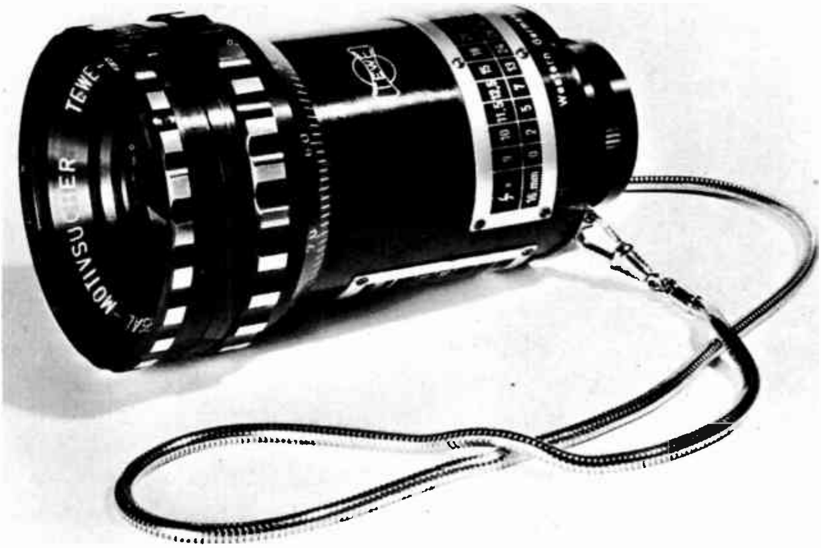
To do his job efficiently an effects man must possess certain tools and equipment. Two of the most important items are an 8-mm camera and a projector. These enable him to try out many of his effects on film without needing to engage a camera crew before the date of the actual programme, and he therefore not only saves a great deal of time and money but can also show results to the director in his office, thus eliminating the need for a viewing theatre. Some film processing laboratories will undertake to process 8-mm film overnight, claiming the processing fee from the film manufacturer.

Other important items are a viewfinder and a "pan glass". The viewfinder is essential for composing pictures, and when models or demonstrations are being set up it is important to know what will be in shot and what can be concealed around the frame.

The pan glass has the effect of converting colour into monochrome. It is merely a filter through which the scene is viewed by eye, but it is very useful when it is required to visualize what the final monochromatic picture will look like.

Finally, a few words about this book.

The reader may often consider that he is getting more information



A zoom viewfinder used to frame scenes by eye. An invaluable aid to the construction of models. (*Rank Film Equipment.*)

on how *not* to achieve an effect than details of an actual method. This order of priorities, however, is very important in a field of activity that relies so much on trial and error. All too often the first "obvious" solution is found to be impractical, and the saving of any time which might otherwise be wasted searching up blind alleys is certain to be of benefit.

In places there are unavoidable areas of overlap. The reason for this is that in grouping techniques, devices, and materials under descriptive headings, some effects are split up. For example, the compressed-air gun described in the chapter on bullet and bomb effects can be used to smash the bottles and windows which appear in the chapter on breakables. Where appropriate, suitable cross references have been added.

References are made to manufacturing companies, suppliers, and specialist contractors. These have been included to assist the reader to obtain items and information on the processes or techniques under discussion. The author is unable to guarantee either the products or their availability, but in most cases the companies mentioned are reputable and well-known organizations.

1

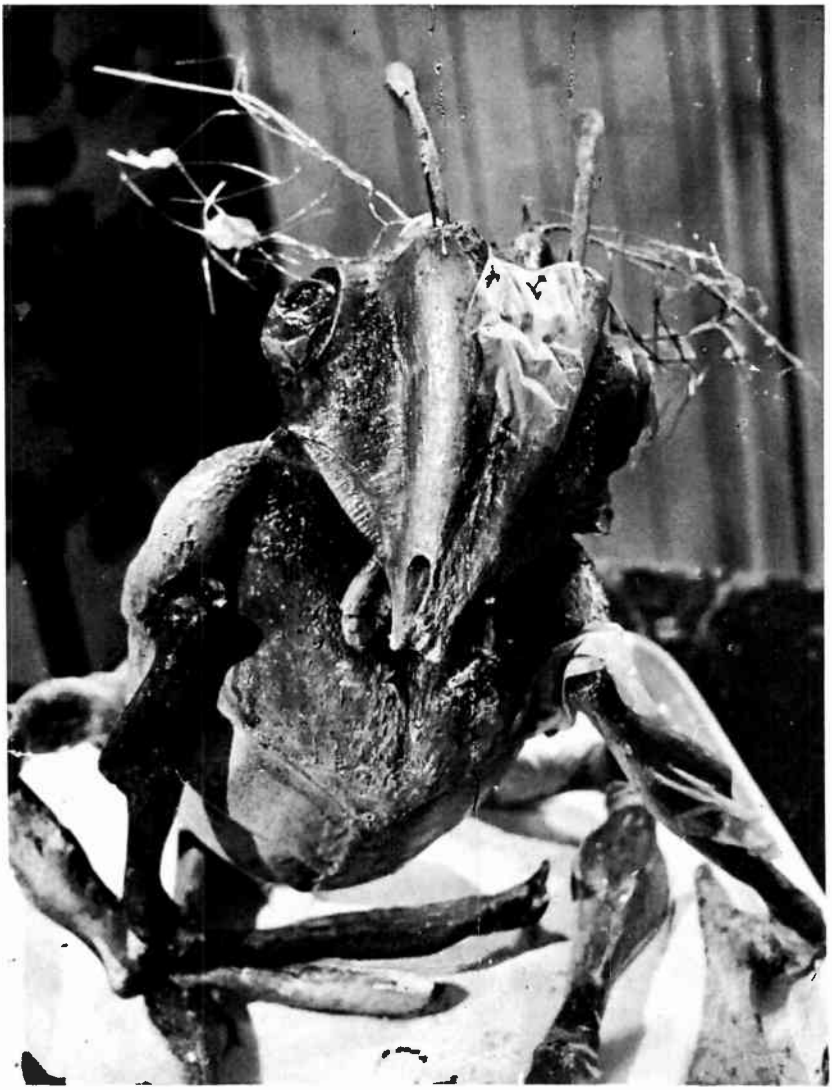
PREPARATION AND USE OF SPECIAL PROPS

THE term "prop" is, of course, an abbreviation of the word property, and refers to all the things in a television production which are not classed as scenery or wardrobe: chairs are props, and so are knives and forks. Special props, however, are those items which cannot ordinarily be obtained from the property department. Chairs which can be broken over people's heads, and knives and forks which bend and break or perform some other unusual function are special props—and consequently should be the responsibility of the effects section. This may not be true in the case of all TV companies, but for those who have an effects section it is obviously economical and sensible to make this section responsible for all the unusual items which cannot be acquired from other sources. Such a section will, of course, be able to build up "know-how" enabling them to deal with anything out of the ordinary, and it keeps all the tricky and messy stuff in one area. It also allows rules of conduct and safety to be applied more easily.

Nature of special props

The term "special prop" may imply different things to different people, and there are no boundaries or definitions which can clearly establish where a property ceases to be ordinary and becomes special. Obviously if a clock has to fly apart in vision it is no ordinary prop, but what of a request for a piece of medical equipment invented in 1801? The chances are that after some attempt has been made to find one in a museum or teaching hospital the visual effects section will be asked to make a copy from a reference drawing or contemporary engraving.

Descriptions of the special props used by just one TV company in the course of one month would fill a sizeable book, and it is impossible even to consider such props in general terms. There are



A glass fibre monster from *Quatermass and The Pit* circa 1959. It would be difficult these days to recreate the spine-chilling effect that this creature induced in audiences of the time, but the same rules apply today.

obviously no limits to which special prop making can go, and no list could ever be considered typical. However, an attempt has been made here to describe items which will be called for again and again, albeit in different guises.

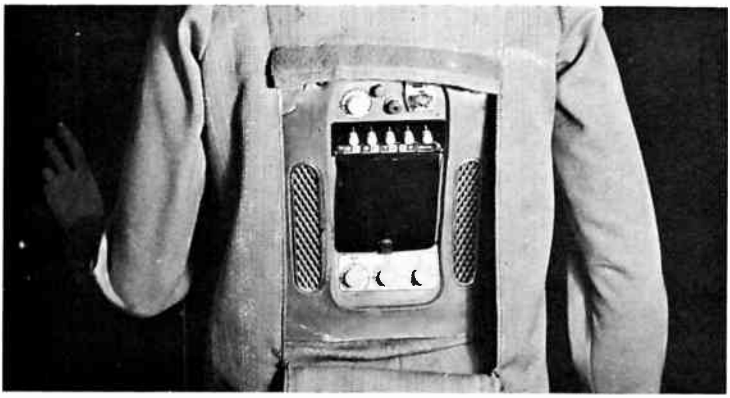
Many years ago, when television was transmitted live, a play was screened in which one scene took place in a small village shop. The director, anxious to get a particularly dramatic shot to commence the sequence, asked the effects men to provide a special prop. He wanted to see a girl shop-assistant climb on to a chair, reach up to a shelf and "accidentally" knock down a tin. From a ground-level viewpoint he wanted to show the tin roll across the floor towards the camera, stopping only a foot or two away from the lens with the label facing forwards and with the words "Rat Poison" clearly seen on the front.

As it had to come to rest in exactly the right place and also the right way round, the tin had to be something special. No pre-filming could be entertained in those days. Nor could use be made of such things as special trick floors, "cut aways", or models. Such luxuries would never have been possible in the small crowded studio.

The problem was solved by having a tin containing an elastic band and a hanging weight, rather like the self-propelled toys children sometimes make. Starting from a position near the camera, the tin was slowly rolled back to the place behind the counter from which it had to emerge. This caused the elastic to wind itself up so that when the tin was released it returned of its own volition to its original position. An invisible nylon thread, carried from below the camera and over the tin and tied off behind the counter, gave a satisfactory amount of deceleration and arrested the tin at exactly the right spot. Nevertheless, this was live television, and if the device had failed there would have been no chance of a retake! It was a one-off shot and it had to work! Nowadays such chancy situations would be avoided at all costs, but not to have attempted this sort of thing in those early days would have meant limiting all television drama to the mere photographing of stage plays.

Special props and trick gadgets form a large part of the "special effects" seen on television. They range from the smallest items (for example, a human tooth to contain diamonds) to such things as grand pianos that have to "explode". In many cases they are much the same as those constructed for use on the stage and in film production. But generally television special props differ slightly from those constructed for the other two media, in that they do not have to be made to the same specifications.

Props for stage use have to last for many performances, and therefore have to be robustly constructed. Those made for films often have more money and time lavished on them, because the larger screen size demands property-making of a particularly high



To create a convincing female "robot" a hollow dummy was provided with "controls". A flap that could be raised showed conclusively that there were "works" within. For the scenes in which the robot had to walk and talk an actress took over, displaying a latex facsimile of the control gear affixed to her back by sticking plaster.

standard. None of these things, however, are essential for props used in television. A special prop in television normally has to work only a few times and, while first-class workmanship should be the only standard acceptable, there is little point in elaborating in areas where elaboration is not required. A trick prop should be practical and as simple to operate as possible, and it should have a finish suitable for the occasion. This philosophy applies to a great deal of television work, but is particularly relevant in the field of special props. If a thing can be animated satisfactorily by pulling on a hidden nylon thread there is not much point in fitting it with radio control.

This should not be confused with the earlier statement that it is better to dress up the "mousetrap" in a more elaborate form. If the mousetrap works satisfactorily there is no reason to build a special spring-loaded device with automatic release mechanism. The same thing therefore applies in the case of the radio control and the nylon thread. If the thread is right for the job and will perform in the manner required, then the radio control will prove no better. In fact, it might be worse, as freak reception conditions, battery failure, accidental damage, and other complications might prevent the effect from working.

Candle flicker

During the course of a play a tiny night-light burning inside a glass bowl had to splutter and then go out.

There are many ways in which this problem could have been tackled, but it was decided that the most satisfactory method was to use an electric torch (flashlight) bulb. This meant that the extinguishing could be easily managed on cue. There was some difficulty, however, in making the small electric light resemble a flickering candle flame. The first step was to disguise the lamp with small slivers of Cellophane to alter its shape. The next step was to treat the glass bowl with wax "drippings", which further camouflaged the light source and also gave a touch of authenticity to the prop.

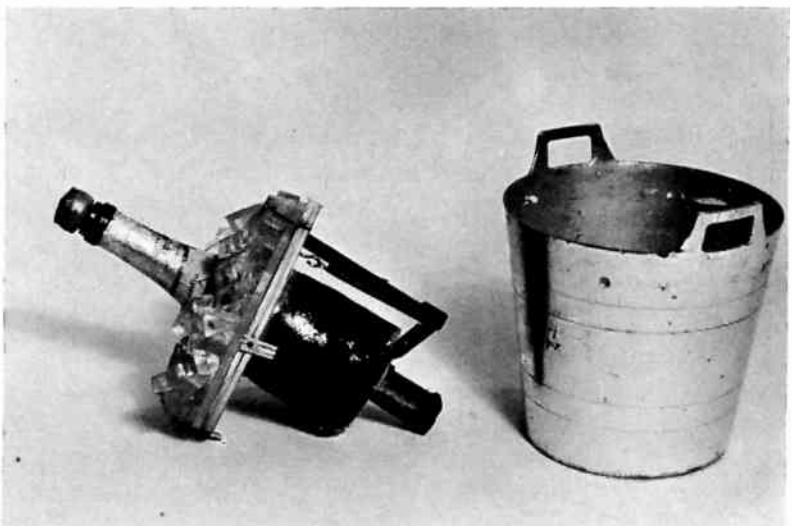
The flickering was achieved by connecting the supply leads to spring contacts which rested on the various wheels of a cheap clock movement. The escapement had been removed and a small governor (a piece of sticky tape attached to the spindle of the fastest wheel acting as an air brake) slowed the movement to a suitable speed. The result was that when all the contacts were wired in parallel they each contributed a different flicker rate, the combination of which kept the lamp constantly alight but with a noticeable random flicker that appeared authentic.

Popping champagne corks

Illustrations are shown on page 26 of two types of effects champagne bottles. One is mounted in a bucket of ice, the other is hand held. Both these eject their corks and some of their contents on cue.

The champagne bottle surrounded by ice in the conventional cooler is in actual fact built around a mechanism removed from a

Two champagne bottles that fire their corks on cue.



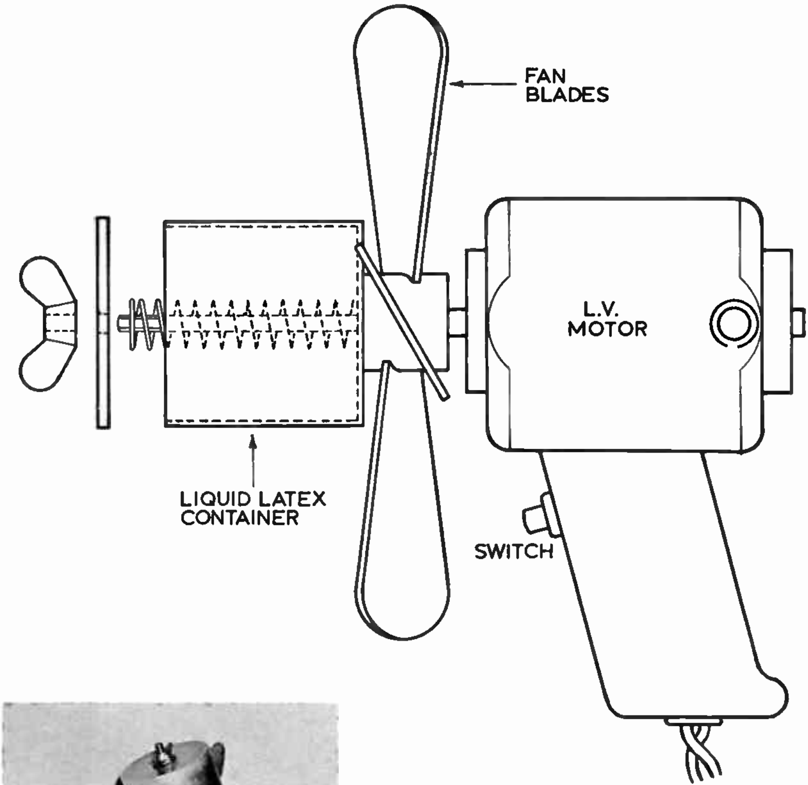
simple air pistol. The barrel and plunger are situated in the top of the bottle (there is no lower part, but this is camouflaged by the plastic "ice"). The pistol is cocked by pushing a ramrod down into the neck of the bottle. Next a small amount of aerated liquid is poured in and finally the cork is inserted. (This, of course, does not have the restraining wire of a real bottle: a metal foil cap camouflages the omission.) The trigger of the gun is taken to a small knob situated in the ice. When this is pressed, the spring-loaded plunger shoots up, driving out liquid and cork and presenting a realistic "explosion".

It would seem natural to query the use of props of this kind. Why should such an expensive device be made when real champagne can be easily obtained? The answer apparently lies in the fact that the firing of the cork of a champagne bottle attendant on the removal of the wire is inherently unreliable. Actors who perform such an action with panache in their own homes may become butter-fingered when on the set, and even those who tackle the whole thing with verve occasionally find that the cork either breaks off or needs coaxing with a twelve-inch screwdriver!

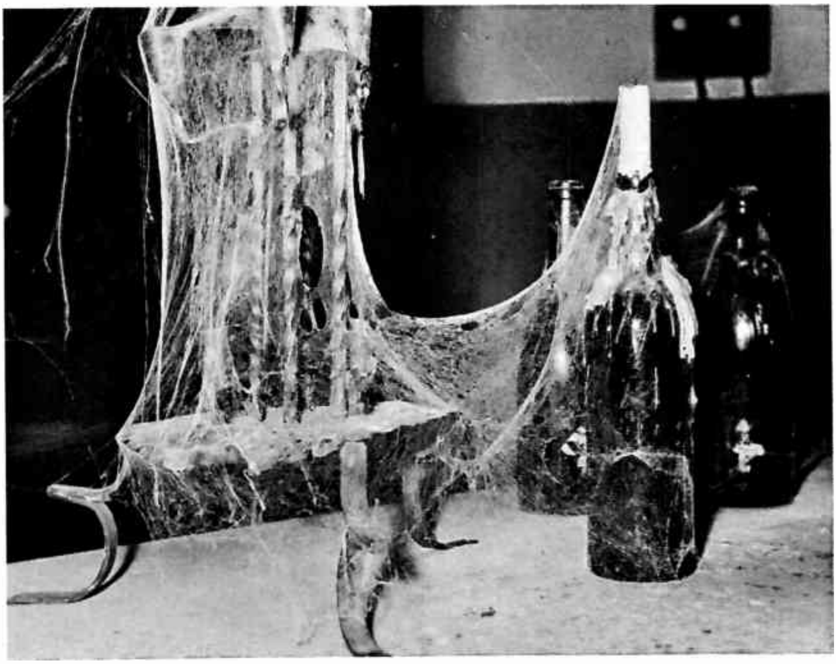
The second bottle illustrated is a glass-fibre casing housing a metal chamber large enough to contain a small amount of liquid as before—and the cork. This time, however, the ejection takes place by the operation of a small carbon dioxide operated cork remover. This device (obtainable from most wine stores) consists of a small handle containing a replaceable CO_2 cylinder, a needle (to be driven into the cork when used in its intended fashion), and a thumb-operated control valve. Built into the bottle shown, the needle is connected to the chamber by a small length of plastic tube. If it was required that the device should spew out a larger quantity of liquid, the chamber would have to be designed in such a fashion that the CO_2 was applied to the surface of the liquid, driving the liquid at the bottom up the walls of an outer cylinder until the entire contents were expelled.

Creation of cobwebs

Cobwebs can add greatly to the atmosphere in dingy interior scenes, and provided they are arranged sensibly can look quite convincing. The trouble with cobwebs is that they are fragile and take some time to prepare, and if a scene in which they are to be swept aside is to be shot a number of times a great deal of time may be spent in replenishing them.



Typical cobweb guns. The fan blades may be constructed of metal in which case they should be surrounded by a suitable guard. Alternatively, made from hard sheet rubber they offer little danger. The front plate should be machined so that it is in intimate contact with the lip of the latex container. From the gap between these two issues the rubber which is centrifuged into gossamer threads before being blown on to the set.



Latex cobwebs can be attached to various props by means of the cobweb guns shown opposite. The cobwebs can subsequently be cleaned off with a dry rag.

There are two types of cobweb which may be used effectively. One is composed of fine-drawn filaments of Terylene or glass which can be bought in hanks and attached to the set where required, while the other consists of slender filaments of rubber which are spun from a cobweb gun and are sprayed directly on to the set.

The cobweb gun is a hand-held device consisting of an electric motor which rotates a fan-blade and a cup containing the rubber solution. The fan and the cup are mounted in line directly on the spindle of the motor, which is fitted with a handle or pistol grip and a trigger-operated switch. The cup containing the rubber solution has a cover plate which should be of the same external diameter as the cup, and both the plate and the lip of the cup must be machined so that they are in intimate contact all round.

The cover plate is retained by a knurled nut, screwed on to a thread at the end of the motor spindle. Inside the cup (on the spindle) and acting against the plate is a coiled compression spring.

This means that by turning the knurled nut different pressures may be applied to the plate, so varying the gap between cup and plate. It is this gap that produces the cobwebs. When the cup revolves, rubber is forced between the plate and the lip of the cup by centrifugal force. If the gap is small the rubber emerges in fine filaments, which are then blown by the fan on to the scene. At this stage they are sticky and adhere to themselves and anything else they meet, so forming the blanket of fine, criss-cross threads associated with cobwebs.

The cobweb gun, if purpose made, is best fitted with a low-voltage motor, powered from a local battery. This ensures that it can be used anywhere on the set without the encumbrance of long trailing leads. (An even better arrangement is when the carrying case is equipped with a low-voltage transformer, permitting the use of batteries or mains as desired.)

In use the gun should be gently swept from side to side. Cobwebs form rapidly once they have something to which they can attach themselves, and if large areas have to be bridged pilot threads of cotton should first be stretched across the set. It is important that these pilot threads do not seem to be too contrived, because, being the framework on which the finer threads form, they tend to show up rather clearly. Sometimes they may be cut or loosened after the webs have been laid.

To present the cobwebs to their full advantage, it is usual to dust them with talcum powder. This may be done by blowing the powder from the palm of the hand.

An excellent solution for use in cobweb guns is Rema Tip Top vulcanization fluid. Alternatively, most rubber solutions used for tyre repairs can be thinned with petrol (about 50/50). Mole Richardson supply their own product for use with the Moleffect Cobweb Spinner.

Smoking flatiron

The electric flatiron which has to scorch or burn clothes is a favourite prop with the writers of situation comedy. There are several ways in which an electric iron can be made to smoke, including those using hot-wire smoke (see page 73) and charcoal tablets (see page 68). Both these methods may be easily applied to a smoking flatiron, but a cheap and simple solution sometimes possible is to make the "electric cord" to the iron a small-bore rubber or plastic tube, through which cigarette smoke may be blown. This not only has the advantage of supreme simplicity but it also allows the effects man to smoke in the studio!

If the charcoal tablet method is used the iron must be provided with adequate ventilation to keep the tablet alight. Holes should be made around the top of the sole plate, and at least one hole should be situated above the tablet (perhaps in the area of the thermostat knob) to allow a through draught. Smoke can be made to appear by squirting oil through a plastic tube (again taking the place of the electric lead) on to the charcoal tablet.

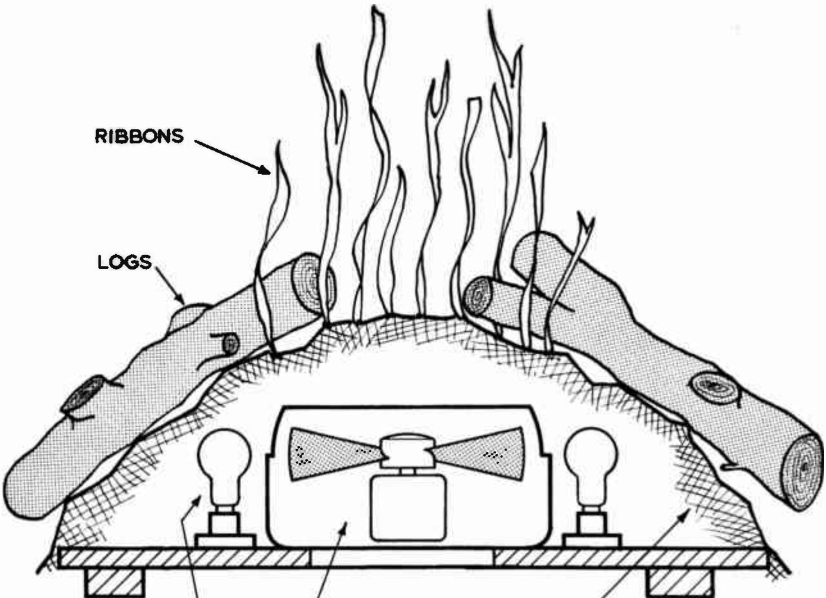
Fires, furnaces, and red-hot metal

Blazing log or coal fires must have practical flames to look realistic, and are often built on a basic burner unit fed with town (coal) gas. Around such a burner can be placed coal or logs which have been made from plaster applied to wire-netting cores. These will last several performances before burning away. For additional realism, smoke may be introduced by using charcoal tablets and oil (page 68) placed below the gas burner.

Furnace fires which are to be seen through open doors or ports can be simulated merely by lighting the interior; practical flames in such "heat" need not be seen. The actual "hot" material seen behind the doors can be a sheet of clear plastic which has been previously heated with a blowtorch until distorted into shapes resembling hot slag or coal. The action of the blowtorch often blackens the plastic sufficiently, but if darker patches are required they can be sprayed on with black paint. Alternatively, a mixture of dyed sawdust and adhesive can be applied where required. This unit should be illuminated from below.

A crucible of "molten metal" can be mocked up if the "crucible" has a bottom of glass or translucent plastic. It is partially filled with water which is then covered with a layer of fine cork dust and aluminium powder. The crucible must be stood on a hearth or stand which has a cut-out hole corresponding to the translucent bottom of the crucible. A light positioned underneath must be arranged to shine up through the liquid. The effect becomes apparent only when the mixture is stirred. The slag on top, broken by the agitation, reveals the "white-hot molten metal" below. If a light is built into the bottom part of the crucible it is possible to pour the "molten metal" quite convincingly.

Implements of torture, branding irons, and similar items which have to look red-hot can be made from fluorescing red plastic of the



A log fire for scenes in which absolute realism is not required.

type in common use for display signs. This material looks excellent in both colour and black-and-white pictures, but where a dramatic close-up is required in a scene depicting torture it is usual to expect the studio lighting to be dimmed in order to heighten the drama; then the red-hot part of the implement needs to be supplemented with a built-in torch bulb and battery.

Some quite elaborate props have been constructed along these lines. Branding irons have been made containing not only built-in lighting but also smoke units of the hot-wire variety (page 73) fed by cables secreted up the performers' sleeves. For additional realism, a small pad impregnated with liquid make-up at the tip of the iron produces a suitably horrifying burn mark when pressed on to the flesh. It is, of course, at this moment of contact that the smoke is released!

Fly-apart clock

The grandfather or cased clock which ejects its works through its own face invariably provokes laughter. It is often preceded by a brief period in which the hands fly round accompanied by exaggerated sound effects. The fun often lies in the fact that the "explosion" is both sudden and unexpected.

A simple method of getting good results is to have a number of clock parts loosely assembled and held together by lengths of curly spring. These are attached to the back of the face by strong elastic bands and pulled back to an anchor point in the rear of the case. They can be released by a draw pin and trick line, by an electrically operated solenoid catch, or by a pyrofuse release (see page 174). When released they shoot forward, carrying the face with them.

A long spiral spring can be used to arrest their flight, causing them to dangle ludicrously from the empty hole.

If the hands have to revolve beforehand it is a simple matter to fix a small motor-driven device at the back of the face with a metal shield to protect it from damage during the impact.

High-voltage sparks

A laboratory high-voltage sparking-coil with a three- or four-inch spark gap can be used to provide most of the spark or lightning effects wanted on television. This piece of equipment can usually be hired, but some form of spark producer for permanent use is a wise investment. Sparks from this sort of gear have a characteristic pattern that is hard to obtain in other ways.

Spark effects wanted for TV range from the bolt of lightning to the sizzling arc emanating from equipment in the scientist's laboratory. There are also the larger than life effects associated with electric fences and arcing cables.

Sparks may be included in a scene in a number of ways. They can be superimposed live, overlaid electronically, or pre-filmed and superimposed from telecine. Whatever method is chosen, the recording of the spark may be carried out as follows. Two electrodes are positioned in a black box which is totally enclosed. The front, however, has a hole to admit the camera lens. The purpose of this box is to provide a completely darkened area in which the spark is produced against a black background. It is important that the box should be sufficiently large and constructed in such a way that the spark does not illuminate anything which might also be recorded. Inside the box, two electrodes of copper wire are connected to the coil. This is done by taking two stiff copper wires from the adjustable spark gap, positioned in such a way that sparks do not jump between the wires or from the wires to any conductive surface. It is necessary to ensure that the spark gap in the box is smaller than the spark gap of the coil, otherwise sparks will jump between the latter instead of in the box.

In use the electrodes in the box are lined up in the camera viewfinder (either the TV camera or the film camera) so that the extremities of the spark appear over the points from which the spark must emanate in the scene. It must be remembered that the spark is superimposed and therefore is not capable of illuminating anything on the set. It is desirable to position the spark where this is not too obvious.

If two fixed points are not essential random sparks may be obtained by making the electrodes two parallel bars. This will cause the sparks to hunt up and down. Other random effects can be obtained by making one electrode completely circular with the other a point source in the centre.

In order that the electrodes themselves are not seen, they should be situated behind a separate mask within the box. It is not sufficient merely to paint them black.

If sparks are to appear simultaneously in different parts of the set it is possible to film them individually in their corresponding positions and then to have them combined on one piece of film by the processing laboratory.

All superimposition work of this kind means that while the effect is being used both the superimposition source and the principle camera must be lined up accurately and no movements, such as panning, tracking, or zooming, can be undertaken.

Electric sparks of a different nature may be produced by the use of a welding transformer or a twelve-volt car battery. One of two stout leads taken from the appropriate terminals can be connected to a metal plate or wire grid while the other is connected to a wire brush or a hacksaw blade. When either of these is drawn across the plate or grid a shower of sparks results.

There are many ways in which this effect can be applied. The unfortunate man who clutches the electric fence might in reality be rubbing a steel wire with a hacksaw blade, the leads being concealed by his body or taken behind a convenient post.

It is necessary to avoid maintaining static contact in this set-up, as it results in the welding together of the two components and consequent heating of the leads. The two ends should be touched together only in short bursts.

ment itself has to break. It is rarely possible to construct an instrument of this kind so that it can also be played. For breakage of this nature (whether caused by special "business", such as dropping, or whether by unexpected disintegration during the rendition) it is important to provide a prop that can be rehearsed with. It must be capable of being reassembled. It is inadvisable to suppose that the effect will happen successfully "on the night". This rules out props which are constructed with dabs of glue. The aim should always be to provide the sort of prop that a clown in a circus might use: one that will perform successfully night after night. This might seem to be another of those contradictory statements, because at the beginning of this chapter it states that props for TV have to operate only a few times; and this is generally true. The point that has to be appreciated, however, is that there is a considerable difference between various types of special props as well as the manner in which they are used. Jerry-built props usually lead to trouble. Property musical instruments, particularly those that have to be handled and operated by artistes, should be built as robustly as possible.

When a violin has to snap it is possible to build an instrument which is held together by small magnets but will come apart with a sharp tap. The magnets must, however, be powerful enough to resist the pressure caused by stringing the instrument (particularly if the strings are of elastic).

If a stringed instrument has to break while being played it is possible to make use of the tension of the strings to pull the pieces apart. Usually a small catch situated somewhere below the instrument will hold it together until the time comes for release.

A "musical" instrument which tends to figure more frequently in television comedy is, of course, the electric guitar. The standard "joke" is for the amplifier to explode. Ways of doing this can be found in the chapters on bullet and bomb effects and pyrotechnics and explosives. Should it be impractical for pyrotechnics to be incorporated, then a spring-loaded device can be released (by an electric solenoid, perhaps) to fire the works through the front, which can be of paper. For details see the method used for fly-apart clocks on pages 32–33.

Wilting plants and falling blooms

It is often claimed that there is nothing new under the sun, and proof of this is constantly being furnished to the effects men, who may have to produce the same gag a hundred times in slightly

Hypodermic syringe

A medical hypodermic syringe can be made which apparently injects a liquid into a patient's arm. The blunt needle is spring loaded so that it retracts into the body of the syringe, where it slides up into the rod that pushes down the piston. The piston is made with more depth than is strictly accurate, because it is hollow and, when pressed home, slides over the "liquid", which is a cylindrical piece of translucent plastic of appropriate colour.

For taking samples of "blood", the plunger is withdrawn, slowly revealing red-coloured plastic. The amount of travel is governed by the depth of the piston, so the effect is concentrated at the lower end of the syringe. This is a good general-purpose prop that can be used in close-up without any special preparations.

Lifts and indicators

A convention well established in films is the one where a lift (elevator) goes up or down when the doors have been closed. There are various ways of displaying this implied movement, some complicated and some easy.

One of the most complicated situations is where the main doors are translucent and a lattice gate is seen to close behind them, after which they "ascend" or "descend" followed by a blackout. For television purposes this is unnecessarily tricky, and it is more usual to use doors which have (if there is to be any sort of window at all) small apertures fitted with translucent plastic. It is an easy matter for these to be fitted with sliding shutters which are raised or lowered by the scene crew (who are out of sight on either side to operate the main lift doors). Even more simply the implied travel can be arranged by merely raising or lowering a board thrust into position when the doors have closed. Conveniently the doors open only when the "lift" is at the particular floor, so when the board has been lowered from the windows to allow light to fall on them it can be pulled out of sight before the doors are slid back.

Another method to imply movement is to show an indicator which may be fitted to the wall at the side of the doors or fixed over the top. One of the simplest arrangements is to have a series of low-voltage electric lamps situated behind numbered windows, controlled from a remotely operated rotary switch.

Much depends on the period in which the scene is set. An old-fashioned device whereby a moving arrow shows the whereabouts of the lift by pointing to numbers which then illuminate is both easy to make and to operate. It needs no wiring or separate lights at all. The pointer, which is moved from behind, has a mask attached to its spindle. The mask, which rotates behind the facia plate, has a cut-out which lines up with the tip of the pointer. A light shone from behind illuminates each floor number in turn as the pointer is moved.

Musical instruments

Although they do not figure largely in the effects man's repertoire, musical instruments occasionally have to be modified to perform some unnatural function. In the majority of cases they are fully practical instruments, capable of being played, but having such additions as a hidden pipe to squirt water or an electrically fired flash hidden somewhere out of sight. The very nature of the performance usually dictates that the performer shall have to operate the gag himself, as there is seldom opportunity for hidden wires or pipes to be secreted on his person.

On other occasions the effects man may have to design musical instruments which fly apart, blow up, or merely break. Fortunately these instruments rarely have to be played! If they have to seem to make music it is generally possible for this to be dubbed in an appropriate fashion.

The pictures on page 37 show a grand piano which explodes when a certain key is pressed. This is an ingenious prop and has been used many times. Although the blow-up appears to be spectacular, there is only a single flash (mag-puff, see page 101) incorporated in the design, the major part of the disintegration being actuated by spring-loaded devices and release bolts. Inspection of the pictures will disclose the fact that the pedal support flies upwards away from the artiste and crashes through the works of the piano. Other simultaneous actions, such as the flying keys, are triggered by this demolishing pedal support.

Occasionally there is a request for a violin or guitar on which a string must break while it is being played. This can be arranged by fitting a false string of elastic terminating in a small ring. The ring is slipped over a special peg which can be withdrawn from behind while the instrument is being "played".

There is also the occasion, usually comic, when a stringed instru-

A harmless "exploding" piano. The lightweight components fly apart on cue while a flash (fired from internal contacts) completes the effect. ▶

differing forms. The perennial prize-winner must surely be the wilting plant! These unfortunate plants are subjected to various sorts of maltreatment, but usually it is the "Moonshine" or cocktail poured furtively into the plant-pot which causes the plant to wilt, sag, shoot straight up, or simply shed its leaves or flowers.

The simplest method of effecting the instant wilt is for the flower stalks to be made of flexible plastic tubes. Stiff wires are inserted into these tubes and, when slowly withdrawn from below, cause the flowers to sag convincingly.

The blooms which leave the parent plant may be remotely controlled in either of two ways. The first is for the stalks to be made from small-bore, soft, copper tube. The blooms, terminating in small caps, are placed over the ends of the tubes and a sharp burst of compressed air causes them to leap off into space.

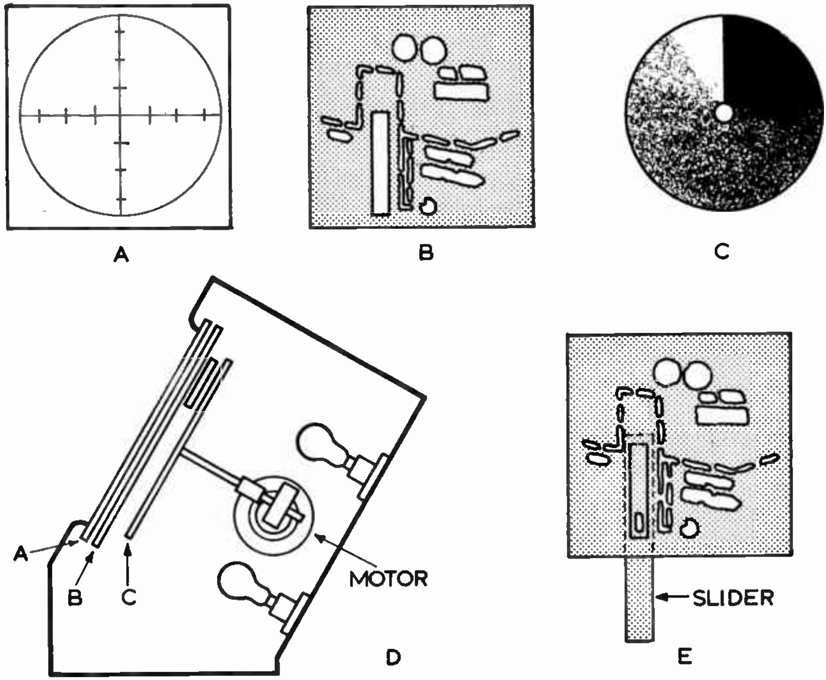
If the blooms are required merely to drop to the ground magnets can be used. At the back of the blooms are fixed small bar magnets with one pole uppermost. Suitable magnets can be obtained measuring no more than $\frac{1}{4}$ in long by $\frac{1}{16}$ in square. At the end of each stalk or branch is fixed a small nail with its head outward. Around each nail is wound a few turns of insulated copper wire, and these coils are connected in parallel. The magnets adhere to the nails, and so the flowers may be "stuck" to the ends of their stalks. If low-voltage, high-amperage current is now applied to the coils the nails also become magnets, but if the current is arranged so that the polarity of the nails *opposes* that of the magnets the flowers drop instantly.

It is important to connect up the coils so that they all produce like polarity, and equally important that the magnets on the flowers have similar poles pointing outwards.

Radar scanners and oscilloscopes

Simulated radar scan patterns are frequently called for in TV plays. Often they are used only as animated dressing in the interiors of ships, aircraft, or control towers, but occasionally they are wanted to convey some specific action in close-up, such as the approach of other ships or perhaps the trajectory of a guided missile or space-craft. An easily made basic unit can be installed in various cabinets or bays of equipment, and will work well for both the simple, continuous scan and for the movement of a "blip" which has to be seen in detail.

The basic unit consists of three layers of Perspex, an electric motor, and gearbox with a final speed of about 15–20 rpm, and a



A mock radar scanner capable of very realistic results. Disc C, revolving behind the display, is graduated from clear to opaque. Sliders are used when a blip is required to travel on the display.

base or frame to house the complete assembly. It may also have its own internal illumination. Of the three layers of plastic, the first purports to be the front of the cathode-ray tube, the second supplies the picture to be scanned, and the third, which is slowly revolved, provides the scan. More specifically, the front, a sheet of clear plastic, has a translucent backing. This is best arranged by placing tracing paper at the back, with a second sheet of clear plastic to hold it firmly in place. Thus the front element is a screen capable of having patterns projected on to it from behind but sufficiently opaque to obscure a view into the works.

The second element, the scanned picture, may be either a photograph of an actual display or a special drawing. If the former it should be a negative transparency (i.e. mainly opaque with the design in clear "blobs" and lines) sufficiently large to cover the screen; but if a cheaper version is required the scanned image can be scratched on a sheet of clear plastic which has previously been sprayed with black paint.

The rear element is a revolving disc. Centred on a spindle and driven by the small electric motor, it, too, is of clear rigid plastic sheet and sprayed with black paint. But the painting of this disc must be done with precision. On one side of a radial line drawn from the centre it must be opaque, but must get progressively less dense as it goes round until it fades away altogether, leaving the last quarter of the disc completely clear. The object of this is to produce a disc which when revolved will have the effect of slowly dimming a light shone through any part of it, giving the characteristic sudden lighting up and fading of the typical radar display. When assembled with a light source (evenly illuminating the display) placed behind the revolving "fade" the effect is quite realistic, even at close range.

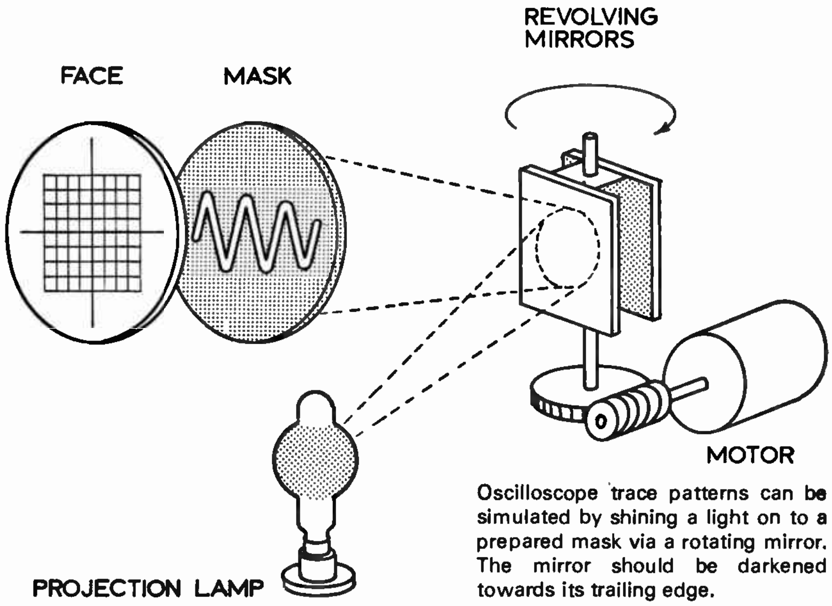
When a moving "blip" is required to travel across the screen an area must first be marked out on the middle display sheet. This area governs the amount of travel permissible, and within it no other part of the pattern may appear. Assuming that a single blip, representing a ship, has to be seen manoeuvring into harbour, it would appear as follows. The harbour and its environs would be seen on the screen as a stationary pattern within which would be the moving blip representing the ship. The stationary pattern would be continually swept by the scanning beam, and the ship would move its position only when obliterated by the dark part of the scanner. The blip would naturally have to be a clear portion in an otherwise opaque slide, and for this to be able to move without being obscured by the map there would have to be a correspondingly clear portion in the plate on which was drawn the harbour pattern. This clear portion would have to equal the maximum amount of travel of the blip, and it therefore follows that the slide would have to be at least twice the length of the clear portion in order that the clear portion would always be covered by the slide. This in turn means that the total area in which no part of the stationary, harbour pattern may be placed is equal to three times the length of the travel of the blip. Looked at in detail we will imagine that the ship is moving up one side of the picture from bottom to top in a straight line of about two inches. There must therefore be a clear area in the harbour picture of two inches. This clear strip will be slightly wider than the blip. When the ship is at the bottom the clear area must be covered by black slide and there will be a further two inches of black slide below the clear area, which will serve to cover it when the blip is at the top. Hence an area of six inches must be clear of all harbour picture, otherwise detail will be obscured when the slide moves (see page 40).

Blips on slides may be manoeuvred by a wire or lever operated from behind, but in some cases it may be required for them to be operated remotely. In such cases they may be drawn on a sheet of cel (or rather the opaque area round them may be drawn on the cel) and the sheet then wound up on a motorized drum. The clear cel would not, of course, obscure the picture, so it could be of any size or shape.

Oscilloscope patterns can normally be achieved by using fully practical equipment hired for the programme. Oscilloscopes give an infinite variety of patterns if wires are taken to appropriate terminals and connected to suitable voltages. Traces can be made by connecting the wires to microphones which are tapped or spoken into, and even the touching together of the ends of wires produces suitably dramatic traces.

When it is not practicable to use real equipment prop oscilloscopes can be built which give a display very similar to the genuine article.

One method (below) is to use two elements. The first, the face of the "cathode-ray tube", is prepared from clear plastic sheet and tracing paper (as described for the radar unit). The second (also similar to the radar unit) is clear plastic which has been sprayed black and on which has been boldly scratched the "wiggly" trace



Oscilloscope trace patterns can be simulated by shining a light on to a prepared mask via a rotating mirror. The mirror should be darkened towards its trailing edge.

pattern. This time, however, the light source is projected on to the back of the display via a mirror which is rotated on the shaft of a horizontally mounted electric motor. Two mirrors fixed back to back on the shaft give a less intermittent rate of scan than a single mirror.

Another very simple, but effective display may be obtained by using a revolving bent wire which has been painted white. The wire, driven by an electric motor, is positioned behind a circular hole in a fake control panel, the hole being backed by a black painted interior. This device produces some intriguing patterns, but is best reserved for science fiction or laboratory scenes where busy action is required in the background.

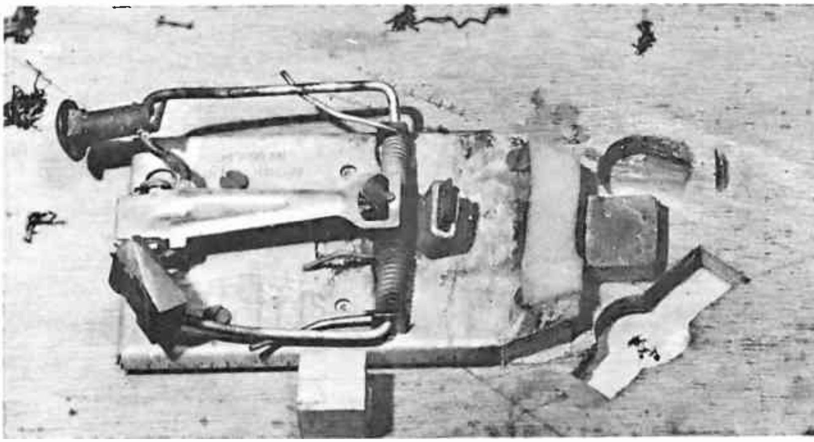
Rat-trap and mirror

Wall-mounted mirrors which have to be broken are often the casualties of gunfire, but occasionally a script calls for an artiste to break a large mirror, either by hitting it with his fist or by using some object such as a bottle or a shoe. If the object is heavy enough and the actor is prepared to deliver a sharp blow the mirror shatters in the normal fashion, but to protect him, a thin sheet of rigid clear plastic may be put in front of the mirror. If this is unacceptable the back of the mirror should be covered with self-adhesive plastic vinyl sheet of the type used to cover tabletops and walls. This keeps the pieces of mirror intact and gives a better smashing effect.

Where the mirror has to be smashed by a blow from someone's fist there is often a marked reluctance on the part of the actor to give his all! This natural diffidence can be overcome by fixing behind the mirror a rat-trap which has been provided with a metal block attached to the backbreaker. The trap is fixed to a sheet of plywood in which there must be a hole large enough to allow the metal block to pass through and strike the back of the glass.

The trap can be sprung by pulling a nylon thread, but if the mirror and ply are fitted loosely in the frame the effect is automatic when the mirror is struck. To ensure positive results, a small weight fixed to the trap retaining wire (which must be hair-trigger set) provides sufficient inertia to spring it when the trap is disturbed by the blow.

To protect the actor's hand the front of the mirror is covered by the sheet of clear rigid plastic, but it is still advisable to cover the



A rat-trap fitted behind a mirror can, by having a weight fixed to the release, be so sensitive that it will smash the mirror when lightly tapped. Two interchangeable slugs are shown fitted to the back-breaker.

back of the mirror with the self-adhesive sheet. If this is not done, pieces of mirror can fall down between the front sheet of clear plastic and the plywood backing, revealing the "works".

Rifle sights and binocular shots

Rifle sights, binocular shots, and periscope views have been seen so many times on television and the movies that they have established their own conventions. Most of these are, of course, quite incorrect. For example, good binoculars never produce the sharp, black figure-of-eight so often shown. Nevertheless, these things are now accepted by the viewing public as being an accurate representation of what they pretend to be, and there seems little reason to change them. After all, who would believe a slightly fuzzy circle to be a true representation of the view through a pair of binoculars, or a double blur as being rifle sights?

The simplest method of obtaining the silhouette effect (the hard vignette of the binoculars, the porthole with cross wires for the periscope, etc.) is for these shapes to be provided by the inlay-operator in the gallery. Masks, if not readily to hand, can be cut from paper or card to suitable specifications and laid on the inlay machine, where they provide black silhouettes around the picture.

More realistic results can be obtained in the case of rifle sights if they are mocked up in balsa wood and actually fixed to the camera, suitably enlarged and with the necessary distorted perspective. No particular rules apply and it takes only a few minutes to try out suitable sizes and distances in front of the camera to establish the correct proportions.

Similarly binocular and periscope surrounds may be cut from card and fixed on a supporting arm in front of the camera lens. (In studios not equipped with inlay facilities this is the simplest expedient.) It is not always easy to produce the sharp lined graticule associated with the range-finding device in the periscope, and if the camera is not called upon to move they may be drawn on a sheet of glass stood in front of the lens. As with the rifle sights, this is a matter of trial and error.

A snag arises with the telescopic rifle sight which has crossed lines, as this is generally required to sweep across the picture until it comes to rest on the head or body of the victim. Both the lines and the victim are expected to be sharply in focus at the same time. This demands that both should be within the depth of field, and if this means that a sheet of glass attached to the camera would be so large as to be impracticable, then the lines can be constructed from wire, fastened within a circular cut-out of black card, and supported on light arms attached to the camera body.

One of the most offending qualities of the stock binocular or telescope shot is that they invariably appear to be rock steady. Most people know, if only instinctively, that hand-held binoculars must waver quite perceptibly and it can add enormously to the realism of these shots if a slight undulation is shown. If the master shot is on film, then the camera should have been hand-held and not tripod-mounted. In the TV studio the cameraman can impart sufficient movement by lightly tilting or rocking his camera.

Rigged roulette wheel

Many people assume that for a roulette wheel to be "fixed" it is necessary only for it to be equipped with suitable electro-magnets. This myth has no doubt been perpetuated by those Mississippi gambling movies where the hero snatches out the rigged wheel, displaying the wiring underneath! Those who try to develop this method will probably be disappointed. A wheel, however, which will come up with a pre-determined result works on the principle that while the wheel is revolving it is possible to remove the ball without its being seen and to return it to a different pocket. The wheel, which has to be specially built, has compartments which are open, in that they have no retaining walls on the periphery of the wheel. This means that whichever compartment the ball rolls into it is immediately thrown out by centrifugal force, disappearing into a gallery constructed below the numbered ring. One particular compartment has its dividing wall extended into this gallery in order that it can quickly gather up the ball and sweep it around as it goes. The ball propelled by this sweeping arm circulates until it comes to a part of the gallery which is deliberately constricted. This constriction forces the ball to re-enter the wheel at the compartment in front of the sweep. This compartment, apart from having the sweeping arm, also has a tiny tongue of steel spring which acts as a non-return gate. The ball, forced past this obstruction by the constriction in the gallery, can no longer be flung out by centrifugal force, and so remains trapped in the chosen number. To pre-select this winning number it is only necessary to lift off the numbered ring and replace it so that the desired number is situated over the special compartment.

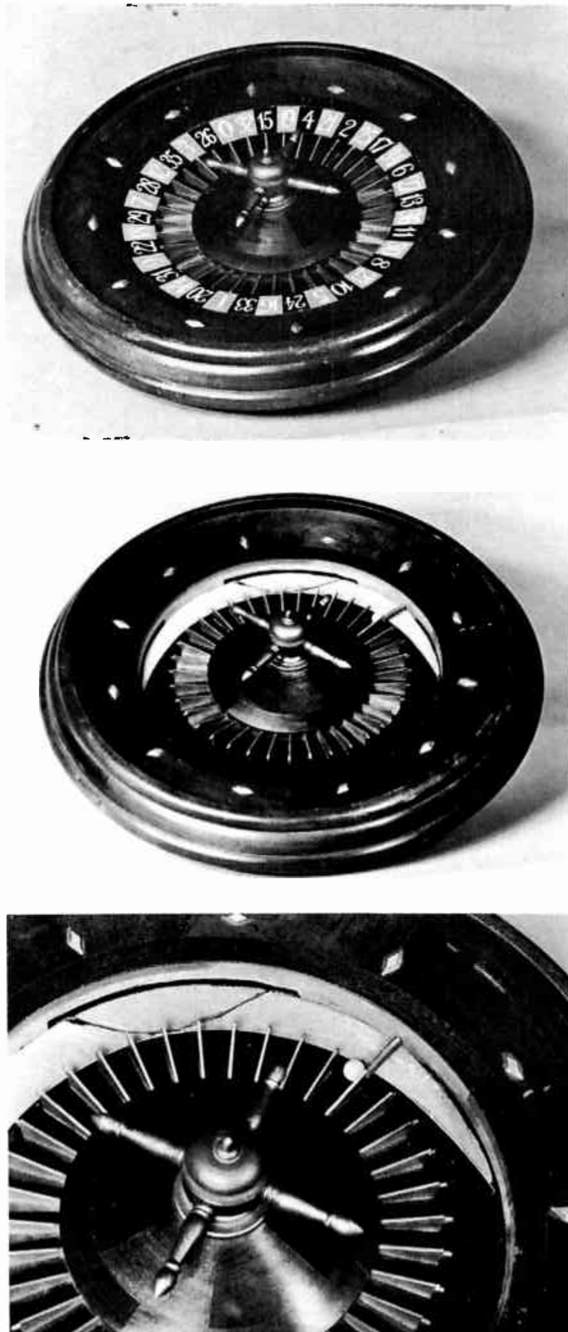
This wheel is designed for use in television plays (lest anyone should be dreaming of the lucrative possibilities), and the action is undetectable if the wheel is used to the best advantage. The operation must be smooth, and the actor responsible (unless it is a cut-away shot) should be coached in the art of spinning a roulette wheel. It must not be too fast nor should it be too slow. A gentle action ensures that the ball drops in and goes to the right compartment in more or less one complete revolution. Furthermore, attention must be given to the lighting. It is vital that a wheel of this kind is designed in such a way that the whole thing glitters. The compartments with shiny black floors and golden dividers amply camouflage the momentary disappearance of the ivory ball, and the fact that there is a black cavity under the numbered ring passes unnoticed even in close-up. It appears as the black peripheral retaining wall.

Props of this nature cost money and take time to build. They should be used properly, and a good director will take pains to get the most from them. After all, if there is drama to be had from a shot of a certain number coming up on a roulette wheel it is more effective to stay with it than to cut away to a croupier merely calling the number.

Science-fiction lights

Science fiction is a subject so extensive that it would be possible to devote whole volumes to the sort of effects that might be

A roulette wheel designed to give a pre-selected result. See page 45.



incorporated in TV plays and serials. Nevertheless, present conventions dictate that there should be flickering lights in every control room, and so TV and the movies employ these flickering-light effects in profusion!

There are many ways of obtaining them. The most common in present use is the battery-operated lamp with an internal thermostat which causes the light to flash on and off. These are cheap and offer a simple means of getting random flashing lights.

When specific travelling patterns or sequences of lights are wanted the problems are more complicated. Rotary switches can be purchased or made, but they are often expensive, and in any case involve a great deal of wiring. An alternative is to direct a powerful studio lamp (or projector) from behind, via a motorized mirror, on to a display of imitation lamps, which can be either Perspex windows or glass domes set in panels.

Another random method (but this time restricted to equipment placed in the background) is to hang sequins on cotton, where they will move naturally in the convection currents in the studio. Sometimes dramatic action can be obtained by punching holes in the tops of small metallized-plastic patterns which are hung on pins on a board and blown by a small fan.

Shaking equipment

This type of prop comes in all shapes and sizes, from demented alarm-clocks to uncontrollable washing machines.

Two methods worthy of mention both depend on electric or spring-wound motors for their operation. The first has an off-centre weight attached to the motor spindle. This causes the motor to set up vibrations which are transmitted to the item in which it is installed. The second has a cam which, by driving a peg that is in contact with the ground (or something solid), causes the motor and its prop to leap up and down. Sometimes it can be arranged that the prop is on spring feet. This is often necessary where the prop must be seen to vibrate but must not leave its position. In this case the springs are attached to a sub-baseboard, which in turn is fixed to the floor.

If a spring-wound alarm-clock is required to leap about it might be impractical to drive it by an electric motor requiring supply leads. In such a case the motor, either the original spring-wound device or a self-contained battery motor, could be activated by a pin withdrawn from below.

Water in the studio

In the normal course of events people are quite used to seeing water. It flows from taps and runs down plug-holes; it spouts from fountains and it flows into gutters. So when water appears on the TV screen it occasions no great surprise. But for the effects designer some of the most mundane usages of water can cause considerable problems. First there are the problems which arise when water is being used close to scenery, painted floors, studio lighting, cameras, etc., etc. Secondly, there are the problems of getting water *to* the effect and then disposing of it.

Apart from rain sequences, the sort of uses likely to concern the effects man are those in which water squirts from burst pipes, plays funny tricks in conventional plumbing (e.g. flows from one wash-basin to another), or is used in simulated ponds or streams wherein some special effect must occur (e.g. machine-gun bullets in water).

If a scene is to be unusually messy a tarpaulin can be spread on the floor and overlaid with surfaced hardboard. If the tarpaulin is a good one it can have its edges raised on wooden battens to form a catchment area which will hold the water. It is, nevertheless, advisable to put absorbent material *under* the tarpaulin, as water is sure to find its way through punctures or nail holes made inadvertently when the set is first erected.

It is undesirable to run long lengths of water-filled hose across a studio, and so those effects requiring water are often fed from suitable reservoirs situated behind the set. To control the flow of water, taps or cocks may be fitted to these tanks, but it is sometimes much better to have a tank of water coupled directly to the effect by a flexible pipe, but *without* any taps or valves at all. The tank in this case is supported by a rope which allows it to be raised or lowered. This means that the flow of water is controlled entirely by the changing head of water. It also means that not only can the rate of flow be speeded up or slowed down but that it can be reversed without the need for additional piping. Taking the example, previously mentioned, of the plumbing gag, one can picture a bewildered plumber clearing one sink and watching water rise in the one next to it! (A separate tank is required for each sink.) One advantage of this moving tank system is that only a specific volume of water is involved and that an accident could not result in large-scale flooding. Very rapid filling or emptying action can be effected if a large-bore hose is used to connect the tank to the effect. Alternatively, a number of small-bore hoses will give similar results.

This method may be employed in many ways. Another example features a cooker on which a saucepan is required to boil over. A pipe secreted beneath the saucepan connecting it to a small movable tank permits the liquid in the saucepan to flow over on cue. It also allows the two separate vessels to be filled with chemical liquids which on mixing would froth. A raised portion somewhere in the pipe prevents pre-mixing of the chemicals.

For a small amount of water, particularly where it has to squirt, the ordinary domestic soda-syphon is commonly used. (The telephone which squirts water must be familiar to everyone.) It is simple to rig and may conveniently be operated by the performer himself. Should coloured liquid be required and a rechargeable syphon is not available, a separate container can be connected between the syphon and the effect. This container should have an inlet at the top and an outlet at the bottom, but should otherwise be sealed (it can, of course, be filled from the inlet pipe before the connections are made). To prevent dilution of the coloured liquid by the soda-water, the syphon may be operated upside down. This releases only the compressed gas.

For the comedy effect where the studio or scene becomes flooded, a narrow, double-sided, glass tank can be placed in front of the camera lens. On being filled, the rushing, rising water can look as if it extends over the entire scene. It is, of course, principally a comic effect, but situated behind ships' portholes or submarine "windows" the results can often be thoroughly convincing. The water may be poured in from a position outside the picture, but it is better to use the raising and lowering supply tank method whenever possible.

A shallow tank consisting of a single sheet of plate-glass with a three- or four-inch surround may be used whenever it is required to peer down into water. Assume that we look into a pond and that on the bottom lies a dead body. For this dramatic effect the actor or actress lies on the studio floor, which has been suitably dressed with stones and plastic ferns, while, above, the glass tray is supported on legs or blocks. An inch of water, gently rippled in the glass tray, produces an effect comparable to that of a real pond or river and even the static weeds appear to ebb and flow.

2

DRY ICE EQUIPMENT AND EFFECTS

DRY ice is supplied in blocks weighing about 25 lb. Primarily it is intended as a refrigerant for ice boxes and cold stores, and it has a temperature of approx. $-79\,^{\circ}C$. It is carbon dioxide gas which has been subjected to pressure and temperature changes, causing it to solidify. When it is immersed in hot water the gas is liberated and, taking up a great deal of moisture, becomes the dense white clouds beloved by choreographers and effects men.

Carbon dioxide is a heavy gas and will settle in low-lying areas. It is impossible to breathe in areas of high CO_2 concentration, and as it excludes oxygen it also extinguishes fires and gas burners.

Dry ice should not be handled with the naked hands, because it can cause frostbite. Blocks to be broken into pieces should be wrapped in sacks and broken with a hammer.

Although well known in connection with the familiar dream sequence effects, dry ice has a variety of other uses. As well as being a portable source of low temperature, it can also supply the means for producing pressure. It provides the harmless ingredient for foaming drinks in comedy scenes, and it can be made to simulate steam in cooking utensils.

Dream sequences

The dream sequence has become part of the motion-picture legend. It epitomizes the Hollywood musical era in which glittering stars cavorted through acres of fluffy white clouds. There is no doubt, however, that this timeless effect is just as popular on present-day TV. Tastefully handled, it can still be endowed with almost magical qualities.

Dry ice clouds, being both heavy and cold, tend to flow like liquid. Therefore retaining walls must be erected if the clouds are to be contained within a specific area. Narrow scenic flats stood on

A dry ice scene in the studio.

edge usually suffice to keep the clouds in and the draughts out. Even if it is not possible to place these walls in shot, it is usually a good idea to spread them out from the camera and around the edge of the shooting area.

Dry ice clouds are kicked up by energetic action, and care must be taken if the floor is to remain hidden. Overall floor painting camouflages any bald spots, but it sometimes helps if the atmospheric conditions in the studio are controlled. Dry ice clouds form better and last longer in a cool damp atmosphere. Anything, therefore, that can be done to lower the studio temperature or create more humidity ultimately improves the effect, and in winter this can sometimes be achieved by opening studio doors before the scene is recorded.

It is easy to commence a scene with the full treatment, but if a shot is to last more than, say, half a minute, the dry ice must somehow be sustained. With modern dry ice generators this is not difficult, but it is wise to study the positioning of the machines. Generators placed on either side of the picture replenish more obviously than those placed below or just to either side of the camera. In panning shots it can be arranged that large doses of cloud are injected into areas not being seen by the camera, but for static shots it is better to top up with a steady flow, and a flexible supply hose can be used to great advantage.

It must always be remembered that dry ice clouds are essentially composed of water. Anything therefore that is likely to be affected by moisture should not be included in such scenes. Some floor paints tend to run or get tacky when exposed to prolonged dry ice effects, causing artistes to slip and drapes to become soiled. There is also an obvious danger where electrical supplies are involved.

Dry ice generators

The simplest method of releasing dry ice clouds is to put pieces of dry ice into a container of hot water. In a small container the effect is short-lived, as the water is quickly robbed of its heat and eventually freezes. It is necessary therefore to have either a sufficient volume of water or some method of keeping it hot. In television's early days it was common practice to heat large tin baths of water over gas-burners. This worked well enough in a rough and ready fashion, but the gas burners were smothered as soon as the CO_2 was liberated. This meant that they could be used only for pre-heating, and could play no part in sustaining the effect. Woe betide the effects man who forgot to turn off his burners and was reminded by the smell of gas! Fumbling around beneath the fog, he was always sure to find the hot iron burner before locating the tap.

It is possible to construct a simple dry ice generator from a galvanized-iron dustbin. Suitably insulated and provided with an immersion heater, it can work well and is cheap to make.

If something ready made is required there are small domestic clothes-boilers which have proved quite satisfactory without any modification. A slight disadvantage is that they seldom hold more than about five gallons of water. Ten to fifteen gallons is a better measure. It is obviously necessary to have as big a heater element as possible, as the time taken to reheat water can be embarrassing when a scene is under way. However, the wattage of the heater may well be limited by the power supplies available. In any event, the heater should be thermostatically controlled (about 80–90°C is favoured, never boiling point, as this causes too great an eruption), and warning lamps should be incorporated to show whether the equipment is in operation—or whether the power supply has fused! A further refinement is a tap for draining.

A dustbin with an inner, insulated liner and fitted with an immersion heater may be used to generate dry ice clouds.

In use, this type of generator relies on simple manual control. A plastic bucket pierced with holes is first filled with broken dry ice and then lowered into the water. This produces copious clouds which flow over the top of the container and swirl around the floor. As these clouds must usually be directed into a specific area, a box should be built having a separate lid and a hole in one of its sides. A long "snout" or large-bore tube from this hole ensures that the effect is uni-directional.

A great deal of loose water forms around this type of generator, and it is essential to ensure that all electrical connections are safeguarded.

Another method of producing dry ice clouds is to employ live steam. Steam is obviously less easy to come by than electricity, so this type of generation is less popular than the water boiler; but it has many advantages and, where steam is available, is a thoroughly worthwhile and economical system to use. Its advantages are that it is almost silent in operation, it requires no time to heat up, it functions steadily without the diminution caused by cooling down, and it is naturally directional, as the steam pressure blows the clouds on to the scene.

The steam generator is simply a long wooden box with a hinged lid. It is internally lined with fibre glass or zinc to make it water-tight, and has an outlet for the effect at one end, and an inlet for the steam at the other. The outlet can be a short length of metal drain pipe about four inches in diameter, while the inlet is usually a piece of iron tube with a suitable connection for the steam hose and a local valve to control the flow. This piece of iron tube should run the length of the box and its far end should be sealed. Holes drilled along the length of the pipe allow steam to flow into all parts of the box. The tube should be placed near the bottom of the box (about two inches above the floor), and above this can be suspended a wire basket containing the broken dry ice. A more elaborate arrangement can be made where one pipe feeds steam to the front of the box and a second pipe supplies steam to the rear. With two separate control valves the dry ice clouds can be made to rise or fall according to the ratio of steam to dry ice at the outlet.

Some variants of this device have been made for waterfall effects, where the clouds have had to pour down flights of steps or from high positions in the studio. Usually these specials have been long boxes with slots down their length or merely troughs with a steam pipe at the bottom.

In all steam-fed boxes condensed water forms in the bottom. This can be removed by fitting drain tubes which are bled off at intervals.

Dry ice machine

Hitherto dry ice machines have been largely custom-built, but some are now available commercially. They all work on similar principles, however. A tank of water is heated by one or two thermostatically controlled immersion heaters, the wattage of the heaters being sufficient to sustain the temperature of the water when in use. Broken dry ice is loaded into a wire basket which can be raised or lowered into the water from controls outside the box. Fans are provided to waft the clouds from the machine. These fans must be speed-controlled, as only gentle action is required to push the clouds along. Vigorous blowing tends to diminish the vapour.

Machines of this type should be capable of being wheeled about the studio without fear of water being spilled on the floor. They should also be well insulated to retain the heat. One of the most essential requirements is that they should be quiet in operation, and

A dry ice machine which can be bought or hired. *(Concept Engineering Ltd.)*

this applies not only to the fan but also to the dry ice itself, which rumbles and bubbles when lowered into the water. A well-designed machine with internal muffling is quite capable of working with very little noise.

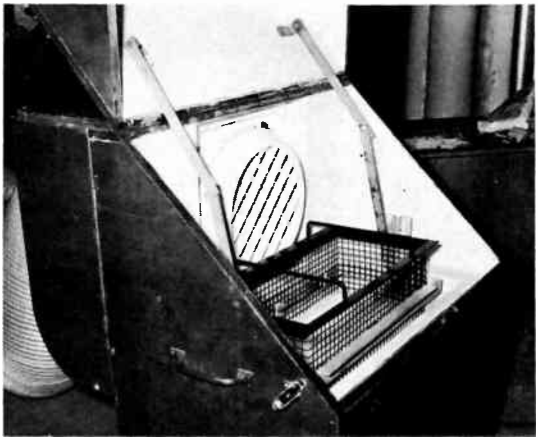
Simulated hot steam

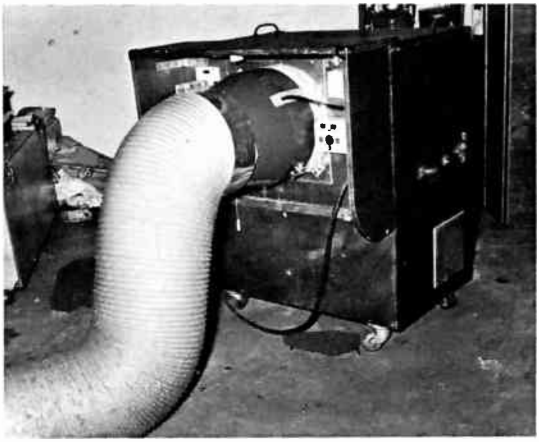
For scenes in Turkish baths or laundries it is desirable to present a steamy atmosphere, and for this it is generally necessary to use smoke. Dry ice will not last long enough to cloud up a large scene of this sort, and is too dense when used in close-ups.

Sometimes it is necessary to show steam gushing from a pipe or machine. Typical is the steam that flows continuously from laundry equipment, or perhaps as a more dramatic example the boiler pipe that fractures in the engine-room of a ship, scalding the unfortunate engineers. For this sort of thing live steam offers the only practical solution. For very quick shots it is just possible to get away with smoke, but where the action is sustained, smoke will quickly fog up the atmosphere.

If live steam is not available in the studio it is possible to hire portable boilers. Only those heated by electricity or gas should be considered. Some of these boilers can be obtained from heating-equipment firms, while others can be bought or hired from firms

A purpose built dry ice machine used in television studies. The removable trunking is used for piping the clouds into confined spaces. The fan can be reversed to blow clouds from the front of the machine. The wire basket (containing dry ice) is lowered below the water level when the lid is closed.





who market the small portable equipment used for degreasing or cleaning industrial plant.

Naturally enough, steam itself is not used in these effects. Steam is invisible. It must be cooled to the point where it becomes water vapour, and for this dry ice can be used to good effect. Broken pieces placed in a suitable container and fed gently from a steam hose will give a very realistic touch to the laundry equipment mentioned above.

For the broken steam pipe it is necessary to accommodate a sealed container of dry ice somewhere in the steam feed just before the point at which the effect is wanted. Usually this container can be disguised as part of the machinery. Care must be taken to ensure that there is sufficient dry ice to last for the duration of the effect, otherwise the water vapour will be replaced by steam—with predictable results.

For certain "steam" effects a small, portable, electrically heated kettle can be made. It consists of two containers (empty paint tins will suffice) mounted one above the other. The bottom one should hold about a gallon of water, which is boiled by an electric immersion heater of the type used in domestic electric kettles. The resultant steam exhausts into the container above through a short pipe, where it plays on to a wire-mesh basket of broken dry ice. This little device is quite useful in a number of ways. It is relatively silent and can be placed in such props as the cannibals' cooking-pot or placed around the machinery in factory scenes, where it lends an air of authenticity.

If such a device is made in the effects workshop the following points must be noted. Should it be switched off for a period after use, there is the possibility that the communicating pipe between the two cans could freeze up. To prevent the lower can from exploding when again switched on, the filler cap should consist of a rubber washer held down by a small weight. This is sufficient to prevent steam escaping during normal use, but serves as a safety valve in an emergency.

The bottom can, which contains the boiling water, should be either thermally insulated or provided with a suitable guard to protect ankles and lino floors. Lifting handles that don't get hot are also desirable.

Low-lying mist

As stated earlier, cool damp conditions favour the production of dry ice effects, particularly in scenes requiring low-lying mist, such as the boggy marshland or dockside on cold winter mornings. Fortunately these scenes lend themselves to the support of low-lying mist, because the large areas of water or moist turf increase the humidity of the studio and cool the temperature by evaporation.

Smoke cooled with dry ice can be used where large areas of mist are to be sustained, but action in these areas quickly disperses the smoke, causing the effect to degenerate into fog. On the whole it is more efficient to use a dry ice machine with its water temperature set low and with a maximum load of dry ice, or a steam-fed dry ice generator set to trickle a constant supply of mist into the back of the set.

In river or other water scenes low-lying mist can be made to adhere to the surface of the water without too much trouble. For mute scenes dry ice can be thrown into the water, but occasionally this produces gas-filled bubbles which float into the shot. It is better to use dry ice generators. They spread a gentle cloak over the surface of the water, which can easily be maintained, because the level surface aids the dispersal of the mist. Furthermore, moving mist seems more appropriate where outdoor water scenes are concerned.

Liquid nitrogen

Liquid nitrogen is a commonly used industrial gas. It is benign and has certain uses in the field of effects. It can, for example, be used to freeze things rapidly for scientific demonstrations. It is better for this purpose than dry ice because, being liquid, it can flow around small articles, producing uniform and rapid loss of heat. It is obtainable in special insulated containers, and for use may be transferred to open vacuum flasks. All containers of liquid gas must be open-topped, because the return of the liquid to its natural gas produces expansion which would burst a closed vessel.

Liquid nitrogen, in cold damp conditions, "fumes" in the same fashion as dry ice in hot water. This means that it can be used to simulate corrosive liquids, providing that the low temperature can be tolerated during use. This low temperature is in actual fact not much of a hindrance, as it is quickly absorbed when it comes into contact with other materials. The rapid exchange of heat which causes it to turn back into gas can be useful when it is required to imitate the pouring of "acid" or even "boiling water". For these effects it can be poured over artistes' clothing with no worse effect than a slight lowering of temperature. It was once used very effectively to appear as boiling oil. Poured from the ramparts of a castle on to actors storming up ladders it looked suitably awesome. It was also used in close-up in a similar fashion when two flasks, one containing a mixture of aluminium powder and water and the other the liquid nitrogen, were poured simultaneously over the clothing of an actor. This "smoking" silver liquid looked remarkably like molten lead.

Dry ice as a propellant

As solid CO_2 returns to its gaseous state it increases in volume. This means that if no more convenient source of pressure is available, dry ice can be used to operate small devices or to produce bubbles in mock chemical equipment. Typical of the latter is the laboratory set-up of glass tubes and flasks filled with coloured liquids.

It needs only a flask of hot water and dry ice somewhere in the circuit to set it in motion. The liberated gas flowing as bubbles through the various components continues for several minutes without further attention.

3

FIRE SEQUENCES AND SMOKE MAKERS

FORTUNATELY for all those concerned with studio productions, fire and smoke effects are now both easy to rig and to control, but at one time many dubious (and often dangerous) contraptions were employed to create smoke and flame, and artistes and technicians were forced to endure conditions that would have tested the stamina of trained firefighters. Pyrotechnics were burned indoors without regard to their hazardous and demoralizing effects, and studios and clothing were impregnated with the smell of burnt sulphur and bitumen. Even the machines that were used to generate the now well-tried and accepted oil smoke would occasionally convert to flame throwers without warning, spewing flame and boiling oil at the long-suffering actors.

Present-day equipment can occasionally malfunction, but there are now numerous safety devices included in its design, and as far as medical evidence can show, most of the smoke is easily assimilated by the human body and passed out without harmful consequences.

It is a relatively easy matter to get dramatic fire effects, but the designer must at all times assess the dangers involved, not only to the actors but also to the operators—who may well find themselves trapped in uncomfortable or dangerous positions if insufficient thought has been given to their means of egress. One of the most common dangers is to the effects man who may walk freely into an area to operate an effect but be unable to leave once the effect has started because his way of escape is blocked by flame. Another dangerous situation arises when a man perched on a high rostrum or near a drop has to leave his position while enveloped in smoke.

All these situations should be thoroughly investigated before attempting to proceed with the shot. Many an effects man, feeling unable to cry out or even move during an important sound take, has suffered for his art with singed eyebrows and scorched clothing, and this is a condemnation of the original planning.

Where gas forks are to be deployed around a set it is essential in the interests of safety to have sufficient staff to ignite and control them. It is wise to ensure that each man is responsible for only those burners and taps which are within his easy reach. He should never have to light burners while leaving others unattended, and wherever possible it is sensible to arrange for one man to switch on while a second one ignites. This is particularly important where bottled gas is being used, because any delay in ignition can cause pools of gas to form, with alarming "flash-over" consequences.

Smoke-guns

Machines for making smoke have been in use for many years, not only in the entertainment business but also for military, scientific, and agricultural purposes. One popular smoke producer used for outdoor filming is in fact a machine for spreading insecticide.

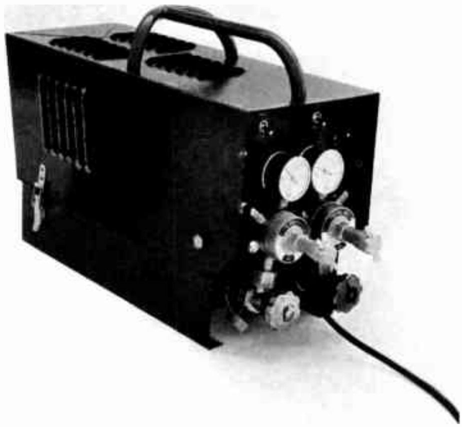
Only recently have specialized machines become available from commercial sources: consequently, many of those in use in television and film studios have been developed and made by the special effects men to meet their own requirements. Some machines are large and capable of producing vast quantities of smoke, while others are small, sometimes hand-held, and used only for models or small patches around actors.

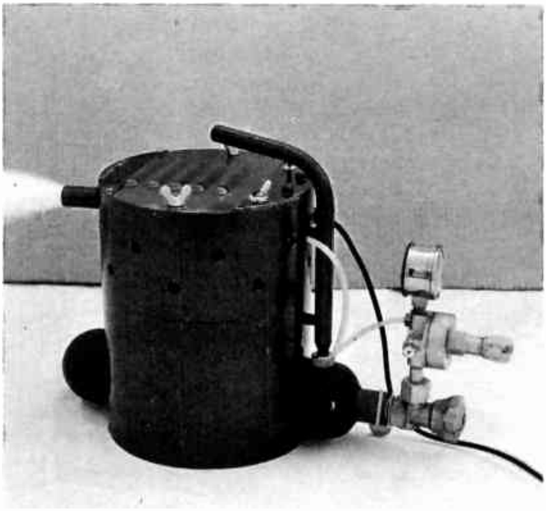
The fuel for smoke-guns (as they are usually called, whatever their size) is generally a mineral oil which turns to smoke when heated.

Guns for use in the studio are usually electrically heated, and in the majority of designs a heat store is incorporated in the coil, allowing the gun to be operated for some minutes after it has been switched off. This is particularly useful, as it allows the operator to work without the trailing lead.

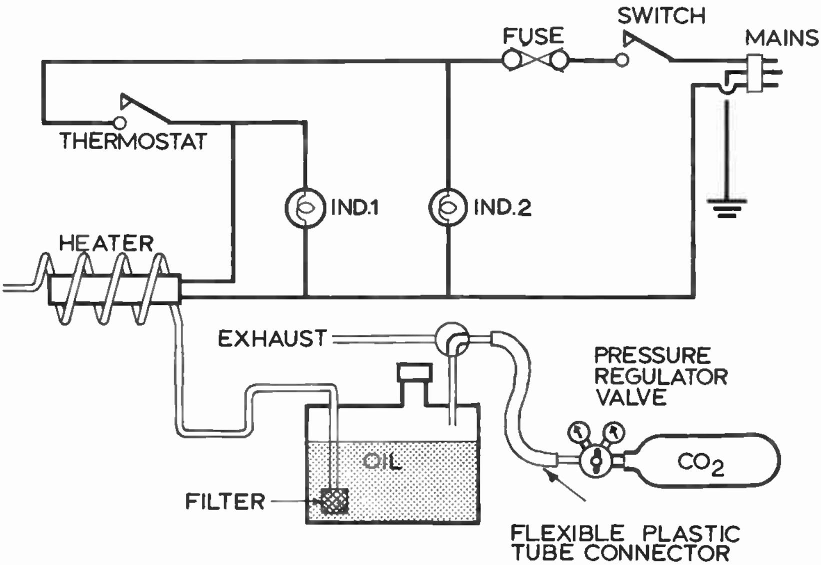
A smoke-gun should never become a flame-thrower, and one of the tests for safety demanded by at least one authority is that when in operation the gun can be pointed directly at burning material without increasing the fire. In one machine carbon dioxide (used to propel the oil) is introduced into the smoke to smother any flame.

Smoke machines specially developed for studio use. *(Concept Engineering Ltd.)*





Most guns work in the following manner. Oil in a sealed reservoir is pressurized by bottled CO_2 and flows to a "head" via a fluid control valve. The "head" is usually a fine copper or stainless-steel tube coiled around a heater, or is the male thread of a cylinder inserted into a non-threaded female. The heat is controlled by switches and thermostats, allowing for variable settings. Indicator lights show whether the gun is ready for use.



Most smoke-guns are built on similar lines to the layout shown here. An electric heater is surrounded by a fine tube through which oil flows under pressure. Passing along the tube and becoming progressively hotter it eventually emerges as smoke. The oil is contained in a pressurized compartment with screw-on filler cap. The connection between this container and the CO_2 cylinder is flexible. This facilitates the changing of the CO_2 bottles and also provides a secondary safety valve.
The switch lever that controls the smoke is a valve of special design. In the "on" position it allows pressure to flow to the oil tank. Returned to the "off" position it cuts off the pressure to the oil tank and opens an exhaust port to de-pressurize the container.

Unvaporized oil issuing from the nozzle is often a problem, and only the most efficient guns are faultless in this respect.

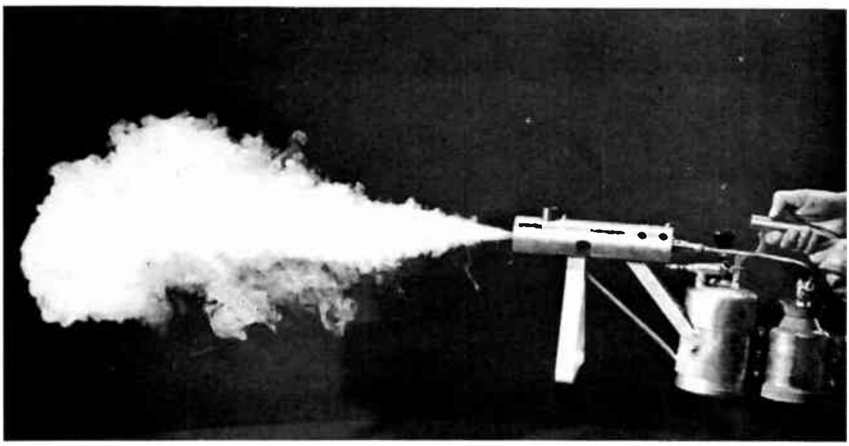
Various attachments can be fixed to the front of some machines. They include plastic hose to pipe smoke to inaccessible or remote places, with traps to filter condensed oil; baskets which, when filled with solid carbon dioxide, cool the smoke and so cause it to stay low; and various shaped outlets for distributing the smoke (for example, a spreader to go under a door for a burning-room scene).

Small hand-held guns have been made and have waxed and waned in popularity, but the present trend is towards medium-sized machines which are easy to carry and capable of producing either large volumes of smoke or small puffs.

A prerequisite of any machine used in the TV studio is that it shall be silent in operation or at least have an operational noise level which does not interfere with recorded dialogue. It seldom matters in the crackle and confusion of a big fire scene, but where smoke has to be topped-up during a quiet episode in the fog, the hissing of a smoke-gun can easily mar the sound track.

Smoke-pots

For battle, fire, and fog scenes which have to be filmed out of doors there is a wide choice of pyrotechnic smoke-makers, usually called smoke-pots or smoke-canisters. They are pyrotechnics which have their materials and cases specially designed to promote inefficient combustion, resulting in thick clouds of white, yellow, or



A well designed, hand-held, smoke-gun. Heated by gas from a disposable container the pressure is supplied from a converted garden spray.

An assortment of pyrotechnic smoke canisters.

black smoke. Many types of smoke-pot are available, and they vary in size, duration, colour of smoke, method of ignition, and, of course, price.

All pyrotechnics must be considered potentially dangerous, and smoke-pots are no exception. They spit fire and deposit burning material around them, and sometimes even erupt violently. It is not unknown for burnt material to choke the outlet and cause the case to burst, although this is usually confined to the black (naphthalene) smokes and those canisters which are made of metal. Smoke-pots should never be held in the hand, nor should an operator position himself so closely to a burning pot that he is likely to get burned should an explosion occur.

Smoke-pots should not, of course, be restricted in any fashion, although they may be burnt in a variety of objects.

Large smoke scenes can be expensive, not only for the smoke that it used but also for that which is unused. Allowance must be made for enough smoke to cope with any conditions that may arise during a period of filming—and that necessarily means over-ordering.

The choice of smoke-pots is a matter for some consideration. The operator has to judge whether he would prefer a long-burning firework (when the scene might be "cut" the moment he gets going) or shorter-duration pots (knowing that he would have to light these at intervals during the take).

If smoke has to appear in various places in a single shot the choice of pyrotechnic smoke is almost automatic, because the provision and operation of several smoke-guns would be impracticable, but for large flat areas of smoke or fog it is possible to use either smoke-pots or a large smoke-gun, or even a combination of both.

Electrically ignited smoke-pots are more expensive than those supplied with fuse, but they have advantages when smoke-pots have to be sited in difficult or high-up positions. They also enable one operator to fire a number of pots, either packed together or dispersed, simultaneously; but it must be remembered that electrically fired devices must have leads attached to them, and the layout of long runs can be both time-consuming and provoking—particularly if the leads keep appearing in shot. This applies mostly to open country, where it is often difficult to disguise long run-outs of cable without recourse to burial.

Most commonly used are the pots that have a short length of quick-match, for ignition, and it is preferable for this fuse to be lit with a portfire rather than a match. Matches tend to break and blow out, and in any case with a match the operator's hand is too close should there be a rapid ignition.

Smoke-pots will fail to smoke if the escaping gases catch fire. This sometimes happens if the paper or card top ignites, but usually the fire is extinguished when the pressure builds up. Smoke-pots should face neither each other nor any material which will burn. The exception to this rule is when it is necessary to douse the smoke. A collection of pots can be kicked together so that they may ignite and feed each other, burning up the smoke as it is produced.

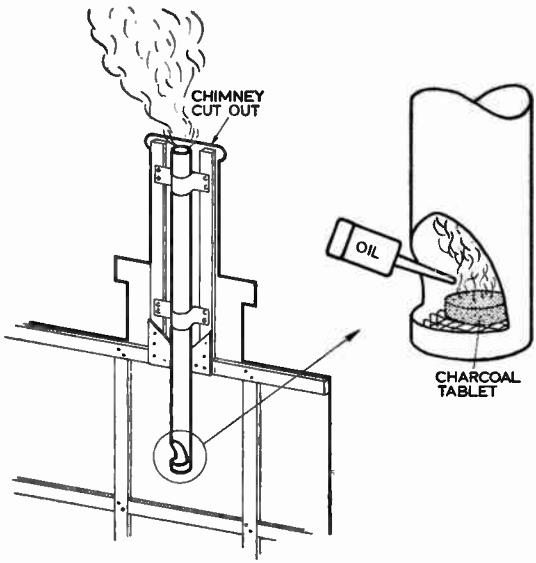
Smoke pellets

The effects man sometimes needs pellets or capsules capable of liberating small amounts of smoke, and although some such pellets exist, the perfect article has yet to be produced. One of the favourite devices is a pellet about $\frac{3}{4}$ in in diameter and 1 in high which can be lit with a match. Manufactured for the purpose of testing ventilation plant, it is composed of crude DDT and other ingredients and gives off a non-toxic, heavy white smoke that is excellent both photographically and for simplicity of use. It should not be used in confined places, as it has an irritating effect on nose and throat, and being a DDT material, must in any case be considered undesirable where it will be inhaled. Its use for model-shots and scenes where it can be quickly ventilated away need not be ruled out. These tablets release a fairly large volume of smoke, but burn for only thirty seconds.

A charcoal tablet kit. The burning tablets treated with oil or gum will give continuous smoke for up to 30 minutes. They can be used for "burning food", smoking chimneys, studio fires, etc.

More useful where smoke is required in smaller amounts, but for longer periods, are the charcoal tablets sold for use in ecclesiastical incense burners. They are composed of compressed charcoal, usually circular, and are sometimes treated with a chemical to assist ignition. They glow red-hot when alight and give off no smoke at all. (This useful factor means that they can often be placed

Prepared charcoal tablets may be left unattended for long periods. They are ideal where chimneys have to smoke throughout the action of a long scene.

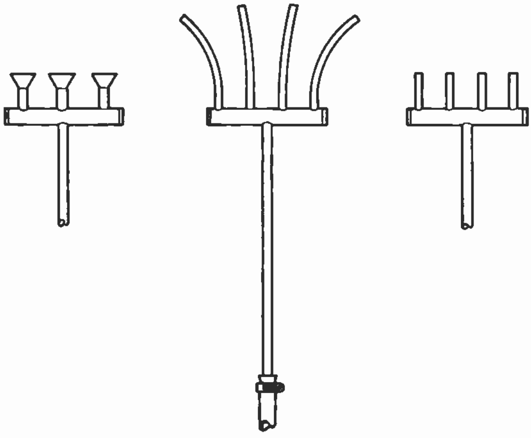


in position before they are required, without their being noticed.) When a few drops of oil are poured on to the surface the tablets immediately smoke and continue to do so for up to half an hour. They are particularly useful for smoking chimney-pots, fireplaces, industrial scenes, engine rooms, etc., and have also proved useful when burning food is snatched from the oven. For convenience the tablets can be kept in a box which also contains burning tray, asbestos mat, oil, and matches.

Flame-forks and burners

Flame-forks are burners which, connected by flexible hoses to either piped or bottled gas, produce various sorts of practical flame. They are usually based on the "Neptune's trident" pattern, and can be laid in fixed positions or manipulated by an operator to produce moving flame patterns.

A useful length for the main tube is about 3 ft, branching into three or more smaller tubes approximately 6 in long. A separate air intake (as on normal gas-burning equipment) is not desirable, because it is better photographically for the flame to be of burning gas only. The same forks will therefore burn both piped and bottled gas. Thick-wall rubber tube is used for the supply pipes because it does not kink, makes better gas-tight connections, slips over the metal pipes easily, and stands up well to studio wear and tear.



Some typical flame-fork designs.

Plastic pipes are not satisfactory, because they melt if they come into contact with the hot metal of the flame-forks.

The total amount of flame that can come from any design is determined more by the pressure and rate of gas supply than by the shape, and the chief purpose of any burner is to concentrate or disperse the flames according to need.

When the effect of widespread foreground fire is required an operator positioned below the camera can wave one or more forks around to give a random pattern of flame, implying much more fire than actually exists. The viewer, seeing flames leaping up at rapid intervals and stretching the width of the frame, is not to know that they come from a single flame-fork skilfully manipulated.

For flames in a static position the forks can be laid on the ground or fastened to props or scenery. A door post, for example, might have a small fork fitted to the bottom so that flames climb up the post as the gas is turned up. If forks are made from soft copper they can be bent to conform to their surroundings.

Where gas forks have to be ignited remotely, suitable pilot burners can be fixed alongside. These should have separate supplies and controls clearly identified so that in the general hurly-burly one gas tap is not mistaken for another. It is seldom satisfactory to turn down flame-forks to burn minimally until required in action. Large-bore pipes with low pressure tend to have flames that easily blow out. It must be remembered that coal gas rises and bottled gas sinks when positioning the pilot jets.

For small effects (e.g. flames coming from the electric toaster), ignition of miniature burners can be achieved by using the tiny platinum-filament unit which forms the business end of most battery-operated commercial gas-lighters. One such arrangement was used for a candle which had to light itself on cue.

Flares

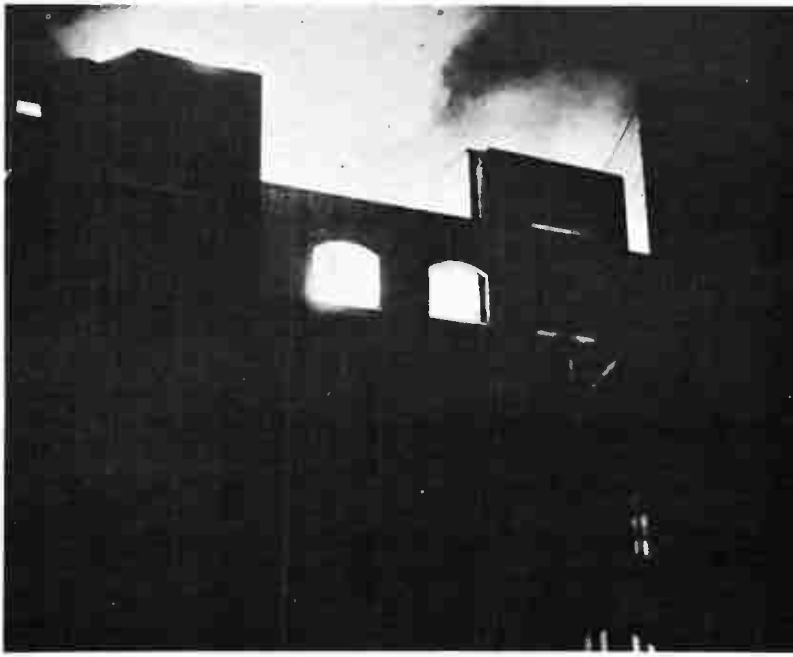
Photocine flares are used to illuminate scenes on location where it would be difficult to take heavy lighting equipment. An example might be a night scene in the mountains, where normally it would be impossible to haul a generator. The flares are usually constructed with a hollow end which allows them to be stuck on broomsticks and held to the required working height. They have a powerful lumen output and burn for about two minutes.

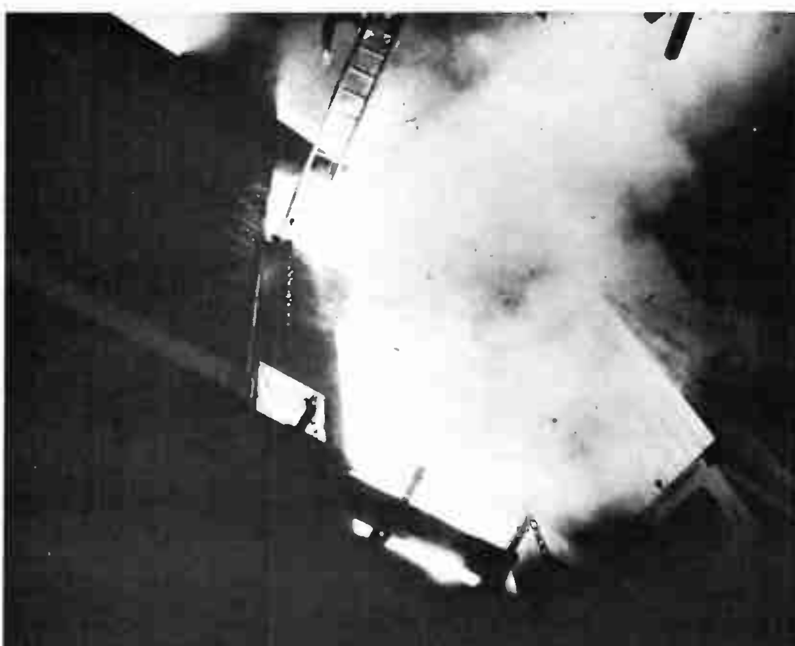
Their usefulness to the effects man lies in the fact that they produce white smoke when burning, and so provide an excellent combined smoke and flame-simulator in one compact cartridge with a useful duration. One or two of these, placed in steel trays and sited behind windows, can produce a burning building effect indistinguishable from the real thing.

Should a shorter duration of burning be required, the flare can be sawn into lengths (the untreated ends can be ignited by a portfire). For longer burning time, several flares can be laid end to end in a pile of sand (which stops them rolling), the hollow ends having first been removed with a saw. This provides better continuity than lighting individual flares to cover a take.

Flares should be used only for outdoor (non-studio) work and, if they are to simulate a fire in a building on location, adequate ventilation must be available because the smoke in heavy concentration

A photocine flare supported in an asbestos tray. This arrangement would not suffice if the floor could be damaged by sparks or heat.





is bound to be a health hazard. The smoke does not normally create much of a dirt or smell nuisance, and photocine flares have been used extensively in empty houses and factories without affecting the fabric.

A considerable amount of white powder builds up around the flares while they are burning, and it is usual to lay them in steel trays partially filled with a layer of sand about 2 in thick. The sand, besides serving as a heat insulator and providing a non-roll base for the flare, also allows the white powder to be dealt with by stirring the sand.

The steel tray should be about 2 ft long by 1 ft wide and at least 6 in deep. It is better to put these trays on larger sheets of asbestos if they are to be used on a wooden floor.

Like all bright sources of light, flares can be injurious to eyesight, and it is obviously sensible to position them where an actor or operator will not have to stare directly at them.

Hot-wire smoke

Sometimes smoke is required in a place where it is impractical to pipe it from the smoke-gun, in which case it is often possible to use a heated wire which has been treated to give off smoke. This wire, usually nickel–chrome resistance wire, is sheathed in fibre glass or woven asbestos sleeving which has been lightly wetted with smoke-oil. The wire is heated from a low-voltage, high-amperage supply, such as a car battery or transformer, to a temperature sufficient to cause the oil to smoke. (If the wire gets too hot there is a danger of the oiled sleeve bursting into flames.)

There are many applications for this technique, as the wire can be either stretched out or wound around other components; for small work it can be coiled spirally into quite short lengths.

Three examples of its use on TV were: (*a*) a lead to an electric soldering iron which had to burn out; (*b*) a xylophone which had to emit smoke when played energetically by a comedian; (*c*) a ball-point pen which had to melt and smoke when thrust into a "laser-beam".

For the soldering iron the lead was simply run into the handle and out again, terminating in a plug on a workshop bench. The plug was not practical (although it could have been), and heavy leads

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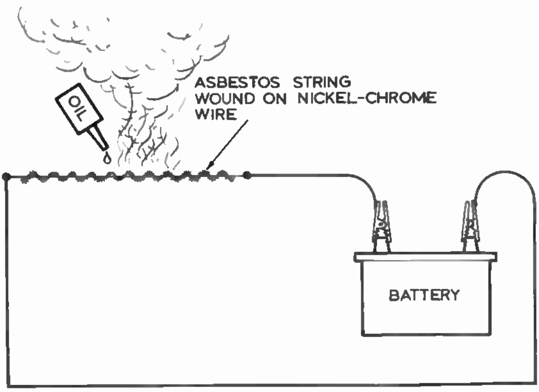
◀ A disused warehouse used for location filming: The blaze was simulated entirely by photocine flares and smoke-pots.



A method of producing smoke in remote or inaccessible places.

from the back of the socket were connected to a battery when the effect was required.

The xylophone, which was fully practical, had the wire stretched below the notes, and the supply was controlled by a heavy duty, sliding rheostat to bring it up slowly. The smoke, which rose from the entire length of the instrument, appeared to be coming from the notes themselves, and even a close-up failed to divulge the real source. Hidden supply leads were taped down the backs of the legs of the instrument and were taken away out of shot along the floor. No other form of smoke production would have been as convenient for this particular requirement.

The last example required a very carefully made prop in the form of the ball-point pen (or rather pens, as there had to be several of them to allow for rehearsals and retakes). The barrel of the pen consisted of a fine coil of steel wire, around which had been cast a body of paraffin-wax finished to resemble a duplicate pen used elsewhere in the action. The trick pen had its leads protruding from the cap, and during the take these were hidden by the actor's hand and secreted up his sleeve.

When the pen was placed in the "ray" from the invisible "laser source" the current was switched on, causing the wax to melt and smoke in a most convincing fashion.

The supply leads to any such hot-wire device must necessarily be of heavy-gauge copper to reduce the resistance of that part of the circuit which has to stay cool, and this is about the only disadvantage to a very neat and effective way of getting smoke on cue.

Flame loops

Fire can be added to a scene by superimposing flames which have been prefilmed for use on telecine. Filmed "loops" are discussed on page 206, and it will be seen from the examples quoted there that the technique of adding to a picture in this way is quite a versatile one.

It is possible to film an area of fire or flames which may later be superimposed over any specific part of a picture in the TV studio (providing, of course, that the flames have been filmed in the correct relative position). Normally, however, stock flame "loops" have flames which emanate from the bottom of the frame. These appear in the combined picture as occurring *between* the action and the camera. In light scenes the flames are transparent, but against a dark set they look authentic.

Superimposed flames are particularly useful in operatic scenes (where singers exhibit an understandable antipathy to smoke), comedy sketches, and dance routines. It can be appreciated that flames capable of being brought in and taken out at the touch of a button find great favour with harassed directors.

It must always be borne in mind that the use of the "loop" precludes any mobility of cameras. The camera recording the main scene must not pan, track, or zoom while the flames are being superimposed. The reason for this is that should any such movement occur, the flames would appear to travel in sympathy with the camera movement. Switching from camera to camera is also prohibited unless the superimposed "loop" is faded out beforehand or is removed at the moment of switching. To clarify this, one can take the example of the operatic scene. A tenor, carolling his way into Hades, is seen in long shot. Flames leap upwards from the bottom of the frame, apparently in front of him. He is able, in this shot, to walk towards camera, or down a flight of steps, or even from side to side, but the camera must never pan with him. The director might now want to cut to a close-up of the singer's face, and so the change of cameras is made and the flame "loop" is taken out, freeing this second camera to move in any way required.

To retain continuity it would be sensible to use a flickering-light effect on the singer's face during the close-up shots.

Flame-drum

Outdoor fire sequences allow the effects man considerable scope, but when it comes to indoor commitments there usually has to be more improvisation than actual fire. On these occasions the flame-drum offers a means of lighting the set with a flickering effect which, coupled with smoke, can give a fair simulation of wide-spread conflagration.

A simple flame-drum can be made in the following fashion. A strip of black paper (say 1 ft wide by 6 ft long) has slits cut along its entire length. The slits should be wavy, cut diagonally, and stop about an inch from either edge. The paper is now joined end to end to form a cylinder, and to keep it in shape a disc of hardboard is fastened inside at the top. To operate, the drum is hung from a conveniently high point in the studio by a length of string and is then rotated until the string is wound up.

Allowed to spin freely, the drum revolves as the string unwinds, and if a lamp is placed behind it the light pattern formed by the slots passing in front of each other gives an effect of flames flickering upwards. Two or more such drums used together give a random pattern that disguises repetition.

A more robust design incorporates a drum made from clear rigid plastic sheet. Mounted on a top and bottom axle, it can be motorized with a speed control, and instead of the slots, the flame

A motorized drum which, when stood in front of a studio lamp gives the effect of flickering flames.

pattern can be painted directly on to the drum with water-soluble paint. (Other patterns can be applied in similar fashion for other effects.)

Model fire sequences

If they are to look convincing in a model shot, flame and smoke must be handled with the greatest restraint. First, it must be appreciated that flames and smoke do not scale down well, either in performance or in texture. Small flames do not look like big flames, and changing the speed of filming rarely lends conviction. Slowed down, small flames take on an oily quality and the movement of smoke becomes quite unreal.

Burning buildings are obviously easier to cope with as models than such things as motor-cars. The cost of building a good scale-model car of sufficient size could be almost as great as its life-size counterpart, and furthermore, if it is the sort of model that can be ignited only once the operation becomes risky as well as uneconomic. Wherever possible, allowance should be made for the retaking of any burning model shot. Even with two or more cameras turning, it is unsafe to assume that the burning sequence will go perfectly first time.

Sometimes a model fire sequence can be shot without any practical flame at all. One method is to "back-light" white smoke. Useful for burning buildings and towns, it relies upon suggestion created by a model silhouetted against a roof-top glow. A cut-out (or series of cut-outs placed in front of each other if a crabbing movement is required) is positioned at lens-height in front of a black backing with sufficient space between the two to house a floor-mounted lamp. Just before the shot is required this space is given a light puff of smoke, which should drift naturally in still air while being heavily back-lit by the lamp. Heat from the lamp causes smoke above it to rise, and gives an effect of realism that is acceptable if carefully set up and used sparingly. It is effective only for night-shots.

Another way to get realism without using practical flame on the model is to employ back projection. Suppose a large model, which is to be seen as part of the background set in the TV studio, is to be shown with two rooms on fire and later with its roof burning. This could be achieved in the following manner. The model house (or, more likely, a painted cut-out) is set up in a large studio (or outdoor, open space) with its back to a film camera. Behind the cut-out

A fire sequence on a small model. This shows how the form and texture of flames will change when scaled down.

windows and roof are placed piles of material to burn (or flame-forks). These are situated well back from the model so that they may have the correct proportions of flame and smoke. Their exact positions are checked through the camera viewfinder. The model is then removed and the camera, which is now locked off and focused on the flame, records the burning for the period required. This film is used later in the TV studio on back projection with the screen set behind the model, which is now installed as part of the set. This method can be used for both day and night shots, but is effective only where the original film camera and back-projection equipment both give steady pictures. To minimize any judder, the picture area should occupy as much of the frame as possible.

It is not always necessary to split this operation into live model and pre-recorded back-projection film. Many satisfactory shots have been shown on television where a model building with cut-out windows has had small fires placed farther back in the studio. Provided that only one camera, and that in a static position, handles all the fire shots on the building, the effect can be reasonably realistic.

Where model buildings, towns, ships, volcanoes, etc., are to be made and fired as separate filmed inserts the golden rule must be to make them as big as possible. Care must also be taken to ensure that the materials chosen to build the model react in the same way as the real materials would behave. Concrete walls that curl up when on fire look pretty silly! This can also apply to such things as the rigging on a ship or telephone lines to a building. Made from cotton or string, they flare too rapidly and appear obviously unreal.

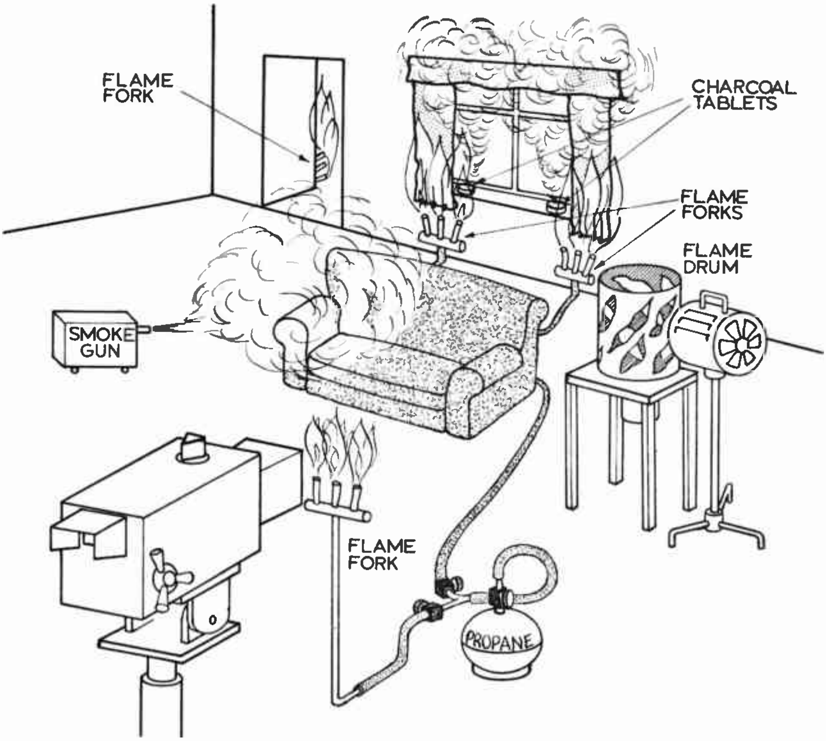
Where applicable it is generally advisable to construct models, which have to be used in burning sequences, from incombustible materials. The flames can then be provided either from a gas source or by inflammable liquid poured over the model. Cardboard and wood can be textured with materials such as "Artex", a form of plaster that can be painted on, and which retards their burning rate.

Fire effects in the TV studio

Most fire sequences which need to be carried out in the TV studio are those in which a room is on fire, and sometimes burning furniture or a pile of combustible material has to be shown. Exteriors, model shots, and more elaborate burning interiors are invariably filmed.

In most cases it is necessary to use only smoke and lighting effects to provide adequate realism, but occasionally practical fire must be seen to be emanating from the scenery or from furniture or props. In these scenes greater precautions have to be taken than for similar scenes set up in the TV film studio. The specially levelled and prepared surface of a TV studio floor must be protected. Such materials as sheet asbestos or fireproofed hardboard will suffice, but they invariably present the set-designer with problems of camouflage—unless the entire set is on rostra, in which case the rostra tops can be suitably clad with fire-resisting material.

Because of the limitations of the TV studio, practical flame should be confined to gas-fed burners, but where this is either impossible or unacceptable, flame can be provided by using domestic firelighters. An example of this might be where a scientific experiment has just gone wrong, resulting in an explosion. The explosion could be provided by a combined pyrotechnic flash and a compressed-air (whoofer) "explosion". We are now concerned with the aftermath. The "scientist" is dragging himself to the telephone, and we see the bench littered with debris from the shattered equipment, many pieces of which are still burning and smoking. These



Using a combination of smoke, flame, and lighting devices, a realistic fire sequence can be portrayed in the studio without danger to the artistes or damage to the set.

pieces are broken sticks of the type of firelighter available in packets from hardware shops. Some are white and some a very dark colour, so a mixture can be obtained for almost any purpose. They are usually impregnated with paraffin or waste industrial products, and burn well with a certain amount of smoke. Smoke tablets placed on the bench augment the scene, while general smoke is provided by the smoke-gun. A break in recording is necessary to bridge the explosion and the aftermath.

Because of sprinkler systems and other considerations, it is possible to use only a limited amount of actual flame in the studio, and it must be disposed in the most effective manner. A flame 2 ft high and 6 in wide may look dramatic if seen in the foreground, but it looks quite insignificant when placed at the back. It is advisable therefore to plan an arrangement where the majority of the available flame is situated in the foreground and the middle distance.

Backgrounds can be illuminated by light effects such as those provided by flame-drums or projectors. Smoke, back-lit by flickering light, often appears as flame if discreetly situated.

When piles of burning material (books, packing-cases, bedding, etc.) are required it can often be arranged that the flames are in reality behind the objects. If smoke is arranged to curl up the front a convincing conflagration is achieved without anything being actually burned.

This applies equally well to furniture. Once on fire, a padded armchair will smoulder for hours, and only the most determined efforts will bring about extinction. It is better therefore to place the armchair in such a way that the flame surrounds it without igniting it. Smoke capsules in containers placed behind the arms help the illusion. Should it be absolutely vital that upholstered furniture be seen actually burning in the TV studio, it should be specially constructed with asbestos-cloth in place of the original fabric and with gas and smoke pipes built in.

Smoke, although very frequently used in productions, also has its problems. The ventilation system can often get rid of smoke faster than the effects man can provide it, and sometimes the situation is made even worse by the fact that air from the studio floor is convected up to the heated area above the lighting. This problem can be counteracted by covering part of the set with clear polythene sheet (under which, of course, there must be no flame) and also by cooling the smoke with solid CO_2 placed in a basket at the nozzle of the smoke-gun.

Very often in TV scripts authors demand that a door of a smoke-filled room shall open, causing clouds of smoke to billow out. This is not an easy one to rig, particularly if an actor has to stagger out, but if the area behind the door can be boxed in, with clear plastic sheet above and with one side of the box consisting of a hanging drape, the actor standing in this space can put his head out into the fresh air of the studio while the effects operator fills up the box with smoke.

Fire effects in the TV film studio

The special effects man gets a great deal of satisfaction from his craft, but never more so than when arranging a large fire scene. In television he seldom gets a chance to think big, but exceptions are provided in the filmed battle sequence or the burning building—and when these opportunities come along he is often tempted to run the gamut. Unfortunately this sometimes leads to film clichés, king

A wooden-handled flambeau. The steel top contains asbestos wool impregnated with paraffin. Rope binding should be used to protect the artistes' fingers from the hot metal. The cup is used to impregnate the filling as well as to extinguish the flame.

of which must be the falling beam in the fire sequence. The countless baulks of flaming timber dropped close to actors would build a complete film studio if it were possible to construct one of balsa wood! If dramatic incidents *are* required it is better to avoid the ones that have been done to death and endeavour to approach the problem with more subtlety. Directors demanding falling débris can be given a number of alternatives, but these should always be related to what would happen in real life. If a piece of the upper floor is to fall, there should be as much architectural realism as possible, and any alternative to the straightforward drop into shot should be considered. Assuming, however, that the director is adamant, and that a piece of something is to make a sudden surprise entry from above, it is wise to construct it in such a way that it contains hidden pockets of asbestos cloth. These, impregnated with petrol and lit just before dropping into picture, give better flame control than pouring inflammable liquid all over the timber. These built-in units not only give bigger, longer-lasting flames but they have the advantage that they do not emit sparks when the contraption hits the studio floor. Smoke can be fed in via a pipe from the smoke-gun (in the confusion the pipe will not be noticed, and in any case can be released with the rest of the unit). An alternative is to equip the falling prop with built-in smoke tablets.

Sometimes falling, burning material can greatly enhance a fire scene if used with discretion, and it is not always a good policy to feature these occurrences in the centre of frame. Much more realism can be suggested if they happen at the edge or back of the scene, suggesting that even more is happening off-stage than is seen in the picture.

One of the most common faults concerning falling items is when large, flaming, and apparently heavy pieces of architecture cascade down close to actors or extras without invoking any response. These characters continue "fighting the fire" or "rescuing the trapped" without even flinching. They have rehearsed the scene a dozen times and know exactly where and when the stuff will fall, and their reactions are limited to occasional furtive downward glances to make sure that their trousers are not on fire! The reactions of most people would be to look up to see if anything else was about to descend; and this form of slipshod direction often mars an otherwise authentic scene!

For obvious reasons fire sequences are *filmed* whenever possible, but the choice of how and where they are filmed is dictated by the availability of studios or locations as well as the nature of the scene.

Two bed fire scenes. The four-poster had replaceable drapes which were ignited, the other was shot across flame-forks.

It is generally assumed that exterior shots are handled on location and interiors are filmed in the studio. There are, of course, countless exceptions. The exterior of a wooden hut, for example, could be set up in the studio, while a large interior set could be built out in the open. Where it's a question of "all stops out", the interior constructed on a vacant space has much to recommend it.

Fire effects in a film studio are virtually the same as those carried out in the TV studio, except that the limitations imposed on effects in the film studio are considerably less. For example, should "firefighters" with practical hoses be required, tarpaulins can be laid to channel away the water—something that could hardly be countenanced in the average TV studio—and, of course, each shot can be dealt with separately, enabling everything to be orientated to suit one camera viewpoint.

Fire on film presents one problem not usually encountered in the TV studio—that of continuity. Controlled flame-forks and cinéflares can be relied upon to give similar results take after take, but smoke continuity is a different matter. For one thing it is not always possible to reproduce similar results each time. Fog from previous takes can thicken up the atmosphere; draughts or convection currents can clear a scene at most inconvenient moments; and even if all conditions are perfect, how can an operator remember exactly what the smoke looked like in the previous shot (or visualize what it may have to look like later) if scenes are filmed out of sequence?

The most that can be done in these circumstances is to cover each scene with a Polaroid camera or note-pad, but however much attention is given to this problem, accurate matching is always a matter of luck.

A shot that is often asked for in filmed fire sequences is the one where an actor or actress is supposed to start a blaze by setting fire to the curtains—usually long drapes covering high windows or possibly short ones surrounding a four-poster bed. In either case the drapes tend to burn too quickly, and must have their burning rate reduced in some way. Often they can be lined with heavier material, and if further slowing down is necessary the lining may be wetted.

If prolonged burning is wanted, patterned fibre glass or asbestos cloth can be hung in place of drapes with the flame emanating from concealed flame-forks positioned behind or below them.

Continuity is often a problem with burning drapes, and it is better to cut away from them once their peak has been reached. A large fire scene can quickly go dead once the curtains have burnt down, and in order to maintain the drama they should be burnt in sequence.

Some plays call for actors' clothing to be on fire. These range from the full-blooded dramas, where stunt-men have to be employed, to the milder ones, which may require only an actor's sleeve or a trouser leg to be alight. The latter effect can usually be produced by moistening the appropriate area of cloth with a mixture of paraffin and lighter fuel, the artiste being provided with a heat-proof inner garment or pad made from fibre glass, woven asbestos cloth, or some other non-inflammable material.

Where stunt-men are employed, some prefer to supply their own special apparel and also to supervise the effect, while others rely on the effects team. A prerequisite for a man who has to perform with his clothing on fire is an inner fireproof safety-garment that insulates him from the heat. This garment should never be

A stunt-artiste, his clothing on fire, runs away. By confining the treated parts of clothing to arm and back the flames were kept away from the dangerous areas of face, neck, and hair.

wetted with water, because it might transmit heat or even scald with steam.

Inflammable liquid should never be poured over clothing where it can penetrate to inner garments; better to apply petrol-jelly just before ignition, this being the last operation before the cameras roll. It is a fairly obvious fact, but nevertheless worth stating here, that all fire material, such as petrol-wetted cloth, gas-filled areas, etc., should be prepared only when the effects operator is sure that the actors, director, and cameramen are all absolutely ready to go.

If a man is required to run with his clothing alight the treated area should be positioned down-wind so that the flames will stream away from him and not into the unprotected parts of his body. Very often danger occurs at the end of a take when the man stops. Flame which has been wafting away from him now burns upwards, setting fire to his hair or scorching under the chin. If his back is on fire it is better for him to throw himself down while the extinguishing party gets to work. If, on the other hand, he has to lie down in the shot, to all appearances a "burning body", he should not sit up until he has been assured that all flame is out.

For smouldering bodies (the effects of the deadly "ray-gun") smoke can be piped around and under the clothing. Some quite gruesome "burning bodies" have been screened using firelighters and smoke capsules placed around the actor.

Whenever it is necessary to produce a sudden burst of flame—such as that associated with the kind of arson where a match is tossed into a room previously soaked in petrol—a pool of bottled gas can be used. An area of asbestos cloth with the sides of the sheet lifted to form an open container can be filled with propane or butane. This should, of course, be out of shot, either behind an open door or situated below the camera. Firing can be done by the actor if this is essential, in which case he should throw in something that is burning well, such as a fuel-soaked rag. If, however, he is supposed to toss in a match, a candle, an oil lamp, or a lighted taper it is better for the effects man to fire the gas out of shot. One of the simplest and most positive methods is to thrust in a lighted flame-fork, but if the situation calls for electrical ignition the pyrofuse should be surrounded by a small amount of gunpowder to spread the flame quickly.

Walls, doors, and fixtures which have to burn can be treated with petrol that has been mixed with a thickening agent. One useful material is Aerosil. For small areas, tubes of such glue as balsa cement can be squirted over the surface and ignited. These adhesives are usually highly inflammable.

Fire effects on location

For filming on location the effects designer has an impressive choice of materials which, coupled with appropriate buildings or settings, enable him to create fire sequences comparable to those seen on the large screen.

Assuming that for an exterior shot a suitable building has been chosen, the effects man must decide which areas shall receive treatment and what that treatment shall be. If flares cannot be used, high-power lighting should be installed where it can illuminate white or yellow smoke from a smoke-pot or gun. Where applicable, windows should be open for the smoke to pour out, but if wind conditions are not suitable, small stand-mounted wind machines can be set up inside the rooms to reverse the flow. Another method of getting the smoke to come out is to cover the window with a

A woman leaping from a burning building. Smoke-guns and lighting had to suffice on this occasion as the building was a school in normal use. It would have been both dangerous and undesirable to use practical flame and pyrotechnic smoke.

sheet of clear polythene, the bottom edge being allowed to bag open so that a smoke-gun placed below can discharge into the open without first filling the room.

For night shots it is a nice touch, where possible, to put flares and smoke-pots behind the roof. Here they show a stark silhouette of the chimneys and the roof outlined against the night sky.

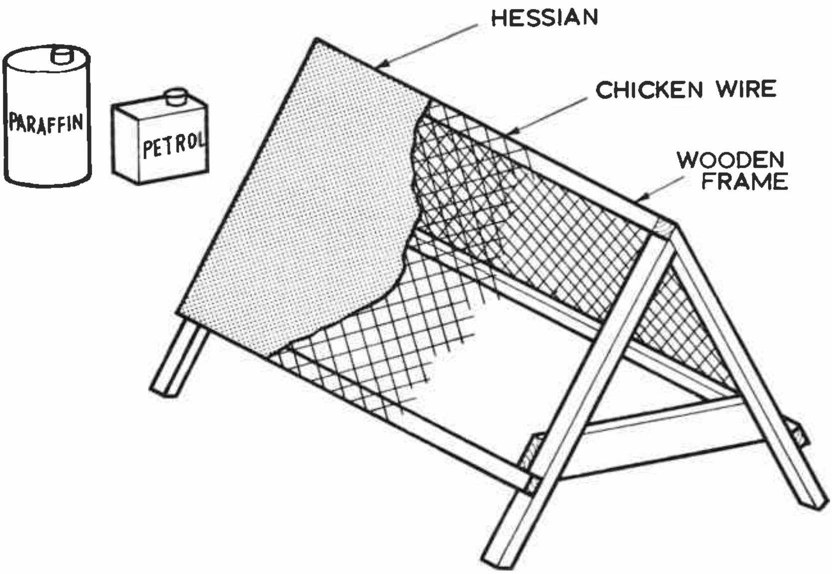
It is better to keep practical flame to the outside of the building. For one thing it shows up better when not surrounded by the illuminated rectangle of a window, and from the point of safety it does not endanger the building or the actors and technicians inside it.

Flame-forks with bottled gas can be used out in the open for

Smoke to issue from a window is force-fed up behind a sheet of clear polythene.

localized work and close-ups, but where really large flaming areas are wanted a special rig must be built. The most efficient shape for this is similar to that of a pitched roof. For simplicity it can consist of a wooden frame which has been covered with wire netting on its two sloping sides and hessian blankets which can be laid over the top. When the hessian, saturated with petrol and paraffin, is ignited air is drawn in at the ends, producing very rapid combustion with flames that rise to almost three times the height of the construction. This device can often be used undisguised; for example, it can be built up to resemble such things as a burning hut or a pile of timber, but usually it is hidden behind some other object which is supposed to be on fire. For an air-disaster sequence a rig of this

A daytime sequence using flares in a rented building.



The flaming ark: A construction designed to promote rapid burning of cloth soaked in petrol. Principally of use for location fire sequences.

kind was situated some distance behind the body of a real air liner while smoke-pots situated up wind and out of the picture covered the scene with smoke. Flares behind and in front illuminated the scene as if with real flames, while small areas of foreground were given specially prepared fires to resemble burning débris. Between these fires were placed pieces of crashed aircraft to complete the illusion.

When further takes are required for this sort of shot it is wise to wet down everything that has been burning before resoaking with fuel. This makes sense not only from the safety angle but if devices fire prematurely the shot is held up unnecessarily.

Rarely does television attempt the sort of sequence which, although commonplace in films, is too expensive and time-consuming for the TV budget. Typical of this sort of scene is the one where a car leaves the road, plunges over a cliff, bursts into flames, and disintegrates as it tumbles over and over. The risk of a faulty take, for whatever reason, the problem of selecting the right terrain, the responsibility for clearing up afterwards, and so on rule this sort of operation right out of court. Authors and script editors, however, continue to demand dramatic effects, and crashing and burning cars figure very prominently in location film schedules.

It is, of course, child's play to set fire to a stationary vehicle, but if the fire has to be extinguished prior to a retake it is important to remove all the upholstery before the car is used. The construction of automobile seats makes it almost impossible to extinguish them entirely once they are alight, even with a full-bore fire hose, and if liquid fuel is being used the second "take" can often happen before the cameras roll.

Petrol tanks must always be extensively holed or filled with water to prevent their exploding. (If an explosion is wanted it is better to fire a *controlled* charge.)

For large explosive fires a substitution technique can be used. Suppose that a script calls for a saboteur to destroy a large fuel tanker. He does this (says the writer) by turning on the valve at the back of the vehicle and igniting the fuel by throwing down a lighted rag.

If models cannot be used, this action might be arranged using a real vehicle, some scrap parts from a similar vehicle, and a rig comprising polythene bags filled with petrol hung above explosive pyrotechnics. The close-ups of hands turning valves, the pool of "fuel" flooding under and around the tanker would all be filmed

A flame-thrower built from a steel pressure cylinder. Petrol in this is forced out by compressed nitrogen (to prevent explosive air/petrol mixtures). The black smoke is coming from a smoke-pot.

in the usual fashion, but the shots of fire would be so arranged that the vehicle was never at any time in contact with practical flame. The fire could be seen to start in a shot of a wheel standing in a growing pool of fuel. Lighted rag, tossed in, would cause the fuel to ignite, and after sufficient footage the wheel, a separate and expendable item, would be extinguished and saved for dressing the later shot of the explosion. Following the ignition close-up there could be a long-shot taken from a low angle. This would feature the tanker, but hidden between the camera and the vehicle would be a trough of burning fuel which would appear to be much closer to the vehicle than it really was. Smoke-pots behind the tanker would reinforce the illusion. It would be necessary for the camera to be locked off for this shot, as the following one would later be joined to the first to provide a continuous action. Finally, the tanker would be driven away and a rig of timber erected in its place, conforming roughly to the size of the vehicle. It would have the scrap wheels stood up in their relative positions. In the middle of the rig would be hung a number of polythene bags containing petrol, and under these large ground maroons and flash-pots would be placed. In order that the rig would not remain standing after the explosion, ground maroons would be taped to the uprights to ensure its destruction. If the shot was sufficiently wide, one or more wheels could be flung into the air by the use of mortar explosions.

4

PYROTECHNICS AND EXPLOSIVES

PYROTECHNICS are frequently used in television productions. They are employed in a variety of ways to simulate warfare and to create scenes of havoc and destruction. They are also used simply as fireworks when they are required to produce the sort of display associated with fiesta or carnival scenes. Ranging from the humble sparkler to the high-powered maroon, the list of pyrotechnics available commercially is quite an impressive one. In addition, there are the innumerable "specials" concocted both in the effects workshop and by the manufacturers.

The use of pyrotechnics in the studio creates many problems for the effects designer—not least being the fact that results are seldom entirely under his control. Artistes straying too far from their marks can cause the firing of an effect to be delayed or even omitted altogether. Technicians crossing the floor may mask the operator's eye-line at a vital moment or, by moving their equipment, inadvertently foul his firing cables. Elements other than human ones can also affect the situation. Drifting smoke may smother important parts of a scene or obscure other effects. Pyrotechnics which fail to ignite can cause the director to "hold" too long on a shot, believing that his cue to "fire" has not been heard. But probably the worst moment of all is when monitors or headphones, specially provided for the effects man, go dead just before a take, leaving him helplessly divorced from the action.

Not all pyrotechnics are used for big, dramatic scenes. Many are employed in ways not necessarily associated with fireworks at all. The electric fuse that blows and the flame of the welder's torch are but two examples. Pyrotechnics may even be used out of shot to actuate other effects, such as falling débris or even breaking mirrors (this by releasing a spring hammer).

A small magazine for the storage of pyrotechnics and explosives used in TV productions.

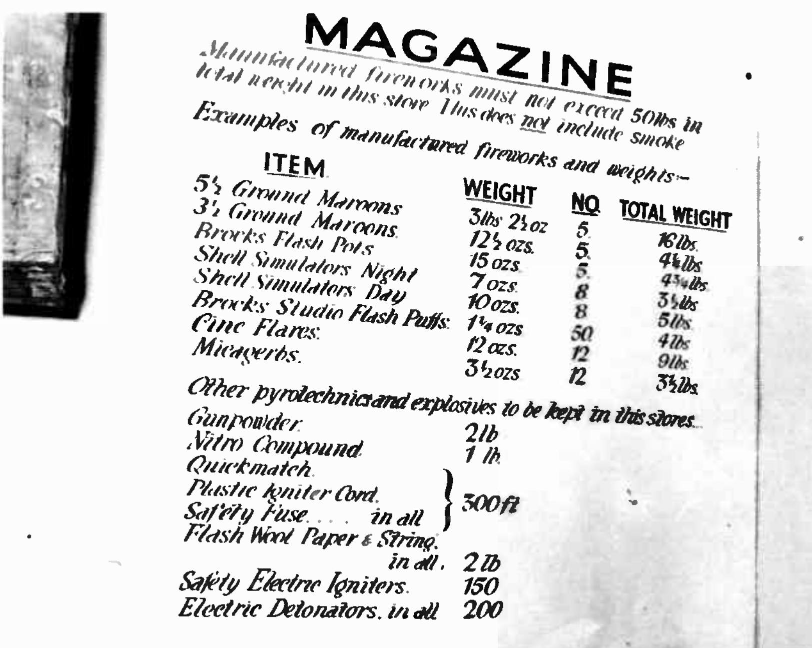
Storage arrangements

The storage of pyrotechnics and explosives is largely controlled by regulations laid down by government departments and local authorities. They differ from country to country and from town to town, and it would be impossible to give even generalizations on the legal aspect.

If pyrotechnics are in frequent use, storage facilities must be provided which should be capable of holding not only day-to-day production requirements but also those pyrotechnics which are *en route* from supplier to location. It is therefore advisable to have storage space as commodious as permissible. Furthermore, it is not always possible to forecast accurately the amount of pyrotechnics needed for a programme, and a healthy excess is much more satisfactory than having to skimp the production.

Storage is best provided away from other buildings, and in some cases this is obligatory; but where only small amounts of commercial smoke-pots are kept, it is feasible to house them in a fireproof cupboard in an area away from inflammable materials and under

The interior of the magazine. Open shelves allow the stock to be checked easily. Initiators are stored separately in the brick-built cubicle, top left. ▶


MAGAZINE
Manufactured fireworks must not exceed 50lbs in total weight in this store. This does not include smoke
Examples of manufactured fireworks and weights:-
ITEM
WEIGHT
NO.
TOTAL WEIGHT
5½ Ground Maroons 3lbs 2½ oz 5. 16lbs.
3½ Ground Maroons. 12½ ozs. 5. 4¼lbs
Brocks Flash Pots 15 ozs 5. 4¾lbs
Shell Simulators Night 7 ozs. 8 3½lbs
Shell Simulators Day 10 ozs. 8 5lbs.
Brocks Studio Flash Puffs. 1¼ ozs 50 4lbs
Cine Flares. 12 ozs. 12 9lbs
Micagerbs. 3½ ozs 12 3½lbs
Other pyrotechnics and explosives to be kept in this stores.
Gunpowder. 2lb
Nitro Compound 1 lb.
Quickmatch.
Plastic Igniter Cord.
Safety Fuse.... in all 300ft
Flash Wool Paper & String.
in all. 2lb
Safety Electric Igniters. 150
Electric Detonators. in all 200

supervision. The cupboard or safe should be clearly marked on the outside to show the nature of the contents.

Large quantities of mixed pyrotechnics must be kept in a properly constructed store-room as far away from working areas as possible and with a suitable access road for loading. Cars should not be allowed to park where they would impede free entry to the store. Details governing the building of a store can be obtained from the licensing authorities, but the interior layout is left to the user. Pyrotechnics may be placed either on open shelves or in cupboards, but it is necessary to separate initiators from the fireworks, while detonators or bullet-hits must be stored on their own in a locked box or cubicle (presumably to prevent felonious use). A notice showing the total amounts of permissible stock should be displayed on an inside wall, and these details should state whether they are in weights or quantities. There should also be a register recording all deliveries, allocations, and returns.

Many fireworks are hygroscopic. They quickly soak up damp from the atmosphere and become unusable. To prevent this happening the building should have baffled air bricks to allow circulation of air, and a flameproof electric heater to maintain the internal temperature at about 20° C.

All fireworks and fuses should be labelled, particularly purpose-built devices which might be retained for long periods. If loose powder is kept it should be contained in a number of small tins rather than in one big one.

No matches or cigarettes may be taken into a store, nor may the store be used for the purposes of manufacture (and legally this can embrace even the simple cutting of a firework).

Safety precautions

Of all scenic effects operations, the use of explosives presents the greatest hazard, and it is hardly necessary to state that it has caused many serious accidents. Sometimes mishaps occur purely through negligence or carelessness, but others can happen even after all sensible precautions have been taken. It is therefore advisable that all rules and regulations be carefully observed and that everything is double-checked before operations begin.

When any pyrotechnic mixture is being used in its loose form it should be handled in the smallest quantities practicable, even if this means subdividing the total amount into smaller lots.

Whenever a container of pyrotechnic mixture is in use it should be kept covered.

Loose pyrotechnic mixtures should always be measured with a set of standard units.

All mixtures should be labelled, particularly where "special packets" or fireworks are made up in the workshop.

It is not good practice to retain any unused "special packets" or fireworks. It is better to keep records of their formulae and their results. Rush situations can sometimes lead to these "specials" being used in conditions for which they were not primarily intended.

All pyrotechnic devices should be capable of being tested or sampled before a recording. Explosives which are rigged to give a once-off display in front of cameras should, where possible, be avoided.

An explosion should never be increased during filming or recording without a preliminary test in conditions of safety.

Where electrically fired pyrotechnics are used, the battery, firing-box supply, or magneto should not be connected until immediately before firing.

No electrically fired pyrotechnic should ever be connected to a circuit without the operator first having made sure that the firing device or battery is safely disconnected from *both* leads. Furthermore, it is essential, if a battery is being used, that it should be removed to a place where the leads could not possibly touch it if either were accidentally moved.

No switch, press button, or firing box should be used unless the internal circuit is demonstrably foolproof.

Safe distances, once assessed, should be rigidly adhered to.

Artistes should not be asked to fire or ignite pyrotechnics.

Leads to pyrotechnics should be positioned where they cannot be kicked by artistes or dragged by moving equipment.

Long runs of cable should have their ends shorted together before connections to pyrotechnics are made. This precaution minimizes possible danger from static or induced current.

Flash-pots and similar devices should be checked to determine their "fall-out" area if they are likely to be used near drapes or inflammable material.

Artistes' clothing should be checked for fireproof qualities if the wearers are likely to be working in close proximity to stage flashes.

Flash-powder, although commonly used in TV and stage effects, is a potentially dangerous material. Sometimes compounded of flake aluminium and potassium chlorate, it can, if these constituents are suitably "balanced", detonate with considerable force. (A "safe" formula usually includes a stabilizer, such as barium nitrate.) Flash-powder therefore should never be used where an unforeseen explosion could have serious results. This does not necessarily apply where the powder has been purchased from a reputable manufacturer and its properties are well known to the user. It should never, however, be automatically assumed that because flash-powder has been obtained from an outside source it is therefore safe.

Transportation and handling

Regulations governing the transport of explosives, detonators, and pyrotechnics in Britain are complex. So many Acts, rules, and byelaws apply to this subject that it is difficult to ascertain exactly where a person engaged on special effects work involving the use of pyrotechnics is likely to contravene the regulations.

The essential aspect of this subject is that, as in all pyrotechnic work, common sense should prevail at all times. Pyrotechnics which have to be transported from base to location should be carried in the vehicle of the man in charge of them. They should not be consigned in vehicles carrying props, wardrobe, or scenery. Moreover, it is sensible that the vehicle carrying the pyrotechnics should also have a passenger or co-driver. In the event of a breakdown one man can remain with the vehicle while the other summons assistance.

It is generally assumed that up to 100 lb of pyrotechnics may be carried in any one vehicle provided that the contents are packed in a manner unlikely to be hazardous.

No pyrotechnics or explosives should be carried loose. They should be enclosed in strong cardboard or wooden boxes according to their type or the nature of their original packing or casing. Those materials pre-packed in tins or strong cardboard outer casings may be carried in covered cardboard boxes, whereas those having paper containers (or paper tops) or being pre-packed in plastic bags should be carried in boxes strong enough to protect the contents from being ruptured or crushed if packed below other equipment. Generally it is better if all pyrotechnic devices are carried in metal ammunition boxes clearly labelled in red lettering. This prevents their being confused with other boxes or cartons which might be carrying equipment or other materials. Pyrotechnics carried in metal boxes should be further packed in separate cardboard boxes.

Electrically fired pyrotechnics should never be carried in such a way that their leads might contact any battery or firing device. (If these are being transported at the same time they should be separately packed, clearly marked, and carried in a different part of the vehicle.) It is important to guard against such pyrotechnics being fired accidentally by being placed in the boot of a car. If their leads are left protruding from their containers they might contact live wiring within the vehicle (the stop lights and indicator leads particularly) or in some cases the car battery itself!

If fireworks are likely to roll around inside their containers they should be packed with paper or cloth. Grit or pieces of pyrotechnic material in the bottom of a metal box could lead to ignition.

When a vehicle has to be parked overnight it is advisable to contact the local police or fire officer, who will usually give advice regarding permissible parking areas. In some instances they will make arrangements for the vehicle to be left in their own precincts.

Before transporting pyrotechnics it is advisable for the driver to check with his insurer to ascertain whether his policy is likely to be invalidated by the carrying of such a cargo. A similar situation arises when a vehicle containing pyrotechnics is left in the private car park of a hotel or even the driver's own house. In this case the fire policy relating to the building might be in jeopardy. Needless to say, when a vehicle carrying a substantial amount of pyrotechnics is parked it should be positioned as far away from buildings and other vehicles as possible.

Pyrotechnics are classed in Britain either as "shop goods" or "large fireworks", the latter being those usually employed in special effects. They both appear to be classified as class 7 division 2 (manufactured fireworks). Bullet-hits or electric detonators appear to come within the category of class 6 division 3.

All the preceding information is intended for guidance only, and the author has not attempted to interpret the true legal implications.

Maroons and flash-pots

These are used either together or separately to simulate outdoor explosions.

A maroon consists of a stout cardboard case (which is sometimes bound with string) containing either gunpowder or safe flash-powder. These fillings are compounded to give what is known as a "deflagrating" explosion. This differs from the effect produced by high explosive, which is referred to as a "detonating" explosion.

A deflagration is brought about when a pyrotechnic mixture, which has a fast burning rate, is ignited in a confined space. The rapid rise in temperature and pressure causes even faster burning, with a corresponding further rise in temperature and pressure resulting in an explosion.

Maroons are generally electrically fired, but some thunderflashes (explosive fireworks to simulate hand-grenades for military use) are supplied with a short length of fuse. On the whole, thunderflashes are not very useful for effects work, where most explosions have to be carefully positioned and fired on cue.

Explosive ground-maroons, shell-burst simulators, and flash-pots. The small flash puff pictured in the foreground is the only item suitable for use in the studio. The others are intended for outdoor use only.

Small maroons, usually called stage-maroons, may be used in the TV studios, while the larger ones known as ground maroons are for outdoor use only. They all explode with considerable force and noise, and can be used in a variety of ways where things have to be blown up or blown apart. They are useful for sound as well as visual effects.

Most maroons will stand a short immersion in water, but if they are likely to be submerged for long periods they should be sealed in plastic bags.

Flash-pot is the name given to a container of flash-powder which when fired produces a bright flash with a cloud of smoke, but with minimal explosive effect and very little noise. A flash-pot, to work properly, must not be restricted. Any form of confinement, even partial, results in either some explosive effect or complete deflagration. A flash-pot tightly wrapped in paper and adhesive tape becomes a maroon (but this practice is not recommended).

Small flash-pots known as stage-flashes or mag-puffs are frequently used in the studio, but large flash-pots containing up to half a pound of flash-powder should be used only for outdoor work. (This does not, of course, apply to such buildings on location in which it might be both safe and reasonable to use them.)

Flash-pots are normally employed whenever a large visual explosion is required, and generally it is better to use them in conjunction with a maroon, as the slower burning of a flash-pot does not give an entirely convincing "destructive effect". In order that the flash-pot and the maroon do not appear to be separate within the one explosion, they can be placed one behind the other, but far enough apart to prevent the flash-pot being annihilated by the maroon.

Mag-puffs are used in the studio for genie effects or for comic explosions, for which they are usually placed on the floor, but they may also be used inside or behind props if they are not enclosed and if their fall-out is unlikely to set fire to other things. Mag-puffs and flash-pots have a light paper covering on the tops of their containers. This is merely to prevent the contents being spilled, and as it is necessary for the burning of the powder not to be restricted, the paper tops are fragile.

Flash-pots may be fired under water if necessary, but they must be positioned just below the surface. The cases, being generally of thin cardboard, will not stand up to immersion in water, and it is therefore better to remove the contents (or use loose flash-powder) and seal them in a thin plastic bag. The entry for the wires of the pyro-fuse should be at the bottom and adequately sealed. This also provides an anchor point. Air in the bag causes it to float, and positioning just below the surface is an easy matter. It should be ensured that the pyro-fuse is situated in the heart of the contents.

Pyro-fuses and bullet-hits

Two electrically fired initiators that have similar functions are the pyro-fuse and the bullet-hit. These two can sometimes look alike, but any confusion between them can be highly dangerous.

The pyro-fuse is a small device for igniting pyrotechnics by means of an electrical supply, while the bullet-hit, also fired electrically, is an exploding device.

The pyro-fuse consists of a small paper tube about 1 in long and $\frac{3}{16}$ in in diameter, with a tiny exploding head at the end and two insulated wires about 12 in long for connection. In the open it fires with a sharp crack and produces sufficient flame to ignite most pyrotechnic mixtures. It can also be used for firing quick-match fuse and inflammable gases and liquids. It operates from a supply as low as four volts, but it is generally better to use a higher voltage, particularly where long leads are involved. Pyro-fuses are fitted into most of the commercial electrically fired maroons, flash-pots, and smoke-pots, and are generally regarded as being very reliable, any misfires usually being attributable to some other factor. It is sometimes a good idea to use more than one to fire a single effect.

It is important that pyro-fuses are positioned so that they fire directly into the heart of the material, and it sometimes happens

A pyro-fuse and two bullet-hits. The pyro-fuse, in paper tube, is on the left of picture.

that when connecting them to the main firing lead they are pulled clear of the mixture. This may occur particularly when pyrotechnic material and the pyro-fuse are together in a plastic bag. It is not unknown for the pyro-fuse to fire through the wall of the bag without igniting the mixture. Similarly, in a cardboard container a badly positioned pyro-fuse can discharge its flame around the wall of the case without igniting the mixture below.

Yet another form of misfire can occur when a pyro-fuse is used to ignite small quantities of loose powder. The "explosion" of the head sometimes blows away the powder without igniting it. An adequate amount of material must always be heaped around the pyro-fuse to ensure good combustion.

Bullet-hits (also known as "miniature plastic detonators") are similar in shape and size to pyro-fuses, but can be distinguished by the fact that they have plastic cases instead of paper. They are supplied in two strengths, full charge and half charge. Different colour leads denote the type of charge. (It is advisable to consult the suppliers for specific information on colour-coding of these devices.)

The noise from a pyro-fuse can be likened to that of a sharp crack, but a bullet-hit is considerably louder, resembling more the firing of a short ·22 in blank cartridge.

A bullet-hit contains small amounts of powerful explosive and, as its name suggests, is used chiefly for the effect of a bullet striking an object. Buried in plaster or wood, it has considerable destructive power, and must be used with discretion. It may also be used to smash small items on cue. One of its greatest assets is the fact that, unlike the pyro-fuse, it produces little or no flash. This allows it to be used for breaking or smashing effects where smoke or flame would be inappropriate. Examples might be the shattering of a wine-glass subjected to a high note and the appearance of bullet holes in an actor's chest.

Quickmatch, slowmatch, and fuse

Pyrotechnic fuses which burn at a controlled rate are used as the link between the original ignition and the explosive. They are manufactured in various forms and for different purposes. Some burn extremely rapidly and are used for the simultaneous firing of multiple fireworks, while others burn slowly, allowing maroons and thunder-flashes to be lit and thrown to safe distances. One of the most versatile fuses for scenic effects is quickmatch. This is a cotton string, coated with black-powder (gunpowder) and enclosed in a paper tube. In its tube it burns extremely rapidly, so rapidly in fact that over short distances the effect is almost instantaneous. This is very useful for rapid destruction effects, and instances of its use are quoted later in this chapter.

With the tube removed the fuse burns comparatively slowly (nominal 5 seconds per foot). It can be used in this fashion for many of the dramatic slow-burning-fuse effects associated with gunpowder trails, etc. If the rate of burning is still too fast for the required effect the fuse may be impregnated with a very weak solution of shellac varnish in methylated spirit. When dry, this not only serves to reduce the burning speed but also protects the surface from sparks, which in the untreated slowmatch tend to cause the flames to jump ahead. Only trial and error can determine the right amount of impregnation, but it is possible to produce fuse sufficiently slow for the hand-held "anarchist's bomb" or "sticks of dynamite".

Another useful fuse is plastic igniter cord. Available in different speeds, it can be used for many visual effects where fuse has to be seen burning. It is thinner than the other fuses mentioned in this chapter and resembles plastic-coated wire. Two speeds available are "fast" (burning at not less than $1\frac{1}{2}$ seconds per foot), and "slow" (nominal speed, 10 seconds per foot). Care should be taken to cut igniter cord with a sharp knife, as sawing or breaking might produce sufficient frictional heat to start the fuse, which once alight cannot be extinguished.

The slow igniter cord has an internal iron wire which remains after the fuse has burnt away, but the fast cord burns completely away. These are requirements for the cord's normal function of providing link fuses for quarry blasting, and do not really concern their use in special effects; but where it is necessary for the case to collapse after use the fast version must be used.

A different form of fuse is Bickford or safety fuse. This burns internally, without visible flame, in an integral waterproof cover composed of bitumen and fabric. The only manifestation of its progress is a small amount of blue smoke that curls up from the area which is alight. It burns at about 120 seconds per yard, and may be used for firing or igniting anything where a specific time lapse is required. The Bickford fuse, having a coarse rope-like exterior, is conventionally more dramatic in appearance than the thin igniter cord, but if it is to be shown burning it must be in close-up.

The burning trail of gunpowder is still popular as a method of creating suspense, and is often called for in period dramas. It is possible to use practical black-powder in the conventional fashion, but for use in the TV studio it is generally better to employ quickmatch or igniter cord hidden in a trail of dummy powder. This applies particularly where the short trail to the touch-hole is laid along a gun-barrel. For this effect, black-powder tends to burn either too fiercely (causing the nervous actor to recoil) or goes out if the powder has been swept or blown away by previous action.

For dummy mealed gunpowder, ordinary fine leaf tea is an excellent counterfeit. It can be poured from a powder-flask or keg in convincing fashion, and is not readily combustible (purists might reject it on the grounds that there is powder left behind after burning, but usually this goes unnoticed).

A long-burning slowmatch that looks ominous in close-up can be made by soaking cotton rope in a solution of potassium nitrate. When it is dry, grains of black-powder or flash-powder may be applied individually to the outside of the rope with thin adhesive. The specks must be dispersed around the fuse in such a manner that they do not ignite each other. Their occasional spluttering, coupled with smoke from the smouldering rope, can give good dramatic value in close-ups where delayed action is required.

Fuse may be used to simulate other things. Quickmatch, for example, in its paper tube and spread out in a display of wiring or equipment, can be used to give a most convincing effect of short-circuiting or full-scale electrical chaos.

A weight or platform supported by several strands of quickmatch (without paper tube) or fast igniter cord will be released when the fuse burns through. Fired remotely by pyro-fuse, this provides a dropping device without recourse to solenoid-operated catches or complicated mechanisms.

WARNING: *The details given in this section are meant to serve only as a guide. For accurate descriptions and data concerning explosives and fuses, the manufacturers' literature should be consulted.*

Matches and portfires

The majority of pyrotechnics are lit by match before the commencement of a take, and cameras are not usually asked to turn before the pyrotechnics are burning to everyone's satisfaction. Trouble arises, however, when there is a strong wind on location,

Lifeboat matches and portfires. These may be used to ignite other pyrotechnics.

and on these occasions lifeboat matches may be used. They have special heads which burn for 15 seconds and refuse to blow out. In the absence of portfires they may be laid on the mixture of those smoke-pots which require more ignition heat than can be obtained from a single ordinary match.

The portfire is a slow-burning firework, designed to be held in the hand for the purpose of igniting other pyrotechnics. It is particularly useful where certain visual effects require pyrotechnic flame. Small pieces of portfire pushed into the end of a gas-gun can provide convincing effects for "welding" or "metal-cutting". They may also be used as fuses where something bigger or possibly more comic than those described earlier is needed.

Rockets and aerial flares

Rockets and aerial flares are of two types, the firework sort and the distress and life-saving variety. When the latter type is called for (e.g. a life-line-carrying rocket) it is very often better to use the firework variety for reasons of economy and suitability. A line-carrying rescue rocket is an expensive device, made to very high standards. It is also a very potent projectile and needs a lot of clear space in which to operate. It is therefore as easy to simulate the real thing by using a conventional firework rocket. This would be fired from a tubular metal rig which guides it on its path (as with the real rocket) and connected to a length of cord, carefully laid in an open tray. Most of the larger firework rockets are capable of carrying considerable weights, and will carry a line quite far enough to look convincing.

Rockets are also useful when the "Bazooka" type of weapon is called for. Fired electrically in a long metal tube (mocked up to resemble the Bazooka), they produce an effect that is quite realistic. To fire them it is necessary for the pyro-fuse to be placed in close proximity to the fuse of the rocket, but if a bigger discharge is required the fuse may be supplemented with flash-powder wrapped in paper and bound up close to the business end of the rocket. The pyro-fuse should simply be inserted in a hole in this paper packet to prevent its wires impeding the flight of the rocket.

If rocket-firing weapons are to be used in the TV studio, where it would naturally be impractical to fire a rocket, simulation may be achieved by firing two separate charges, one at either end of the Bazooka tube. These charges should be of gunpowder or flash-powder (or a mixture of both) wrapped in paper. To get a realistic effect and to give the impression of travel, the rear charge should be fired slightly before the front one. This can be effected by using a rotary-switch or by wiping the lead from the battery across the two leads connected to the charges.

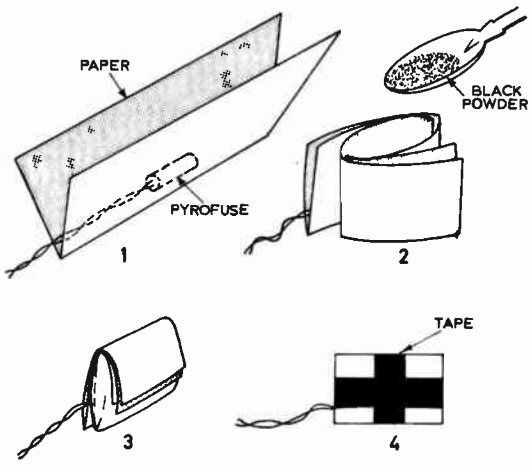
Many types of distress flare are available from manufacturers, and it is seldom necessary to fake anything in this direction.

Sometimes at night it is difficult for the cameraman to follow the progress of a flare-carrying rocket, particularly if it is to be a semi-close-up. Successful results can be obtained if the film is shot in two parts. One shot is taken of the ascent of a rocket and the other is taken of a falling flare. Rocket and flare are joined in the lab, the rocket being faded out at the end of its travel and then, after a few blank frames, the flare being faded in.

The flatpack

The term "flatpack" is used to describe a method of wrapping small amounts of black-powder or flash-powder which are to be fired electrically. A flatpack consists of a single sheet of paper which is folded as illustrated on page 108.

This form of packet has a number of advantages. Its flatness allows it to be placed conveniently under items which have to be blown up. It is simple to make and does not leak powder. If made from stiff paper it can be wrapped heavily with tape to give a "hard" explosion; if made from lighter paper with just enough adhesive tape to seal it, it produces a "soft" explosion or flash.



The flatpack. A simple method of folding paper to contain gunpowder or flash-powder for hard or soft explosions.

Variations of paper, size, and taping can give combinations to provide any type of explosion required.

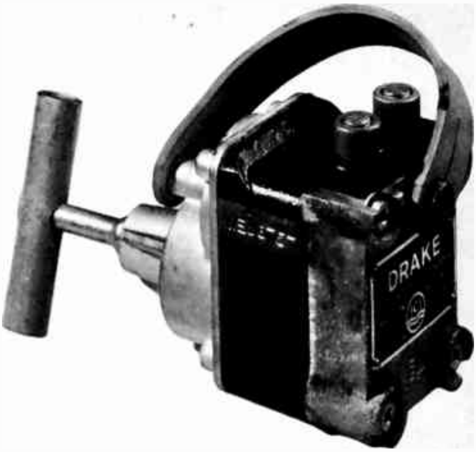
Developed primarily for use with electrical pyro-fuses, flatpacks can nevertheless be fired by quickmatch or igniter cord. The former should be without paper tube and of sufficient length to provide a safe lighting period.

Firing-boxes

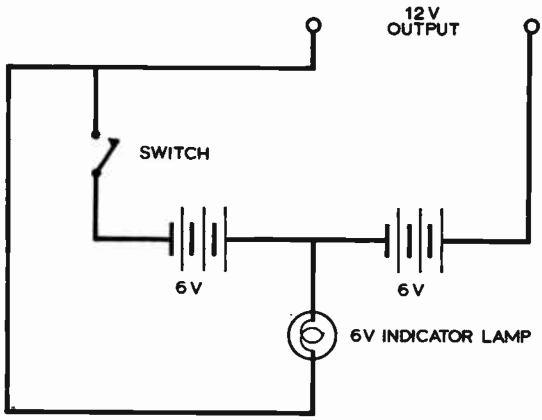
The simplest way to fire an electrically initiated explosion is to touch one wire of the circuit to the terminal of a battery. The disadvantage of this method is that an operator concentrating on the wire and the terminal cannot look at the effect. This arrangement needs a press-button to make it practical and, as a further refinement, a master-switch to isolate the battery when not in use. A red warning light can show when the battery is in circuit, and terminals and extra buttons can be added for additional circuits . . . and so a firing-box is born!

People whose job it is to fire pyrotechnics and explosives for film, TV, and theatrical purposes tend to design and build their own firing devices and, in most cases, these are original and efficient. Some are not so, however, and although their eccentricities may be well known to their owners, they can often be confusing and dangerous if used by others. A circuit diagram is shown on page 110 of a firing-box which at first sight might seem to be adequate; but in fact the red light which was incorporated as a warning provides an alternative path to the output terminals. Small wonder that this design resulted in unexplained ignition. The use of a switch that can remain in a closed position is also to be avoided. Switches that are biased "off" and press-buttons are normally used when they are to be incorporated in a battery-supplied firing device.

It is difficult to visualize a firing-box that could be completely foolproof, but any design should provide a simple and reliable

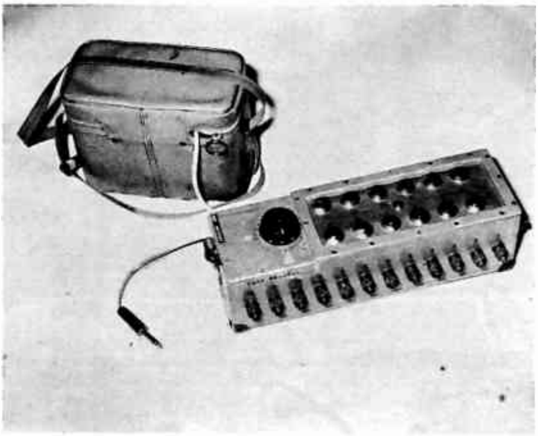


Two commercial exploders which can be used to fire remotely situated maroons. *(Marston Excelsior Ltd.)*



The circuit diagram of a firing-box which produced some unexpected results.

arrangement which is reasonably safe and resistant to wear and tear (firing-boxes used on location can spend a lot of time buried in dirt and mud). One, illustrated below, consists of a firing-box, which has a number of press-buttons and a rotary-switch. Connection points on both sides have corresponding numbers, and large "common return" terminals are provided at one end. The batteries to supply this unit are housed in a case which is worn by the operator. To make connection he must insert the jack-plug into the socket, and cannot therefore walk to the other end of his circuit without first disconnecting the supply. The firing buttons are housed behind a heavy sheet of clear polythene, which protects them from particles of sand or dirt which could cause them to jam in the closed position.



A purpose-made firing-box incorporating 12 individual circuits and a rotary switch. The battery pack is worn by the operator and provides a measure of safety.

Rotary switches are often used to fire a run of "machine-gun bullets", and these switches have the disadvantage that it is possible to leave them in any position. The one incorporated in this design is no exception, but the neutral position is clearly marked, and position 1 is permanently dead, so that the switch can be safely left at the end of its travel.

A red light is included, but this is merely to show that the batteries are functioning properly. It lights up only momentarily when the jack-plug is inserted. Care must always be taken that when the jack-plug is being inserted the hand holding the switch-box is not pressing down on the buttons!

Fireworks in the TV studio

Resident firemen are apt to look unfavourably at the use of fireworks in television, and their reasons can easily be appreciated when one considers conditions in a crowded studio. Nevertheless, pyrotechnics are necessary to many television dramas, and no amount of improvisation can take their place. Provided that the correct type of pyrotechnic is used in the studio and that the rules governing their use are observed, fireworks can be freely employed in TV productions without too much conflict between those who have to supervise the studios and those who have to put on programmes.

Pyrotechnics which are considered suitable for use indoors are summarized below:

For explosive visual effects—

- Flatpacks
- Bullet-hits
- Pyro-fuses

For flash effects (without explosion)—

- Mag-puffs
- Pyro-fuses with flash-powder attachments
- Flash-wool, string, or paper

For simulated electrical explosions—

- Quick match with or without tube

For firework display—

- Micagerbs
- Sparklers

Most of these items can be used in a variety of ways, but the micagerb has only one function, and that is to create a display. Its effect is similar to that of the golden-rain type of firework, but unlike these, its brilliant cascade is formed of heated mica particles, not metal filings. These mica particles cool quickly and offer very little fire hazard.

Micagerbs can be placed on the floor, fixed in holes drilled in wooden battens, or hung from the grid, fastened to metal conduit. Where large displays are called for, it is quicker to have several pre-rigged battens than to replace individual fireworks for a second run. Groups of micagerbs can be wired up beforehand with their leads terminating in plugs and sockets. They should be wired in parallel, not in series, and if a large number of them are to be fired simultaneously it is advisable to use a heavy current supply. A 12-volt car battery is suitable, but if there are long runs of supply cable the voltage might have to be increased.

In wiring up a display of this kind it is essential to identify the circuits. Cables which have to be carried over, behind, and often underneath scenery should have their ends clearly labelled, and it is no disgrace to work from a simple wiring diagram if it will facilitate rapid resetting. Battens of micagerbs should never be connected to their particular circuit without first ensuring that *all* circuits are disconnected from the battery. At least one gratuitous display is recorded.

Sparklers are useful when hand-held fireworks are called for in a production, but their obstinate refusal to ignite often presents a problem. Lighting them from a portfire offers one solution, but when large numbers of sparklers are needed it requires a pretty concerted effort on the part of the scene staff to get the last one lit before the first has gone out. When they are required to be in the form of a static display the problem is greater and attempts to wire them with pyro-fuses and quickmatch or other "starting" materials are usually doomed to failure. One solution, where circumstances permit, is to fit the sparklers into movable arms which enable their tips to be held together for multiple ignition (by portfire) and which will return to their position when released. A display on a Christmas tree can be made to do this.

Flash-wool, paper, and string are cellulose materials which have been treated with acids to change them into a form of explosive. When ignited they burn so rapidly that they practically flash, the colour of the flash usually being light red or orange. Small pieces of paper or wool may be used for certain effects in the TV studio, where loose flash-powder or black-powder would be unsuitable. For example, they may be held in the hand, and are used frequently by conjurers in that manner.

The string burns less rapidly than the wool or crumpled paper, as the flame has to travel a path, but flash string can be used to fire a trail similar to that of open quickmatch. These materials should produce neither sparks nor fall-out.

Catherine wheel effects are sometimes needed for a fiesta or bonfire-night scene, and if it is essential that they have to be in the studio and not on film they can be simulated by fixing sparklers or micagerbs to rotating battens.

5

BULLET AND BOMB EFFECTS

THE effects of tearing bullets and exploding bombs are not easy to portray indoors. Battle scenes in the TV studio are apt to be weak and unconvincing. It is therefore essential that effects of this nature should be kept to a minimum and where possible confined to sound effects only.

There are occasions, however, when a burst of machine-gun fire or an exploding shell must be seen to occur in vision, and if pre-filming is impracticable the effects designer may well have to resort to one or more of the devices described in this chapter to help him achieve the desired results.

Certain effects, such as the shooting of bottles or pictures, are comparatively easy to accomplish, whereas others, such as machine-gun bullets in the studio floor, are difficult. Much depends on the manner in which these effects are staged and on their timing. Visualize the scene where a man going to a window suddenly sees a gunman outside. The first man, seen from a *side-on* viewpoint, drops to the floor, whereupon there is a sharp crack of a gun, the sound of shattering glass, and he is showered with broken window-pane.

In such a scene the effects are predominantly sound effects. There would be no necessity to fire anything at all through the window. The glass which falls upon the actor could have resulted from someone on the outside of the window merely smashing in a pane of Santolite with a hammer, the sounds being added later.

View this same scene from *behind* the actor in the room and one is faced (at worst) with the necessity of seeing the gunman fire, with the window (which would have to be perfectly clear) shattering in synchronism.

Such a shot *is* possible, but it obviously takes much longer to rig, rehearse, and record than the other. Of the two, the first method is less likely to produce a bad effect, and on balance will invoke an equally dramatic situation.

Compressed-air gun

Rarely does the television effects man have the opportunity or the time to set up, polish, rehearse, and finally record a close-up shot of a single-bullet effect. This is a great pity, because a really dramatic bullet impact is a pleasure to watch. In the movies the bullet which smashes into the woodwork only inches from the hero's head has all the credibility of the real thing! However, this short sequence is probably filmed as an entirely separate shot.

Television does not often provide this sort of luxury. The likelihood is that for TV the bullet effect would have to occur during a lengthy scene and would have to be operated on cue with the penalty that should it misfire a substantial part of the scene would have to be run again. These stringent conditions have bred techniques which, although something of a compromise, nevertheless give the effects designer a sporting chance of fulfilling his commitments.

One very useful and adaptable piece of equipment is the compressed-air gun. Basically this is a large, smooth-bore air rifle, fed with compressed air and capable of firing an assortment of projectiles. Usually several of these gun-barrels are mounted together on a stand, giving facilities for rapid fire as well as single

A single-barrel compressed-air gun used to fire projectiles in the studio. The rear end of the barrel comprises a solenoid-operated valve and a bayonet fitting for the heavy-duty air-line.

shots. The gun-barrels, which need be only thick-wall brass or steel tubes, are screwed to solenoid-operated air-valves, which are in turn connected by high-pressure air-pipes to the pressure-control valve of an air-cylinder. Sights are fixed to the barrels, which are mounted on universal joints enabling them to be individually aimed. It is, of course, necessary for them to be locked off once their position has been set. Firing is accomplished either by the operation of a single press-button or, in the case of machine-gun fire, a rotary-switch.

A variety of either hard or soft projectiles can be used with this type of gun. Some are designed to provide their own shower of débris or dust, while others can spatter "blood" or "broken glass".

To examine the technique a little more closely one must first visualize the sort of effects that might be needed in the studio. For example, there is the scene where a gun is fired, followed by a close-up of a vase, window, or bottle being smashed. Another popular occurrence is where woodwork, such as the panel in a door, has to be shot out from behind. There is also the bullet which must appear to kick up a cloud of dust from the studio floor or even from a canvas flat.

In the first examples the vase, bottle, window, or woodwork would all require to be shot at by solid projectiles. These may be of steel, brass, lead, or wood as the occasion demands. They may be fired with full air pressure (the danger can be appreciated), or with only minimal pressure. For example, if a wooden panel had to smash, full pressure might be required and, for splinter effect, a metal bullet (a small piece of rod, sawn to length, the flat end causing maximum damage). Alternatively, a small plaster ornament might require only light air pressure and a wooden bullet. Much depends, of course, on the range, and it is hardly necessary to state that the closer the gun can be to the object, the better for both accuracy and precise regulation of pressure.

A lot depends on the target which has to smash, and very often this must be subjected to some form of pre-treatment in order to assist the effect. For example, the woodwork would probably be a specially prepared balsa wood and expanded polystyrene laminate, while the glass would be backed with transparent plastic sheet (see page 164 on breakables).

Projectiles for an air gun of this kind need not be machined to fine tolerances. Simple pieces of sawn metal rod or wooden dowel can be fired with reasonable accuracy.

Pharmaceutical drug capsules made of gelatine can also be used with this air gun. The capsules, filled with powders or mixtures, can be fired at the floor, scenery, or props where they burst, either giving the effect of a cloud of dust or, by spreading coloured paste, producing signs of apparent damage.

For these effects to be successful it is essential that the surface against which they are to be fired should be both sufficiently robust (capsules will sometimes shoot straight through certain types of scenic flat) and sufficiently heavy to burst the gelatine (canvas flats or moulded plastic-faced constructions can sometimes so absorb the impact that the capsule falls undamaged to the floor).

The same capsules may be used to contain liquid, although this obviously must not be an aqueous solution which would dissolve the gelatine.

Capsules may be prepared to suit special requirements. Some may contain vaseline and slivers of metal foil to produce simulated holes in a plate-glass window.

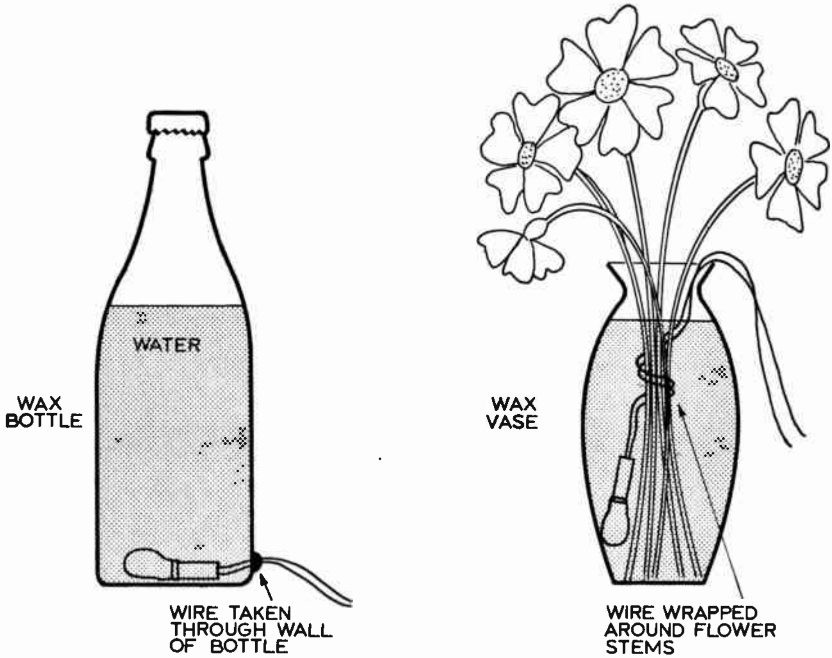
Whatever the projectile, the loading procedure is the same. A small piece of cotton-wool is first pushed down the barrel with a ram-rod. The projectile is then inserted and also pushed down until it can go no further, after which a second piece of cotton-wool is pushed down to anchor the bullet. This second piece of cotton-wool is not required if the barrel points upwards.

Bullet effects using pyro-fuses and bullet-hits

Bullet-hits, being self-contained explosive devices, are ideal for single- or multiple-bullet effects in the studio. They are efficient in operation, having considerable "punch" for their size, and by exploding without visible flame give a wholly realistic effect.

Unfortunately, when a run of several electrically fired bullet holes is required the preparation and wiring-up can take a fair amount of time. This can be embarrassing if a retake is called for. One way round this is to prepare and connect up a second set of camouflaged holes, spaced a few inches from the first. It is then only necessary to cover up the first group after they have been fired. If there are to be several takes the compressed-air system should be considered (page 120).

For single-bullet effects the bullet-hit is an obvious choice. Taking as an example a vase which has to shatter, the bullet-hit should be placed inside, positioned close to the wall of the vessel. It is



Wax and plaster vases and bottles may be made to shatter on cue as if hit by bullets. Pyro-fuses with waterproofed black-powder charges or bullet-hits may be used. The water as well as adding to the dramatic effect helps to spread the destructive force of the explosion.

essential, however, that the vase should be made of wax if the effect is to take place near an artiste, as there is a danger from flying pieces.

It is sometimes a good idea to half-fill the vase with water. This transmits the pressure, causing the breakage to be more widespread. It also gives a more interesting effect pictorially.

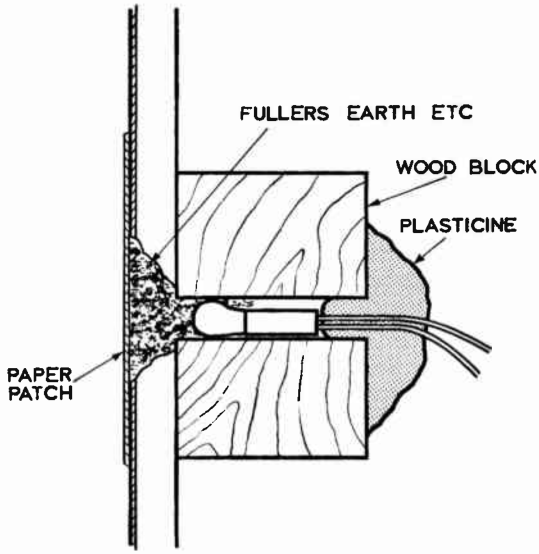
Similar results can be obtained by using a pyro-fuse to which has been attached a small capsule of black-powder or flash-powder. This unit must be suitably waterproofed by dipping it into melted paraffin-wax or a melted mixture of two parts beeswax to one part lanolin. Although not always essential, it is nevertheless good practice to waterproof bullet-hits when they are to be immersed in water, because it sometimes happens that water enters the plastic case via the leads.

For a single-bullet effect in woodwork, a large uneven hole should be gouged out, with a smaller hole drilled through the back to accommodate the leads. The front of the large hole is then camouflaged with either thin balsa wood or card which is painted to match the surrounding wood.

In order that the leads are not left protruding from the hole after the explosion, they can be elasticated to pull back once the bullet-hit has fired. Small pieces of wood put below the surface give a flying-chips effect when the surface ruptures. For "metal", a half-charge bullet-hit embedded into Plasticine gives a dramatic rending effect, while a pyro-fuse gives a neat small hole. To give the Plasticine the appearance of metal it should be coated with emulsion paint, after which it will take most normal finishes.

For ricochets or bullet effects on a rock face, a bullet-hit planted in expanded polystyrene will blast away a considerable hole. If, alternatively, a prepared hole is preferred it should be scooped out and treated with latex to harden the surface. After the bullet-hit (or pyro-fuse and black-powder capsule) has been positioned the hole should be filled in with fuller's earth and pieces of cork. This can then be camouflaged by sprinkling the surface of the fuller's earth with coloured powders to match the painting of the rock.

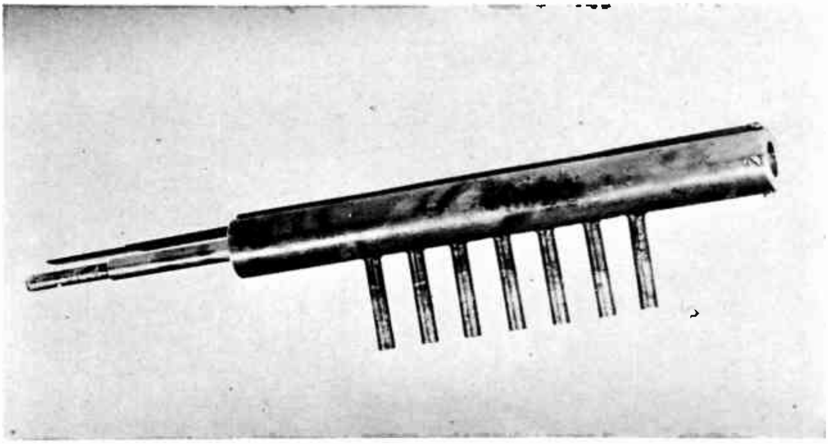
WARNING: *Bullet-hits are in reality detonators, and should not be used in conjunction with material which might detonate sympathetically. This applies particularly to certain varieties of flash-powder which have been known to have high-explosive properties.*



A wooden block fixed to the back of a scenic flat may be used when bullet effects using pyro-fuses are set out. Bullet-hits require metal tubes. The pyro-fuse in this illustration has been provided with a wrapped end containing black-powder installed behind powdered débris.

Bullet effects using compressed air

An economical method of producing machine-gun bullet effects in walls and in the ground is to employ a specially constructed valve which allows compressed air to flow to a number of points in turn. A sequence valve of this type consists of a piston which when moved up and down a cylinder can feed air consecutively to a number of outlet tubes. The piston is formed from two cup-washers at the end of a tube (which is also the operating handle). The cup-washers are spaced apart and face inwards to each other, providing a gas-tight seal, in the middle of which is the hole supplying the compressed air.

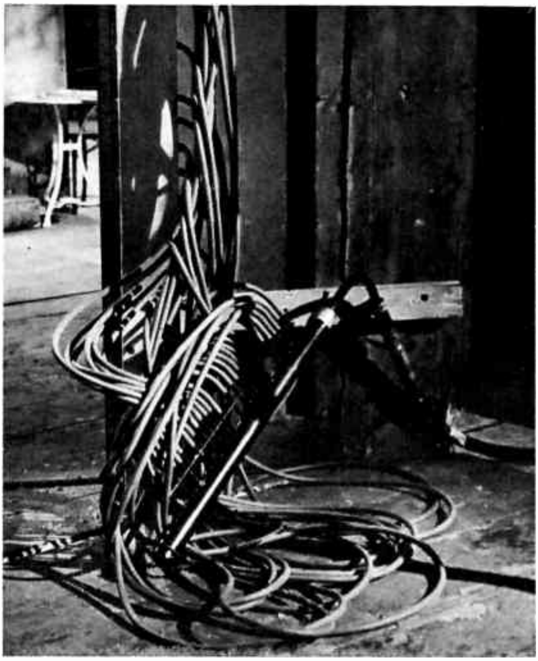


A valve which permits compressed air to be fed sequentially to a number of rubber hoses. Used for machine-gun bullet effects in the ground and in studio scenery.

With a valve of this type air can be supplied, via rubber hoses, to a series of holes in a piece of scenery; or for location work, the pipes may be hidden in open ground. For the former, each pipe should end in a small hole in the scenery, which can then be filled with such material as fuller's earth or talcum powder.

To camouflage these holes before firing it is necessary that the powder should match the base colour of the flat, because it might be necessary to dust it completely over the surface when the holes have been filled. Larger holes may be made, and these should have small pieces of balsa wood or wafer biscuit placed over the cavity. It is still necessary to rub powder into the cracks to hide them, however.

The sequence valve connected up to a door post where it will give the effect of machine-gun fire.



Sometimes the face of the set can be camouflaged to disguise the fact that prepared bullet holes are there, but care must be taken that this does not have the effect of also camouflaging them *after* they have been fired.

The most suitable types of surface for bullet effects are rough concrete or broken plaster walls and rock faces. Worst are unbroken plastered walls or those with prominent wall-paper patterns.

The air-valve device works well when the pipes are run below ground. In hard-packed earth depressions can be made at the ends of the pipes and filled with silver sand (coloured with cocoa or powdered charcoal if required). When operated, spurts of "earth" are blown into the air and the material around the pipe conveniently settles back for an immediate re-run. The effect of machine-gun fire sweeping back and forth can therefore be maintained for two or three runs.

Where large pieces of surface material are to fly off, either on walls or on the ground, it is sometimes advantageous to place small piston pieces in the ends of the pipes. These can be in the form of wads of Plasticine or small wooden dowels.

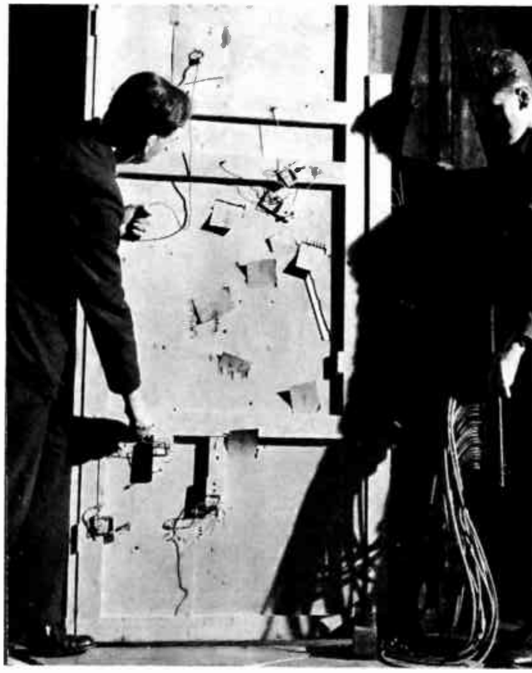
A door subjected to "machine-gun fire" can be constructed as a large, pull-out caption. Strips of paper coloured to match the door are pulled out revealing the black painted backing. Holes appear in a realistic sequence while pieces of moulding, energized by mousetraps, fly off in sympathy. ▶

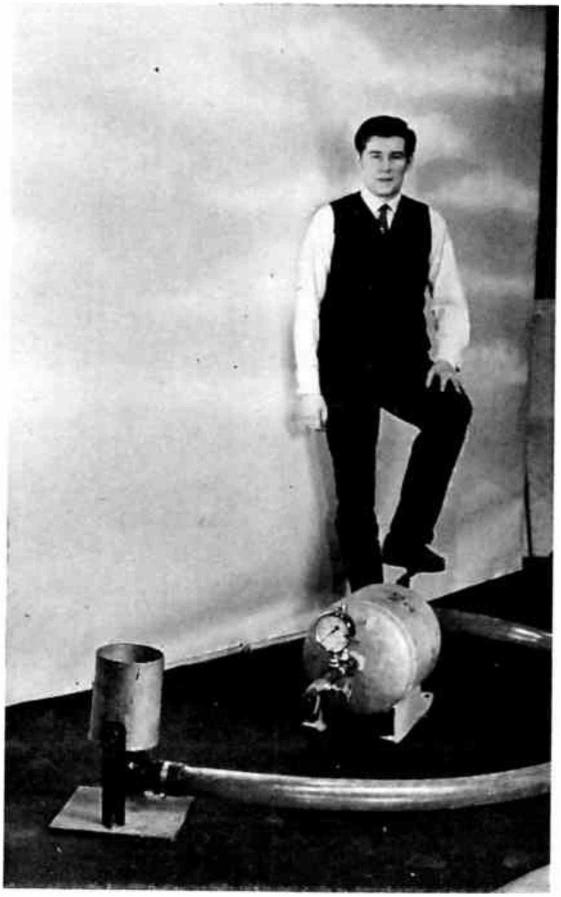
Compressed-air bomb

A device that has many uses in the studio is the compressed-air bomb or projector (although it is more often affectionately referred to as "the whoofer"). It consists of a cylindrical steel reservoir, capable of storing compressed air to a pressure of 75 lb per square inch. A specially constructed exhaust valve with a powerful leverage allows the entire contents of the reservoir to be released at once. A large-bore flexible tube connects the air reservoir to a metal pot into which is packed the type of débris required. On "action" the lever is punched firmly down, releasing all the air into the base of the pot, which, mounted either upright or lying down, discharges its contents immediately. Filled with powder and pieces of softboard or cork, it presents little danger, but looks most impressive.

It is often used in conjunction with an electrically fired flash, which may be placed either in front or behind the iron pot. This adds realism, but it must be positioned in such a way that the exploding flash does not ignite the débris discharged from the pot. It can be arranged for the flash to fire via contacts fitted to the lever of the exhaust valve.

If it is not convenient to dub on sound at a later date a stage-





The "Whoofer". A compressed-air cylinder with a quick release valve is able to provide the energy for harmless "explosions" in the studio.

maroon may also be fired from the flash contacts. This should be placed in a metal dustbin and situated away from the action, but near to an effects microphone reserved for this purpose.

As well as firing loose material, the whoofer may be used to lift or throw things. For example, a table that had mysteriously to jump could be placed over the pot, which would be stuffed with rolled newspapers. The distance between the underside of the table and the pot would have to be determined by experimentation, but it would be quite small, unless something like a cardboard tube could be used between the two. This practice is not recommended, as in the event of an accident the tube might be fired into the studio lighting, whereas the rolled-up newspaper presents little danger.

The whoofer naturally makes a noise when it is discharged, and if this is to be camouflaged by a bang it is of no consequence. If silence is required the operator can be given a button to cut the microphone circuit momentarily as he fires the effect.

For large explosions the loose material in the pot can be used to push up further débris. The pot, once filled with powder and loose pieces, may be covered with sheets of such material as builder's softboard. In turn these may be covered with piles of cork lumps or expanded polystyrene. Quite large areas can be built up in this fashion. It is advisable to use such materials as fuller's earth or coarse sawdust when the whoofer is used in the TV studio. This minimizes the danger to cameras, where ventilating blowers might suck powder into the electronics. Flour must never be used for this or any other type of indoor effect, because in fine suspension it can become highly explosive.

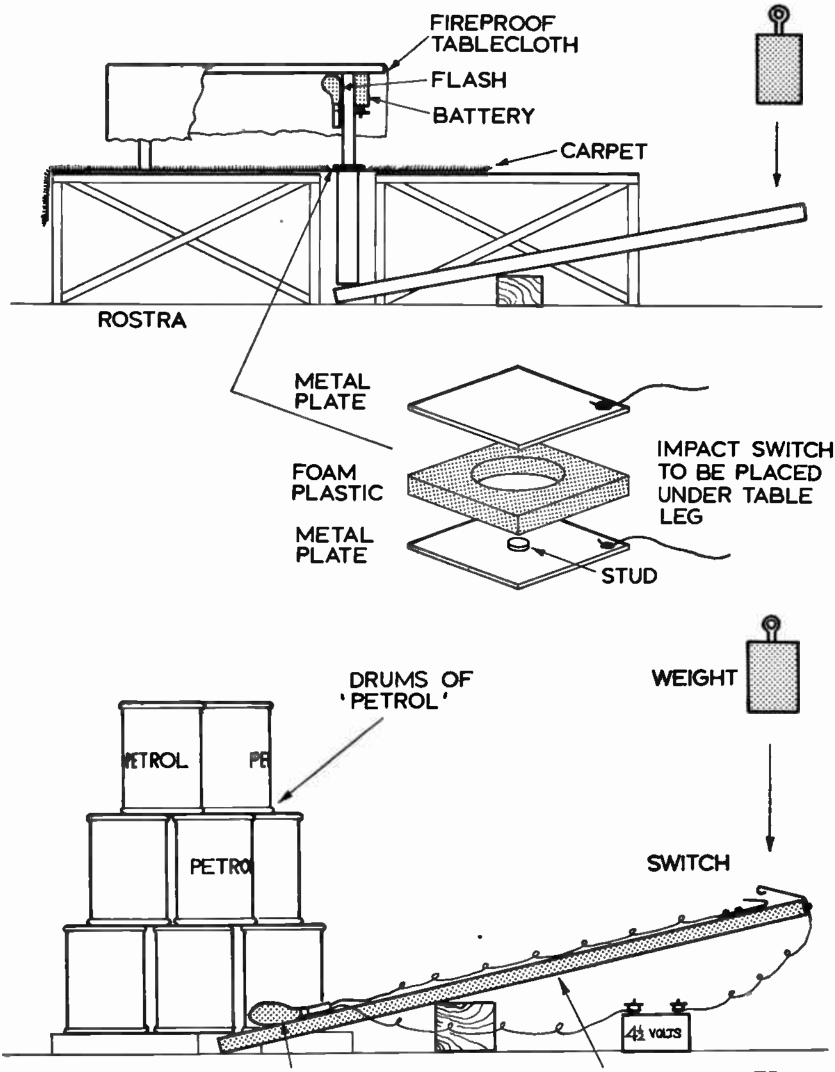
Falling-weight device

Very often it is necessary to arrange an explosion in the TV studio, where it is virtually impossible to use anything other than the most innocuous effect. The falling weight often provides a simple solution. Take a hypothetical comedy where the funny man bangs on the table with a hand-grenade. (Big explosion followed by a comedian appearing blacked-up and with torn clothing, says the script.) Under the table is placed a horizontal baulk of timber which is conveniently out of sight. This beam has a fulcrum, also out of shot. If the end of the beam is pressed down the table rises, but if a heavy weight (such as a large sandbag) is dropped on to the end of the beam the table jumps smartly into the air. It is an easy matter to fix two contacts on the end of the beam, which will act as a switch when wired to a mag-puff or flash fitted to the front of the table. The weight is dropped, the flash explodes, and the table jumps several inches into the air.

The falling weight can be adapted to meet many requirements. It was once used to throw a pile of practical jerricans into the air. The beam was of 6-in by 4-in timber and the weight was a large block of concrete. Between the cans were placed flatpacks of flash-powder and the contacts were positioned where the concrete would strike the beam. The hero, passing the stack of jerricans, stopped, lit a cigarette, threw down the match, and whoof! up went the "petrol".

Swinging-weight device

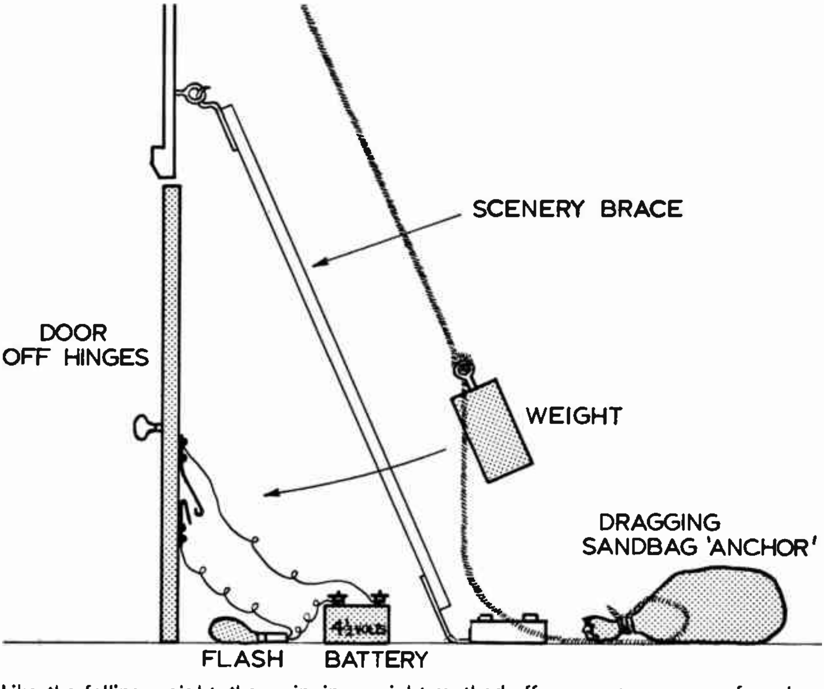
Like the falling weight, the swinging weight can be used in a number of ways, but its popular use is when an explosion, sup-



Two examples of falling weight explosions. The falling weight may safely be used in the studio, but it can also be instrumental in providing big "explosions" outdoors.

posedly happening out of shot, blows out a door or a wall which is plainly in vision. A door invariably presents problems in this respect, because even the lightest construction is difficult to fling around with convincing force. However, the swinging-weight method deals with this problem most effectively. It works by releasing a weight, which is suspended from above in such a fashion that it swings down in an arc, carrying anything in its path. For the door effect it is necessary to disguise the weight as something that might have been blasted from the scene of the explosion. It could, for example, be an unidentifiable wooden construction. Made in box form, it could be filled with sand, and to look the part it could have blackened pieces of wood attached to it. Allowed to swing down, it should hit the door at the bottom, knocking it violently from its place (the door is, of course, freed from its hinges at this stage). To prevent the weight swinging too far into shot it should have an arrester, such as a sandbag laid on the floor and attached to the weight by a length of rope of sufficient length to stop its progress after it has hit the door. Trial and error will fix the position at which the sandbag should be placed and also determine how far it will drag before finally arresting the weight. (It *must* drag, otherwise the arrester rope might snap.)

To make this effect fully realistic it is a good idea to fill the area behind the door with smoke. This is sucked out when the door flies and helps to camouflage the swinging weight.



Like the falling weight, the swinging-weight method offers an easy means of applying energy to a particular spot. The arrangement pictured here shows a door being "blown out". Few other methods could propel a door with such force.

The swinging weight (similarly to the falling weight) can be used to trigger off a flash to simulate the explosion that supposedly blows out the door or the wall. Contacts to fire the flash may be attached to a cord placed in the path of the weight. Ideally the flash should occur at a point when the door just leaves its frame, and although the flash provides smoke, it is still a good idea to use the smoke machine immediately prior to dropping the weight.

Elasticated fly-apart explosions

To effect a big explosion without the use of large quantities of explosive calls for one of those tricks of the trade that satisfy the effects men and puzzle the viewer. Such an explosion may be achieved by elastication and can be made to look convincing, with the added advantage that it can be fired in close proximity to artistes. It works like this. An object is constructed of separate parts, which are assembled without fixings. From each part is taken a long nylon thread which is joined to a piece of strong elastic. The elastic (which is out of shot) is then fastened to an anchor point, which may be specially provided or may be a studio wall or a tree on location. To restrain the pull of the elastic the separate parts of the object are held together by tying them all to a central point, using more nylon lines. At this stage everything is in equilibrium. When the explosion is required the internal nylon lines are destroyed by an explosive charge placed at the point where they meet, allowing the separate parts to fly away on their elasticated lines.

An example of the use of this technique concerned a hand-cart loaded with barrels of gunpowder and drawn by a small group of actors. It was being pulled towards the castle-gates when a musket-shot supposedly hit one of the barrels. Conveniently, just before the explosion the cart had been stopped and the actors had surged forward, shouting threats.

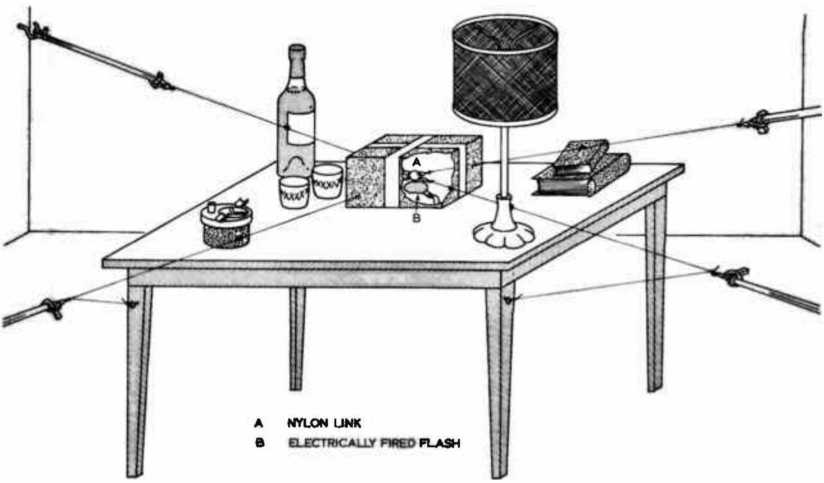
The cart was constructed of lightweight parts made from balsa wood, expanded polystyrene, and thin ply, except for the base of the cart, which was a single sheet of blockboard mounted on a practical axle and cart-wheels.

For the shots where the cart was pulled along the pieces were held together by screws, but for the explosion these were removed. At this stage a camera viewpoint was established and the cart was elasticated to trees, walls, and pegs driven into the ground. The heavy wheels were removed from their axle and leant against the cart, which was supported by black painted battens. So that the battens should not be seen, they were hidden behind the wheels, which, in turn, were partially obscured by carefully placed actors. All the components were held together by nylon lines, conveniently taken to a ring-eye screwed in the floor of the cart. The charge of black-powder which was to destroy these lines was placed close to the ring-eye.

To get the full effect of an explosion, maroons were placed in piles of cement dust on the floor of the cart (hidden by the lightweight barrels) and were positioned away from the actors. Underneath the cart further elasticated lines were taken to the battens and to the wheels, to be released by a charge of flash-powder. This bright light helped to amplify the explosion as well as severing the holding nylon lines.

Finally, groups of actors were positioned where they would not be hit by flying pieces but close enough to the cart to appear to be fatally involved in the holocaust.

It is important to realize that the elastic ropes for this sort of shot must be long enough to pull the parts well clear of the explosion if it is to look effective. Another point worth remembering is that the battens supporting a load such as the cart will pull away only if they are sawn through the middle. This saw-cut does not interfere with their load-carrying capabilities, but ensures that they do not jam between the ground and the item they are supporting.



A typical example of an elasticated explosion. When the flash (B) is fired it destroys the nylon link (A) which is restraining the various lines. The lightly constructed parcel tears apart and the items on the table fly outwards. The front legs of the table are separate and merely stood in position.

The elastic technique is also useful in the studio. For example, it might be required to explode, say, a parcel bomb on a table. The bomb and all the surrounding objects could be elasticated and released by a single small flash-powder explosion in the centre.

Another application is when a soldier has to have his helmet shot off. His headgear is attached to a stout elastic by a suitable length of invisible nylon line. Instead of the explosion release, the nylon pulling line is held taut by another actor. When he releases it the hat flies into the air. If the line between the hat and the actor holding it is slack before release the snatch effect associated with the impact of a bullet is improved.

Where long lines would be impractical, elastication can be carried out internally. For example, an item such as a TV set required to fly apart explosively could be made so that spring-loaded levers fling the sides, top, and front from the base. The levers would, of course, be held in check in similar fashion by a loop of nylon which would be burnt through by a flash-powder explosion.

Safe doors and locks

Techniques change as much in criminal practice as they do in other spheres, and no doubt some master crook will invent a method of opening a safe door without any noise, smoke, or flame —which will be a pity, because it will rob TV of one of its best dramatic sequences. It is generally accepted that explosive is applied either to the key-hole or to some cavity specially made by the criminal. He is then supposed to connect a detonator and cable or to light a fuse before retiring to a safe distance. This spine-chilling build-up must naturally be followed by a culminating explosion, in which the door is seen to burst from its hinges as smoke pours from the safe.

If the safe door is a large one, albeit a wooden prop, it may be projected outwards by an internal spring mechanism or it may receive the necessary impact from a swinging-weight device hidden behind the scenery, with the push being transmitted either by a suitable rod or by one of the actual shelves inside the safe. Contacts fitted to the rod or the shelf can be made to fire a flash inside the safe, and this provides enough smoke to look convincing. Sometimes the flash is not required, in which case a smoke capsule can be burnt inside the safe prior to the blowing.

If spring devices are to be used to operate the door they can be

A safe which can be "blown". The door, opened by a powerful elastic spring, is held shut by a nylon link. This is destroyed by a pyro-fuse fired simultaneously with a flash positioned inside the safe.

held in check by nylon cord, which is destroyed by a small charge of black-powder or flash-powder. One pyro-fuse (or better still, two) may thus be used to blow the safe, create a flash, and supply the smoke.

Sometimes the action of a play calls for the explosion to be muffled, and crooks on these occasions are supposed to surround the safe with mattresses or carpets. The whoofer compressed-air device may be used to good effect during this sequence. Stuffed with feathers or torn-up paper, it may be fired synchronously with the safe blow-out or with a local flash (mag-puff), both being positioned behind the safe.

Fortunately the method of opening a locked door in a hurry has

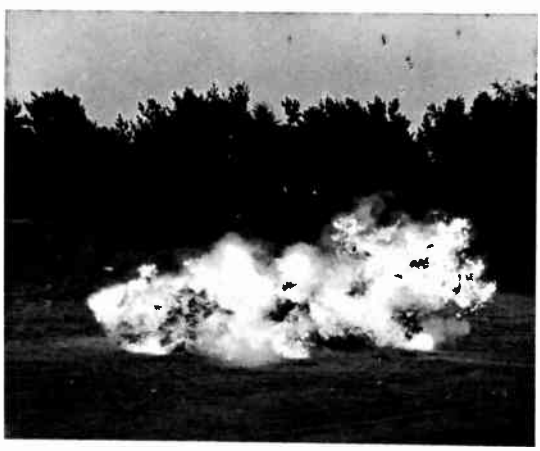
Flour bomb: A ground maroon surrounded by flour bags will produce a spectacular explosion. The flour partly burns giving a yellow flame while the unburned particles add to the white smoke.

not changed. The hero or villain produces a gun and blasts the lock to pieces.

Sometimes a bullet-hit may be used, but for this the lock must be constructed of balsa wood or plaster and must be renewed for each take. More convenient is the replaceable lock. Constructed of metal parts and held together magnetically, it is blown off by a pyro-fuse with a small sachet of black-powder.

A spring-loaded lock hasp can be made where the fly-off energy is supplied by a rat-trap placed at the back. This can be operated remotely by a trick line and is used where only a simple device is called for or where the smoke and flash of the pyro-fuse would be out of place (such as a lock on a door in a dark part of the set).

A naphtha bomb: This produces a characteristic ball of flame with black smoke.



Flour bags, petrol, and gas

Explosions on location can be as varied as the flowers in May. From sharp hand-grenade bangs, they can be increased in size until they rival full-sized bombs or shells. Even exploding ammunition dumps are not unknown in television drama.

Bags of petrol hung over a ground maroon produce an upward flaming explosion with little smoke.

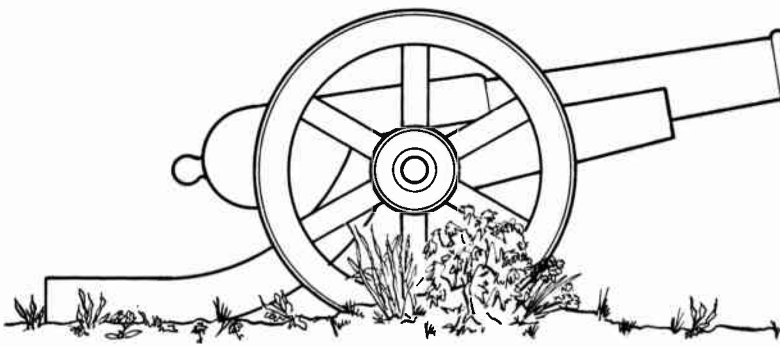
Much depends on the way in which these explosions are filmed, but basically, variations of effect are governed not so much by the pyrotechnics or the explosives used as the material which surrounds them. A maroon fired from a position on top of the ground provides very little visual effect, but the same maroon buried in a pile of flour produces a substantial explosion. Two maroons, more bags of flour, and a couple of flash-pots appear even more devastating. Flour, as has been previously emphasized, must not be used indoors, but outdoors it may be used in open spaces away from actors. It contributes a great deal to an explosion, because it enhances the flame by providing a large orange ball of fire, and that which does not burn is flung into the air as a cloud of dust. Domestic flour, sold in paper bags, can be conveniently stacked like building bricks around maroons. If the position of the explosion is to be camouflaged, both maroon and flour bags can be laid in a hole and lightly covered with earth or coloured powders.

For the sort of explosion associated with the demolition of oil stores, petrol may be poured into plastic bags, which are then hung over a combination of maroons and flash-pots. The effect of this is to send a large burning mass into the sky.

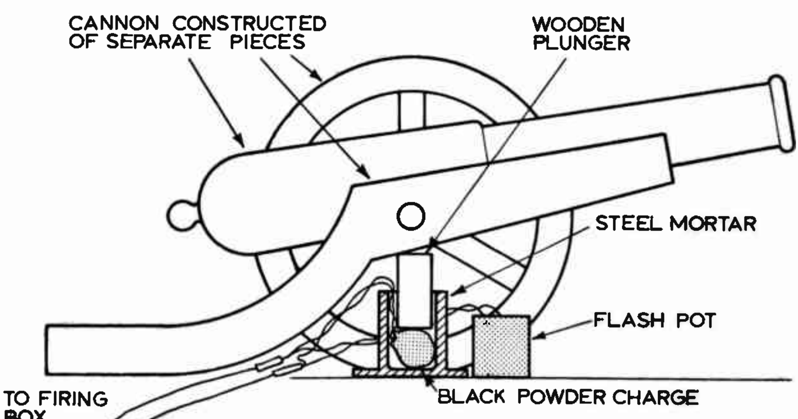
Mortars

Black-powder may be used to lift or project quite large objects when used in a mortar. A mortar is a short steel tube, sealed off at one end and usually equipped with an iron base or stand, enabling it to be firmly positioned when in use. A mortar, being like a short gun-barrel, is able to confine the explosion, allowing the energy to escape in one direction only. To blow up a full-sized cart it would be useless to place maroons underneath. But the same amount of explosive placed in a mortar would hurl the cart into the air.

In use the mortar must have something which would approximate to the shell in a cannon for it to be effective. In the example of



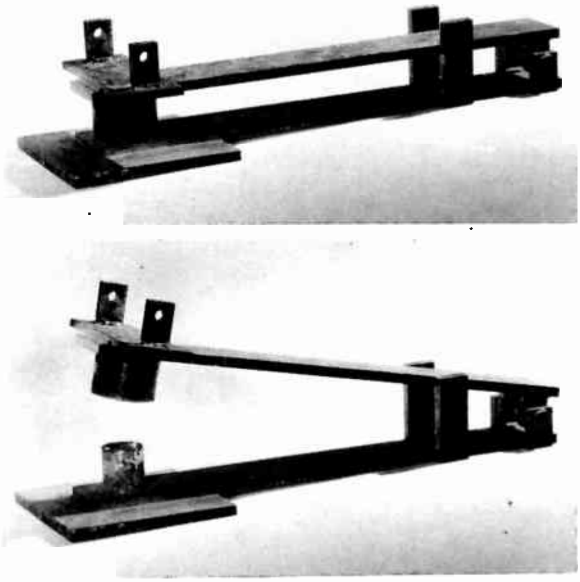
SIDE VIEW



CUT AWAY SECTION

A cannon which had to explode might seem to present both difficulties and dangers. Constructed from separate pieces and "blown-up" using a mortar as shown it could be easily and safely destroyed in reasonable proximity to actors.

Blowing a tree stump: A cylindrical steel mortar placed in a prepared hole is used to blow a lightweight plastic tree stump into the air. The small board was used to protect the property stump from damage by the wooden push-rod.



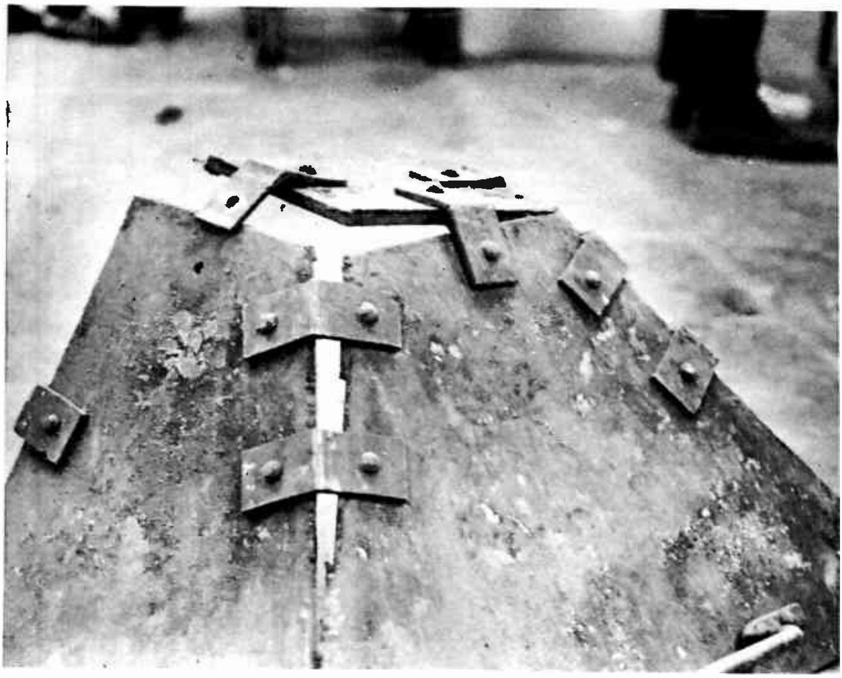
Hinged mortars fitted to the wheels of a cannon will cause it to recoil in synchronism with the firing of the barrel. Small gunpowder charges are fired in the bottom cups.

the cart this would probably be a length of wooden tumbler or dowel. The charge, wrapped lightly in paper, would also contain the pyro-fuse. On top of this would be inserted a wad of paper followed by the dowel, the whole lot being pressed lightly down. The mortar would then be placed on firm ground under the cart with the end of the wooden dowel wedged firmly against a substantial part of the body. If it were not in contact with the cart or if the area above it were not sufficiently robust there would be a danger of the projectile's being fired through the cart without lifting it. Pieces of thick timber placed between dowel and cart would normally prevent this.

Specially built mortars (see above) having a captive projectile (in this case a cap placed over the mortar) are used where it is required for field cannon to recoil. These devices, resembling large hinges, are placed below the wheels and fastened firmly to the rims. They can be fired electrically in synchronism with the firing of the gun, causing the cannon to bounce realistically.

Materials used for explosive effects

It is a great temptation when engaged on a number of simultaneous television productions all demanding effects or service of one kind or another to use whatever materials come to hand. With



A heavy steel mortar pan which has been damaged by repeated firing of ground maroons. Pans like this are used to ensure that maroons buried below ground do not fling stones and earth at nearby actors.

the pace of television this is often a necessity, but for explosions the wrong material can sometimes dilute the effect.

Whether for use with real explosives (flatpacks or maroons) or with the whoofer, the following materials offer good value:

Simulated earth—

Fuller's earth coloured with cocoa or powdered charcoal, peat (damp if used with practical pyrotechnics indoors), bran. For stones use broken cork (obtained from the manufacturers of refrigerated storerooms and usually dark brown).

Sand or light-coloured terrain—

Sawdust, fuller's earth, plaster, cement, flour mixed with fuller's earth or cocoa (outdoors only). Small cork chips (the type used to pack grapes).

Woodwork—

Balsa wood, builder's softboard (used with practical pyrotechnics this material tends to smoulder, and so care must be taken when used indoors), hardboard, sawdust bound with fuller's earth.

Rocks—

Pieces of expanded polystyrene covered with latex emulsion to harden surface, cork, rag and plaster.

Concrete and bricks—

Expanded polystyrene, extended plaster, sawdust bound with fuller's earth, rigid plastic foam.

Soot and coal dust—

Rubber dust—obtainable from retread tyre manufacturers.

Filming and recording techniques

Broadly speaking, effects of an explosive nature can be divided into three categories: small explosions to represent bullets striking a surface, large explosions which are meant to simulate the explosion in the ground of shells, bombs, or grenades, and the sort of explosions where something or somebody is blown to pieces. These may be subdivided into those which are shot on location and those which occur in the TV studio, and subdivided yet again into close-ups or long-shots. All these effects require different methods and techniques, and while some of them are comparatively easy to achieve, others require a great deal of artifice to get convincing results.

It is much more difficult to create realism in the TV studio than in the wide areas available for location filming. It is therefore essential to adopt methods in the studio which will convey realism without necessarily being realistic.

In principle it is better, when showing bullet or bomb effects in the studio, to play these effects around the edge of frame. Machine-gun bullets appear much more realistic if they are not exposed in the centre of the picture. Most action takes place in the middle of frame, and therefore anything happening near the edge is "seen" only after it has gone, and the viewer is probably less critical if he is unable to study each separate bullet hole as it occurs or to see clearly the source of an explosion.

A cannon fires resulting in a direct hit on the castle wall. Behind the wall expanded polystyrene "stones" are piled over a mortar which will fling them upwards and outwards.

Bombs or shellfire in the background can be simulated by using car head- or side-light bulbs slightly over-run. Supplied by a voltage higher than that prescribed and controlled on sliding dimmers, they can be made to flare up and die down like distant eruptions. Short sharp stabs at the switch can make them appear like the fire from distant guns. If the atmosphere is smoked up a little these lighting effects are much enhanced.

For frontal lighting effects it is possible to use either off-stage flashes, such as mag-puffs, or the arc effect produced by the electrician's scissors. The latter device is the one used to produce flashes of lightning for storm effects.

For location filming, the effects of grenades or shells exploding in the ground are relatively easy to produce. Maroons and flash-pots are set up where they will give the most value, and after safe distances for artistes have been established are merely fired when wanted. On open ground the positioning of explosions is not very critical, but when bombs are to be seen exploding in wooded areas problems arise which are often difficult to overcome. The danger lies chiefly in the fact that whereas a real explosion would strip most of the branches and leaves from the trees, maroons may be fired in profusion without causing so much as a stir. For this reason trees and shrubs should be avoided wherever possible, but if it is essential to the plot that an explosion should take place near foliage, the elastication system can be applied. Small shrubs and branches can be connected by nylon lines to strong elastic ropes tied off to other trees with a central anchor point going to a peg in the ground. The main explosion is placed around the peg in such a way that when fired it will release the lines holding the foliage, allowing it to be pulled smartly into the air. Sometimes this effect can be rigged without elastic at all. Branches which surround the site of the explosion can be pulled downwards and tied off to the anchor peg. When released by the charge they jerk sympathetically.

An explosion to destroy something is usually quite simple to arrange, providing it is filmed or recorded in such a manner that later editing will allow two or more pieces of film to be joined up in a way that suggests a continuous take. We will imagine, for example, that a space-age robot seen lumbering along must be hit by a blast from a ray-gun. Zaapp! It blows into a dozen pieces! This might be filmed as follows: The robot (presumably an actor in costume) walks to a predetermined spot, at which point the camera is stopped and "locked off". The robot leaves the scene and is replaced by a pile of robot pieces and such materials as broken hardboard, cork chunks, and fuller's earth. All these are piled carefully over a ground maroon. Wired in parallel with the maroon is a bag of flash-powder positioned where the ray-gun is supposed to hit the robot. This set-up could be reinforced with petrol bags or any of the other amplifying explosive arrangements.

The camera is then restarted and the pyrotechnics fired. Later the two resulting pieces of film are joined together with the possible inclusion of two or three blank frames in between to increase the flash effect. The edited sequence would show the robot walking towards camera and then, with appropriate sound effects, flying apart in a shower of débris and smoke. The same technique can, of course, apply to almost anything, moving or still.

Another application of this "jump-cut" method can be visualized in a scene when a soldier crawling across a minefield is unlucky enough to get blown up. Assume the unfortunate man to be crawling across the field when suddenly there is an explosion and he is flung across the ground. For this effect a stunt man must be employed, and it goes as follows:

The camera records the progress of the actor as he picks his way carefully over the ground. When he reaches the fatal spot the camera is stopped and locked off. He leaves, and a small hole is dug, over which is placed a metal shield treated to resemble the surrounding earth. Under this is placed a charge of flash-powder, connected by hidden cable to a firing-box.

The stunt man, with suitably torn clothing and blast make-up, now stands to one side and several yards away. The camera is run up and on the shout of "Action" he runs to the spot and throws himself on to the shield. As he hits it the flash is fired, whereupon flame spurts out around the edges of the shield and from under the stunt man's body. The flash need be only a mild one, because a heavy sound effect will reinforce the illusion.

The momentum of the man running into this position carries him over the shield and he probably rolls across the ground until he lays still, apparently mortally wounded. Certain refinements can be envisaged. The man could, for example, have his clothing filled with smoke from a smoke-gun just prior to his run and jump.

The two pieces of film when joined should have the first two frames of the second shot printed light to add to the flash effect. The product of these shots is a continuous take in which we never leave the man inching his way forward. When the blast occurs, he suddenly twists away from the spot as if blown into the air, rolling over until coming to rest, clothing torn and smoking and features blackened beyond recognition. Only then is it necessary to go into close-up, and the realism makes it all worth while. Substitution effects of this nature have many uses in television film making, not the least of their virtues being economy and simplicity.

6

GUNS, KNIVES, AND ARROWS

MOST television companies keep a stock of guns, knives, and swords for general use, but any deficiencies can be made up by hiring. There are theatrical gunsmiths who specialize in providing weapons for use in TV and films. Not only can they supply weapons and ammunition but in most cases they will provide operators when required.

Needless to say, the handling and storing of practical weapons are subject to some fairly stringent regulations. As well as the obvious necessity for permits and licences, weapons figure prominently in safety codes laid down by the TV companies themselves. Most rigorously controlled are open-ended, fully practical guns. These have to be registered by the local police, and permits must be obtained by those persons actually responsible for their safe keeping (usually the property master or the armourer). Permits are not required in Britain for the purchase of blank ammunition.

Suitable storage must be provided for all practical arms, and when in transit they must be housed in locked cases in the charge of the armourer.

Practical weapons

Because flame and smoke must be seen to emanate from the muzzle, and not from some hole underneath the barrel, real guns have to be used for most purposes in TV productions. These weapons are referred to as "open-ended". They are often capable of firing fully practical conventional ammunition as well as blanks, and rigid precautions must be instituted to ensure that the two types of ammunition do not become mixed—not that this is an ever-present danger, as real ammunition is rarely used in TV work. When bottles have to be smashed or targets punctured it is usually

A selection of guns which may be hired for use in television. (*Bapty & Co. Ltd., London.*)

Simulated flint-lock. Ammo: ·45 ringed blanks (special).

Simulated flint-lock. Ammo: ·22 Blanks.

Thompson gun. Ammo: 50 rounds ·45 auto blanks. Firing rate 600–725 per minute.

Schmeisser MP40. Ammo: 28 rounds 9 mm blanks. Firing rate 500 per minute.

Vickers gun. Ammo: ·303 blanks. Firing rate 500 per minute.

simpler to utilize special effects than to make the arrangements necessary for a marksman to operate in the studio.

Practical weapons using blank ammunition include pistols, automatics, revolvers, rifles, shotguns, machine guns, and automatic weapons of all kinds.

For the weapon that fires single shots it is merely necessary to insert the correct blanks into the breech, chamber, or magazine, where they should fire in the accepted fashion. This does not, however, hold good for automatic or repeating weapons. The blanks will not function without modification to the weapon itself. This is because automatic guns depend upon the back pressure of fully charged cartridges to recock the mechanism and to eject the empty shells. Blanks cannot build up this pressure, and some method of achieving it has to be found. In the barrel, therefore, a choke or restrictor is placed. Welded or screwed into position, this cuts down the escape of the burning gases and so increases the internal pressure. Needless to say, this work can be undertaken only by authorized people (and furthermore only on premises licensed by the authorities). Any weapons so modified must be subjected to reproofing afterwards.

In some cases the ammunition itself may need to be modified, as in weapons which when fired have to give off more smoke than normal or possibly a greater flash. In such cases it is better to consult the suppliers than to carry out alterations that might either jeopardize the user or damage the gun.

Different types of blank ammunition are available for use with most guns. Some blanks have wads (packing to retain the powder), while other are sealed with plastic mouldings. Those with the wads have their cases either spun over or crimped (this is a method of closing the brass case by deforming the metal into a series of convoluted folds).

Of all types, the plastic-ended varieties are the least dangerous. Wadded blanks, on the other hand, are inclined to be suspect. The wads can be ejected with considerable force, and occasionally crimped blanks will fire small pieces of shattered metal case.

Whatever sort of blanks are used, guns must never be pointed at artistes' faces or at exposed parts of the body. Furthermore, they should never be fired at persons' clothing at close range, as blast alone can cause injury. It is sensible for all guns to be aimed away from people, and a director should try to arrange his camera positions so that an actor can fire to one side of his intended target. It is equally important that while pointing the gun away from a fellow artiste an actor does not discharge it unknowingly at any other person in the vicinity.

Period firearms are constantly required for costume dramas and, like modern weapons, can be hired from gunsmiths. These antique weapons can be either genuine pieces or faithful reproductions; all fire by ignition of the loose powder charge from outside the barrel.

They include matchlocks, flintlocks, wheel-locks, and caplocks. Usually only the caplock is considered to be reliable enough for TV work.

The caplock is a muzzle-loading gun. Black-powder is poured into the barrel and retained by a plug of cotton-wool or tissue paper which, in reality, would be the bullet. On the top or to one side of the barrel is a small nipple with a drilled passageway down into the firing chamber. A copper cap containing percussion material is placed over the nipple, and is fired by a hammer released by the trigger.

As an alternative there are other reproduction weapons that appear to fire normally (i.e. by the hammer striking a nipple, or a flint springing forward on to the firing pan) but actually fire modern blank cartridges in a special breech.

A comment worth making here (although seemingly obvious) is that anyone ordering ammunition should ascertain the actual calibre of the weapon. It is sometimes found that hired arms have different characteristics from those supposed. For example, it is possible to hire revolvers of, say, ·38 calibre which have ·32 in chambers.

A gun should never be left around on the set. Someone is bound to pick it up and pull the trigger! At the end of a scene the gun should always be retrieved by the person responsible for its custody.

The costs for hiring and using guns and ammunition can vary considerably. A single pistol with a dozen blanks places no strain on the budget, but an automatic weapon with a possible firing rate of 450 rounds a minute is a more expensive item—not forgetting the charge for an operator.

Knives, daggers, swords, spears, and other lethal cutlery are also classed as practical weapons.

Non-practical weapons

Guns which will not fire and knives which will not cut (the latter not just blunted weapons but possibly rubber or wooden imitations) are non-practical weapons. Most of them are merely props to be carried or handled in the course of the action, but whether they are beautifully executed reproductions or just crude wooden mock-ups, it is an advantage if they are all controlled by the armourer or the person responsible for the practical weapons. This is because there is often a certain amount of overlapping between practical and non-practical weapons, and it is helpful to have a single source of control and expertise. It is easy to visualize the requirements for a scene where an actor first fires a revolver and then throws it into the river.

Among the non-practical weapons can be listed those special props which are made and controlled by the effects men. These include knives which slide into the handle when plunged into a body and razors which draw blood when slashed across a face.

A dagger with a blade which retracts into the handle is, of course, a simple spring-loaded device, but it is advisable for the point to be shaped as bluntly as possible. A long tapering point will show that the blade is not entering the body and so reveal the trick. The blunt point, on the other hand, will be lost in the clothing.

The knife or razor which draws blood should have a moulded polyester (metal finish) resin blade and a hollow rubber handle. During the moulding of the blade a fine copper tube is secreted in the thickness of the resin, terminating in a narrow slot at the edge of the blade. The tube is taken to the hollow rubber handle, which can be filled with make-up blood before the action. Only the slightest pressure should be required to make the blood flow, but action with this sort of prop should be well rehearsed before the actual scene.

A rapier to be thrust into a body can be constructed from a flexible steel rule. A specially made duct is strapped against the torso of the recipient and the shot starts with the point of the weapon already piercing the flesh (this is because it would be impractical for the actor to aim his sword directly into the entry point in the duct). On being pressed home the flexible rule is guided through the entry slot, but is deflected down the body in the 90-degree duct, appearing to go straight in.

There are several applications for this trick (not all connected with weapons). One worth mentioning is a metal plate or "device" which is inserted into the chest of a robot. The purpose is to convince the viewer that he is seeing a hollow mechanical object instead of a live actor. Several pieces of rule are mounted edge to edge, each piece the same way round, until they resemble a convoluted metal plate which is inserted into a suitable duct against the actor's body.

Other non-practical weapons are the fearsome cudgels used to beat people senseless. For comedy shows this is easy, but in drama, where the weapons must appear authentic, it is something of a problem. A weapon must be soft enough to safeguard the victim, but must not appear to flex unnaturally. For instance when a thug with a crow-bar strikes down an elderly nightwatchman the actor must be given a prop which doesn't require him to slow down the action at the moment of striking.

Effective-looking, but safe, weapons and cudgels can be made from moulded latex. They can be hollow or packed with plastic foam, and if it is necessary to stiffen them they can have cores of soft aluminium wire.

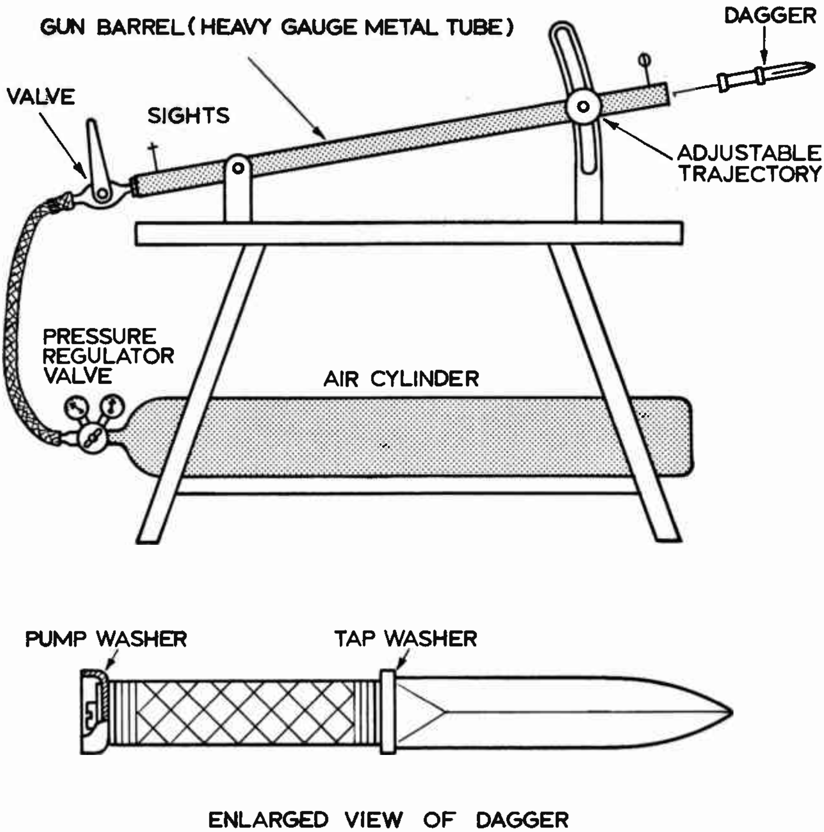
Rigid polyurethane foam or expanded polystyrene can be used to make hammer heads and similar items. These may be given a coating of latex.

One non-practical weapon that performs in a manner resembling the real thing is a machine gun fuelled by gas. Various versions of this exist, and some may be hired. They use a mixture of acetylene and oxygen, or propane and oxygen. The gases are mixed within the gun and are ignited near the end of the barrel by a spark plug. The rate of fire is governed by a motorized switch that controls the low-voltage supply to a spark coil. The gases are fed to the gun by pipes from separate cylinders. These may be hidden in the scenery if the gun is mounted, but if the gun is hand-held the cylinders can be in a pack worn by the operator.

The combination of acetylene and oxygen produces a good visual effect and also gives a remarkably realistic sound effect.

Knife projector

This is a dangerous (one might truthfully describe it as "lethal") weapon that fires a knife as a gun fires a bullet. Nevertheless, the fact that it can be accurately set up and aimed means that it may be considered as one of the safest ways in which to "throw" a knife. In essence it is simply a larger version of the air gun described in the chapter on bullet effects. Consisting of a long, large-bore gun barrel, it fires a knife blade which is set into a cylindrical handle. The handle acts as a piston, driving the blade with force and accuracy at a suitable target. The compressed air which powers the gun is controlled by a manual valve mounted close to the gun barrel. If the rig is a permanent one provision can be made to accommodate the air cylinder and reduction valve on a shelf below the barrel mounting, the framework being equipped with castors for mobility.



A rig for firing a dagger by compressed air.

The barrel should be equipped with accurate sights, and the entire rig must have facilities to lock it in position after aim has been taken.

If the distance between the target and the projector is kept to a minimum the accuracy is improved. The effect should nevertheless be tried two or three times before an actual take. Actors subjected to this type of equipment are entitled to proof of its performance!

The handles may be designed in any fashion providing they comply with certain requirements. They must be long enough to provide adequate stability when the blade travels along the barrel, and it is essential that both ends of the handle should be a full fitting diameter within the bore.

Throwing-knife board

An actor who has to stand against a board and have knives thrown around him may seem to need courage. With the effects board, however, he has only to stand within a specified area to experience all the thrills of the knife-throwing act while safe in the knowledge that the worst that can befall him is a sharp knock from one of the "throwing-knives" should he move out of position.

The weapons in this type of effect are not, in fact, thrown at all. The effect relies upon an illusion. The knives are actually hidden behind the board, hinged in such a fashion that they can spring out of concealed slots when released by solenoid-operated catches.

Knives, axes, and arrows are all amenable to this treatment. Pivoted behind the board, they are strongly spring-loaded with heavy elastic rope and retained by suitable catches. These catches may be released by solenoids remotely operated, or even tripped off by hand if the back of the board is not seen.

The effect relies upon the speed at which the knives flick out, and to ensure that they are not impeded by the slot-covering material, they should be of plain design and uniform thickness. They can be painted to make them look elaborate.

The slots through which the knives appear can be disguised with a covering of sheet rubber or foam plastic suitably slit and, where applicable, painted with a bold, vertical, camouflaging pattern.

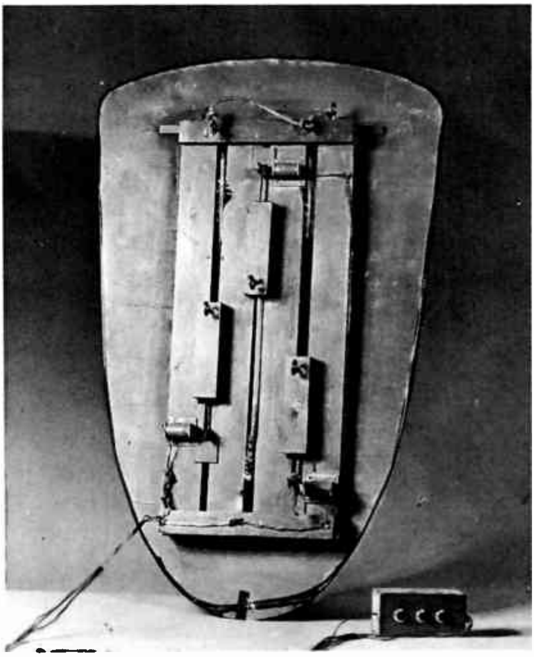
Arrows in scenery

A device similar to that used in the throwing-knife board can be incorporated into certain parts of the scenery when it is required to "shoot" arrows. The arrows, like the knives, do not travel through the air, but merely spring out of the set. A pivoted and spring-loaded arrow is not a difficult object to hide, providing there are suitable vertical lines in the design of the set. Doors, walls, posts, mud-huts, thatch, all offer excellent camouflage.

Where actors are not involved, it is quite feasible to use a bow and to shoot the arrows in the conventional fashion—but the job should be undertaken by a marksman, since even at short range unskilled archers can make a wonderful hash of things once the cameras are on. A lacerated thumb from the bowstring is good for a laugh, but holds up operations.

Enthusiastic effects men might consider the use of a specially constructed, tripod-mounted crossbow for this purpose, but any

Fly-out arrows fitted into a shield. Spring loaded and released by solenoid-operated catches, they whip out so fast that they appear to have been shot from a bow.



device which is capable of being cocked is also capable of being accidentally fired!

There is a method of firing an arrow into scenery which involves the setting up of an "invisible" line. This is usually of fine nylon or spring steel, although the latter is very prone to kinking. The line is fastened at one end to the target and at the other to some out-of-shot anchor point; it is kept taut by elasticating it at the out-of-shot end. The arrow, which is specially constructed from aluminium tube, suitably belled at both ends, must be put on to the line before it is strung up. It is propelled along the line by a simple catapult which has a hole in the centre of the pouch and which must also be put on the line beforehand.

Firing the arrow is not a difficult operation, but may require a little practice. If the ends of the arrow are not belled, or if there are kinks in the wire, the arrow can chafe or cut through the line. If the line gets trapped in the pouch, jerking the line forward and so making it go slack, the arrow will die in mid flight.

Unless the arrow is to bounce back from the target, provision must be made to trap it at the end of its travel. One method is to fasten a pin to the end of the tube so that it goes into the target like a dart.

One way of deceiving the viewer into believing that he has actually seen the flight of an arrow is to perform what is known as a "whip-pan". From a convenient viewpoint the camera (film) is quickly swung round to the point of impact. The target (say a tree) is already provided with an arrow firmly embedded in its trunk, and the camera finishes up by framing this. The effect of this rapid swing and sudden stop leads the viewer to believe that he has actually witnessed flight. The end shot must, of course, be given a suitable dubbed sound effect of "impact" to make the illusion convincing. To speed the flight of the arrow, the pan can be frame-cut (removing every other frame . . . or more), while if the camera swings past the end shot the correct picture can be frozen-framed (reprinting the required frame).

Arrows, knives, and bullets in actors

Generally speaking, no projectile should ever be fired at an actor (even though special padding or garments have been supplied) for the normal purposes of television production. There are many ways of getting satisfactory results without resorting to an inherently dangerous practice. For film work there might be reasons for actually doing this, but success depends on careful and time-consuming rehearsals.

Arrows in the body can be shown either at the moment of entry or as fixed props. If they must be seen to enter it is possible to use the line and catapult, but for most purposes it is enough merely for the actor to spin round, revealing the offending shaft stuck in his back. A special harness worn under the clothing has a protruding threaded stud on to which the arrow is screwed prior to the shot. If there is not time for the arrow to be fixed in this fashion it can be fastened to the harness by a spring. It is then held down either by the artist's standing with his back to a convenient prop or by a thread held off stage.

A favourite and probably well-known method of getting an arrow to fly into the body is to film the sequence in reverse. The trick arrow is held in position by a short tube attached to the body belt, from whence it is removed by a sharp jerk on a trick line. This is best done by elasticating a nylon thread, pulling it forward, and then letting it fly back. The resultant snatch is both fast and straight.

After processing, the film is printed in reverse, showing the arrow entering the body. The trouble with this method is that all other actions must also be in reverse order. The actor must go from his dying bit, through the reactions of pain and surprise, to the attitude of composure which precedes the arrow flight. In order that the actor (and the director) can get it right, it is advisable to film a similar action beforehand (the right way round) and screen it in reverse. The effects man's 8-mm movie camera comes in handy here.

Stabbing may be treated in the same way as the arrow in the back. A special harness containing a slotted receptacle will allow a shortened knife to be inserted through a prepared hole in the clothing. As with the arrow, the artiste can reveal the knife by spinning round or plunging forward.

Should it be required for the stabbing to take place in vision, the knife, suitably shortened, can be left with two spikes on the end. A cork block, backed by an appropriately large metal plate and worn under the clothing, will receive and retain the weapon if used well. The pins must naturally be long enough to support the knife, and a thickish cork block is therefore needed. Its edges should be chamfered so that it does not show under light clothing. The knife can be made of lightweight materials.

Now and then a director wants to show a direct bullet hit on a victim. There are two dramatic conventions for this. One shows the clothing erupting gore at the moment of impact. The other shows the effect on the clothing, but is followed by a stain that spreads slowly. Both may be effected by using "bullet-hits" fastened to a metal plate which is strapped to the body.

For the big gory blow-out, a plastic bag filled with blood mixture is taped over the bullet-hit so that it disintegrates along with the clothing. For the spreading-stain effect, the bag is positioned higher up and the lower end is pulled into a rolled tube shape restricted by tape or thread. The end of this "tube" is placed over the bullet-hit where it will be ruptured by the explosion, allowing the liquid to seep out from the unaffected bag above.

When carrying out an effect where an electrically fired bullet-hit is detonated in close proximity to a person's body it is obviously important to ensure that no real harm results. A stout undergarment should be worn by the actor to cushion the metal plate and also to protect the body from "flash". Inspection of the results of a bullet-hit under clothing will convince even the least timid person of the need for adequate precautions. The bullet-hit itself should be securely taped to the metal plate, and there should be no possibility of its moving away from its position in the centre. To preclude its being pulled free by some action involving the supply cable, this cable should be secured to the body harness by tying or securely taping.

If the effect is wanted without the explosion the blood sachet, attached to the belt, may be punctured by the artiste as he clutches his chest. To do this he should be wearing a ring on which has been welded a small metal pin. The flow will be speeded up if the sac is pressurized by elastic bands holding it to the harness plate.

As further proof that an unfortunate victim has been severely shot a director will sometimes request that his body is visibly flung backwards by the force of the bullet. The means of achieving this must be left to the discretion of the actor or stunt man. To act the jerk convincingly is just not possible. An alternative is for the actor to wear a body harness to which is attached a rope. This should either be snatched back by off-stage personnel or subjected to a dropping-weight device, but there is an obvious danger of neck or spine dislocation if things proceed too energetically. If the incident is filmed it is possible to cut a few alternate frames to double the speed of the action at the actual moment of "impact".

Firing a ray-gun

The ubiquitous ray-gun featured in so many science-fiction dramas is popularly supposed to destroy its target by emitting a pencil-thin beam of intense energy. This is displayed either as an actual ray or light beam from the muzzle or, if the ray is invisible, as the eventual effect on the target. Sometimes it can be both.

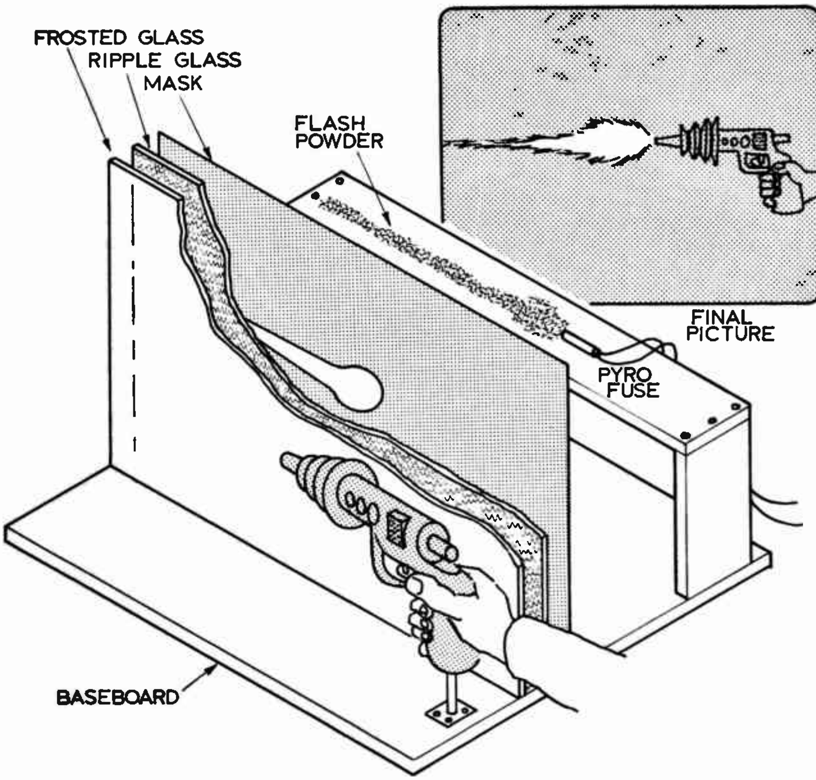
The beam of light can be added afterwards if the firing has been prefilmed, but it can also be superimposed during the actual scene by employing 50/50 mirror techniques (see page 223). In this case the mirror is used to combine the ray-gun with an illuminated picture of the beam. The mirror, placed at forty-five degrees to the lens, features the ray-gun (seen through it) while reflecting the beam. To obtain registration between the two it is necessary to fix the gun in some way. If it is to be hand held, a rod can be taken from the butt of the gun to some convenient anchor point, such as a table or the floor. This support is so shaped that it is obscured by the artiste holding the gun as it passes behind his body. The ray is an illuminated slit cut in a sheet of black card. A light switched on and off behind the card produces the beam "firing" effect.

In the TV studio the ray-gun and its beam can be combined as a straightforward superimposition using two cameras. For this it is sufficient to paint a white line on black caption paper, the flashing being effected by the vision mixer.

If the gun can be seen firing in close-up a slightly more subtle effect can be obtained by constructing a special rig. In this arrangement the gun is fixed by a metal rod to a baseboard which is out of shot below the picture. The metal rod is bent in such a way that when the gun is held in the hand the rod is hidden behind the wrist and arm of the firer. The hand "holding" it is, of course, only resting upon the firmly anchored ray-gun, but the trigger may be operated in the conventional way.

Placed behind the gun is a sheet of frosted glass, backed by a sheet of rippled glass and a sheet of black paper into which has been cut a slot to represent the "ray". The slot is lined up with the muzzle of the gun by shining a light behind the paper while the cameraman looks through his viewfinder.

When the effect is required a small trail of flash or black-powder, situated about a foot back from the paper, is ignited at the end nearest the muzzle. The flash effect is most convincing. The fact that the powder burns along the trail, even though extremely rapidly, gives a quality unobtainable by the mere switching of a light.



Firing a ray-gun: Flash-powder ignited behind this arrangement of mask and glasses produces a dramatic "blast" from the muzzle.

The rippled glass may be dispensed with, but its use helps break up the regularity of the slot.

There are many ways in which the effect of the deadly ray striking its target can be staged, and two are described here.

The first is for use when the ray is supposed to blast a large flat area such as a wall or a table-top. A blasted and burnt hole is first prepared in the object which is to be shot at. Let us assume this to be a table. We must also assume the table to be purpose-made and for the sake of example that it has a blockboard top with a wood-grain finish. The blasted hole is first prepared in the top, but not penetrating through to the underside. A small hole is drilled through the wood somewhere in the blasted area to admit the firing leads of a pyro-fuse, which is equipped with a small paper bag of flash-powder taped to its head. The blasted hole is now treated to a spoonful of black-powder, which is poured in loose. The next step is to cover the entire table-top with self-adhesive wood-grain vinyl. Finally, the table is turned over and lightly shaken to distribute the loose black-powder over the sticky back of the vinyl sheet covering the hole.

On being fired the pyro-fuse ignites the powder adhering to the vinyl sheet, causing it to burn and soften the material while at the same time blowing it outwards.

If this effect is synchronized with the beam from the gun the results are truly awe-inspiring.

The second example concerns the situation where the ray from the gun is to blast a person. For this an unexpected and unusual effect can be obtained by confining the damage to the back of the victim. Assume that we see him facing us, while in the foreground is the ray-gun levelled at his heart. At this angle a beam from the gun would be both inappropriate and difficult to achieve. Instead a light fixed to the muzzle can be flashed from a remote battery, the supply cable running up the actor's sleeve. The lamp, camouflaged in the design of the gun, should be as bright as possible.

When the gun is "fired" a pyrotechnic flash positioned behind the victim is also exploded. This flash can be placed on a table, chair, or some other convenient support. It can, of course, be affixed to the actor himself, but this demands special flame-proof clothing.

Seeing the light flash on the front of the gun and knowing that it is synchronized with the effect behind him, the victim either spins round or falls forward, revealing the hideously tattered clothing on his back. He has naturally been provided with this mutilated garment in advance.

If there is time for elaboration smoke can be supplied to the blasted garments by pumping it up a flexible pipe from a smoke-gun. This calls for some fairly precise timing, as the smoke must reach the affected area a split second before the firing of the flash.

However well the ray-gun effect is carried out, it is undramatic without the all-important sound effect.

Editing for dramatic effect

Whether telerecorded or filmed, an effect of the type outlined in this chapter owes as much to the manner in which it is edited as it does to the original idea. Editing (and this includes timing during the actual recording) can make or mar the dramatic impact.

When considering a shooting scene it is important to decide where the emphasis shall be. If a man fires a revolver at a row of bottles behind a bar counter there are three factors involved. There is the actor firing the gun, there is the smashing of the bottles, and there are the sound effects. How and where these all occur are dictated by the angles of view and the sequence of events required. Owing to the fact that these three elements are separately controlled, there is little hope of successfully synchronizing them during the moment of action without employing some elaborate staging.

The gun is fired by the actor and is under his control. The sound it makes is less dramatic than a recorded effect, and so a dubbed bang is added later. The bottles are smashed by the effects man situated out of shot. If the effects man "fires" at the moment he hears or sees the gun fire the time-lag, however slight, mars the sequence. It is, of course, possible for them to fire in concert from a common cue, but this presupposes that the director wishes to see both bottles and gun in the same shot. If, on the other hand, he wishes to cut from gun to bottles it is better if the gun is never seen to fire, but only heard over the shot of the shattering bottles. (A sound effect of shattering glass is added as well as the bang of the gun.) If he returns immediately to the gunman it is helpful if smoke is seen in the vicinity of the weapon. This can be achieved by firing the gun after the bottle-shattering shot and cutting into this second shot after the firing.

As an alternative he can view the scene from behind the gunman's back. The gun which has been established earlier is dispensed with, and the actor holds a metal tube containing a small charge which is electrically fired (by the effects man) in synchronization with the bottle-smashing effect. This can work equally well if more than one bottle is to be shot at. The actor can hold a small rig of tubes. The viewer sees the bottles smash and repeated "explosions", which he believes to be gunfire, taking place in front of the actor. As the actor's body screens the source of these effects, the viewer imagines that he still has the original gun.

As another alternative where a number of bottles are being "shot up" the director can switch from gun to bottles and back again. With this method he never sees the two together, so synchronization is not required.

In some cases the effects referred to have to be incorporated in sequences of continuous action. In television this is often unavoidable, but wherever possible the rule should be to divorce them completely, recording them as separate and painstaking operations. It is seldom possible to obtain even passable results if these critical effects are attempted without adequate rehearsal and attention to detail.

7

BREAKABLE PROPS AND FIXTURES

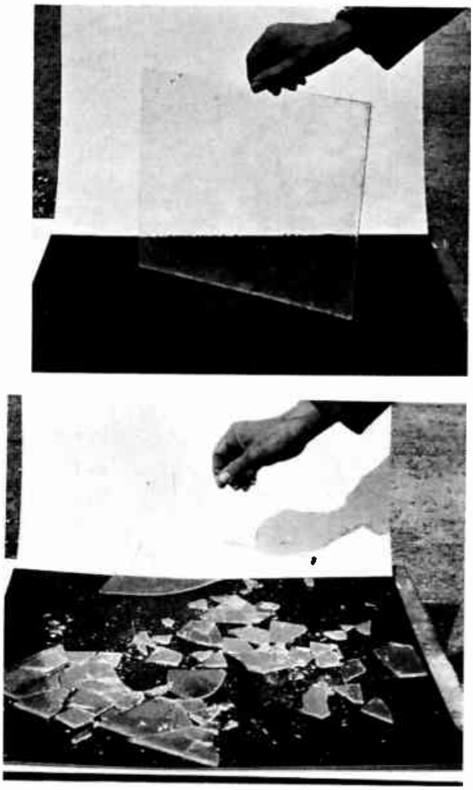
WHILE the staff employed in studios are expected to take care to protect props and furniture from damage, the effects designer is often sorely taxed to devise ways and means of making such items break easily.

To the average viewer these efforts go unnoticed. After all, what is so special about a window that breaks when someone throws a brick through it or a cup that shatters when someone drops it? What indeed? And yet greater difficulties can occur in this aspect of effects work than in the more spectacular commitments. It is an indisputable law of nature that whatever should remain whole will inevitably break, whereas whatever is designed to break will remain stubbornly intact. A china mug knocked from a table accidentally in real life will smash into a dozen pieces, but when dropped by an actor to perform in the same manner it will bounce hilariously. The preparation of breakables has therefore become something of an art; and far from being pushovers, many of the problems involved may necessitate considerable research before solutions are discovered.

Breaking windows and glass

Simulated glass objects which have to break pose considerable difficulties. Glass is a material which is hard to copy, and any material used for this purpose must not only be transparent but should also have the smooth shiny surface of real glass. Such a material must, furthermore, be easy to cast without the use of elaborate processes or expensive moulds. It must, still further, be tough enough to withstand handling and fixing, and it must retain its shape in warm or humid atmospheres. Most important of all it must be safe to handle without the dangers associated with real glass.

At one time a form of transparent toffee known as "sugar glass"



A sheet of window glass cast in Santolite.

was generally used; it had many disadvantages, but was reputedly good to eat.

Although something of a compromise, a material which is reasonably economic and easy to work is supplied by Monsanto Chemicals Ltd. under the trade name Santolite MHP. It is water-white and has a high degree of transparency. Principally used in TV for breaking window glass, it can be crushed in the hand without any ill effects. Trampled underfoot, it is quickly reduced to a benign powder rather like natural pine rosin. It is extremely fragile when made up, and must be specially packed for travel between workshop and studio. A disadvantage is that it suffers from "cold flow". In the studio it tends to warp and sag, and should therefore not be left too long in position before required. Broken dry-ice sprinkled into the transit case reduces warping, which could take place before fixing. Bags of crushed dry-ice may be hung on assembled window-panes if they have to be prepared long in advance of a take.

Sheets of window glass are made by first heating the raw Santolite to its melting temperature of 62 °C. This must take place in a special vat, electrically heated and thermostatically controlled to prevent burning. When molten the Santolite is poured on to a metal-faced table on which metal dividers have been placed. These form the retaining walls of the mould and are made from rectangular-section steel of about ½ in square. They should be of various lengths in order that different-sized sheets may be cast, but owing to the fragility of the finished product, it is unwise to make panes larger than 18 in square.

Before the Santolite can be poured, sheets of Cellophane must be laid on the surface of the table to prevent the material from sticking. The Cellophane determines the surface finish, and should therefore be laid as flat and taut as possible, being held in position by the metal dividers. Strips of Sellotape should be applied to the sides of the metal bars.

To prevent the molten Santolite from cooling too quickly (rapid cooling deforms the cast sheets and produces flow lines), the metal surfaces have to be pre-heated, and it is therefore sometimes easier to use a smooth, solid wooden-topped table. For the same reason wooden dividers may be used, such as laths surfaced with Sellotape. Some users even advocate the use of hardboard strips without the application of tape, these being removed before the Santolite has finally set.

After the Santolite has cooled the Cellophane remains stuck to its surface. It can be peeled off quite easily, but preferably it should be left on until the windows are required, because it substantially reinforces the material, thus making for easier handling and transportation.

Sheets for use as window-panes are normally cast about ¼ or ⅜ in thick. Santolite may be re-used many times, although it tends to darken slightly with constant remelting. Material which has been reclaimed should, of course, be free from dirt, and it is better to discard suspect material than to contaminate new stock.

Glass for bullet effects

Air-gun pellets or other projectiles may be fired into simulated glass sheets made from Santolite, but it depends principally on the type of effect required whether this or other material is more suitable. Generally, where the window is to be seen before, during, and after the impact it is better to use ordinary window glass. To keep the shattered pieces from flying around or dropping out of the frame, the glass must be specially prepared. Probably the simplest method is to apply a sheet of self-adhesive transparent material to one surface. This material is generally available in rolls, its normal function being to cover manuscripts or surfaces which need to be protected. Usually Cellophane or similar plastic material, it has excellent tensile properties. If it is not obtainable, the wider ranges of transparent sticky tape may be used, although it is desirable to minimize the number of visible joins. With both these types of material it is better to prepare the glass sheets well in advance: they have a slightly milky appearance at first, but this disappears after a few days.

The effect of the backing is to keep the glass intact after it has been broken, and whether this breaking is to be the result of a gun or a hammer-blow, the effect is a great deal better than when untreated glass is used. Multitudinous cracks radiate from the point of impact, and the starred effect produced by the bullet is probably the maximum visual effect that can be obtained for this purpose.

Naturally if a sheet of glass is to be smashed from its frame this technique is not appropriate. The fact that the plastic sheet holds the glass intact limits its use to bullet effects (single rounds or machine-gun fire), hammer-blows on burglar-proof windows or articles being thrown at pictures, etc.

Mirrors may be treated in the same way, and as they already have a coating on the back, the self-adhesive material need not be transparent; it can be any of the vinyl decorative materials used for covering furniture, walls, or books.

A bullet passing through a mirror produces the same dramatic pattern as with the glass, the adhesive sheet holding all but the smallest splinters in position after impact. This treatment is particularly suitable for the sequence where someone throws a heavy object at a wall-mounted mirror. It should be realized, however, that a blow may have to be more severe than that calculated to break an ordinary mirror, as the application of an adhesive sheet damps down the essential vibrations which occur when glass is broken. If the mirror is mounted in a frame and if it has a plywood backing it is sometimes advisable to cut away part of this backing where the blow or shot is expected to happen. Lest the breaks follow the contours of this opening, it should be of an irregular shape and not just a square hole.

Breakable bottles and other articles can be made from wax which has been melted and swilled in wet plaster moulds.

Bottles for bullet effects and fight sequences

In making bottles the same sort of problems arise as in making windows. To produce a bottle which will conform in every way to the real article and yet shatter in a harmless fashion is not easy. Again compromises are usually acceptable.

The cheapest and easiest method of producing breakable bottles is to make them of wax cast in plaster moulds. The mould (previously soaked in water) is swilled with molten paraffin wax and immediately emptied. Several swillings produce a bottle of semi-uniform thickness. It is important that the wax at the bottom of the bottle should not be allowed to build up to such a thickness that it might become a danger if used in fight scenes. To be hit over the head with a thin wax bottle is one thing, but to be floored by a 1-in thick wax slab is another! To safeguard against the latter possibility it is better to allow the mould to drain upside down after each swilling.

Bottles produced of wax are not transparent, but if coloured wax is used they can be made to resemble the green or brown glassware used for beer and wine bottles. To improve their appearance they should be coated when cool with high-gloss varnish. Labelled and used in fight scenes, they appear reasonably convincing if not seen too closely.

Vases may be made in the same way, but unlike bottles, they offer scope in so far as they can be decorated afterwards, and can appear in close-up without being too obviously made of wax.

The fact that these items are made of wax means that they may be used to contain liquid; and this fact often adds enormously to the realism, particularly in the case of bullet effects.

Bottles and vases may also be made from plaster. If so, the mould must be either of latex or a flexible moulding product such as Vinamold.

Plaster bottles and vases, provided they are made of shell-plaster (very thin and produced by the swilling technique), may be used for fight scenes in the same way as wax ones, but they should always be broken by smartly banging down on head or body, and never by thrusting. Pushed forward, they have greater rigidity, and can inflict wounds from jagged edges.

Bottles may also be made from various resins, but they tend to be more troublesome, because they often have to be cast or fabricated in sections and then joined. In the majority of cases, moreover, the setting time is considerably longer for resin than for wax.

Furniture

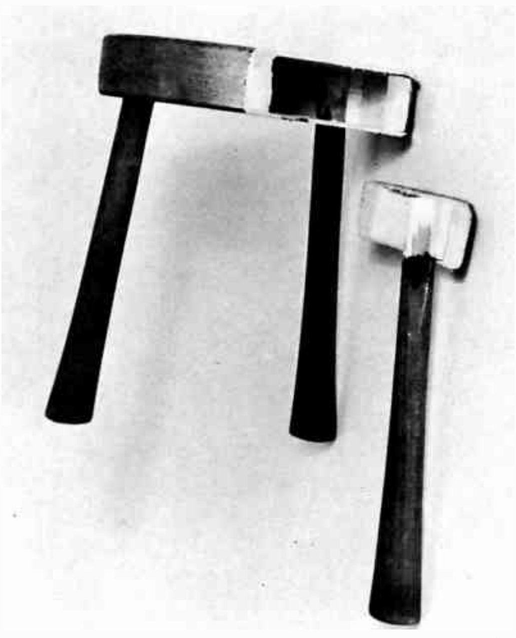
The breaking-bottle fight sequence is rivalled very closely by the breaking-furniture routine familiar to all devotees of the "Western". Stunt men are flung with reckless abandon through balustrades and across tables while chairs are smashed savagely across the backs and heads of apparently indestructible cowboys.

Chairs for breaking are often expensive items. Made, in most cases, entirely of balsa wood, they must be constructed in much the same way as practical chairs. Furthermore, there should normally be three chairs for each smash—one for rehearsal, one for a take and another for a possible retake. Nails and screws must never be used in their construction, and only the lightest balsa wood should be selected. No large or thick sections of wood should be built into seats, and all structurally strong points should be weakened by cutting. It should be possible to make saw-cuts favour the action (i.e. to open on the downward stroke, but to close on the upward one). This helps the actor, who may have to snatch up a chair with a great display of vigour, but in the knowledge that too energetic a treatment will cause this very fragile prop to fall apart in mid-air.

Any breakable furniture which must be smashed over the head or shoulders of an actor should be examined carefully beforehand, as identical-looking items may vary in strength or weight. Before use they should be clearly labelled with "keep off" signs, otherwise some member of the cast or crew is bound to sit on them.

Not all breakable furniture is destined to be smashed in fight.

Apparently heavy, this stool is fabricated from lightweight balsa wood.



scenes. There are occasions when the arms and legs of furniture have to come adrift in the course of the action, or where the ravages of woodworm or dry-rot must be faked. Whether for high comedy or for implied realism, the methods are often the same.

Where wood is to crumble it is possible to make the part either in extended plaster (75% sawdust, 25% plaster of Paris) or a fuller's earth mixture (90% sawdust, 10% fuller's earth). These materials can be cast or modelled, and there are obviously many more which can be used in similar fashion. Being fragile, they must be applied .o stronger parts of the furniture so that they are adequately supported until broken away. An effects designer should always think in terms of replaceable units for this sort of commitment. If, for example, an antique cabinet had to have a leg broken off to show that it was badly affected by woodworm, only one cabinet would be needed—but it would be policy to have a dozen replaceable legs capable of being easily and securely fitted into position.

Where an arm or leg must be broken off a chair it is possible to fix it to the body with small balsa-wood dowels, but for the chair that must collapse when sat upon it is possible to use matchsticks. A leg should be cut through diagonally so that when reassembled it can be held together by inserted matches. As these are in shear, they break easily when weight is applied. It is also feasible to use magnets at the join. Should the other legs also have to fracture, they may be attached to the underside of the chair with balsa-wood pegs. A chair which will reassemble itself can be made by threading strong elastic down hollow legs. One end of the elastic is fastened at the bottom of the leg, while the other is secured to the seat.

In the same field it is often required for a bed or settee to support artistes until on cue it collapses. The toggle support may be adopted for these items. A toggle support is simply a piece of timber or metal which has been sawn through its horizontal centre and hinged at this point. For bed or settee, two of these take the place of two adjacent legs. They are fastened to the underside of the furniture by hinges in a way that allows them to be folded up underneath. Straightened out they will support weight, but pulled out of alignment they collapse instantly. They should be made of material amply strong enough to support the item of furniture required, and the hinges used should be large enough to prevent any sideways movement. They are usually pulled by a line hidden below the furniture. It is better to confine this treatment to two legs only, the others being solid. Should it be necessary for a complete

Beds frequently have to collapse in TV comedy. This method relies upon a centre support held in check by a cable and bomb release. On wheels and slightly angled, the support folds under when released.

collapse to happen, it is possible to arrange the solid legs to be fitted to a detached sub-panel below the underside of the furniture. This separate unit inevitably tips over when the other end collapses. An alternative method, for use when a bed must collapse in the middle, is shown above.

Scenery for smashing

Balsa-wood tables and chairs which have to be broken are usually constructed to be used once only, but with scenery it is often possible to design items in such a way that they can be reassembled after "destruction". This technique is recommended because it allows the items to be fully rehearsed. In the case of a balustrade which has to break away, construction is a simple matter. Replaceable balsa-wood dowels or inserted magnets hold the handrail and uprights together for normal action, but break or separate realistically when subjected to force. In a complicated arrangement, colour-coded ends facilitate reassembly. Should some of the uprights have to appear to snap, they may be sawn through with one portion fixed to the handrail and the other wedged in the staircase. The saw-cut should be an elongated vee to lock the two parts together in registration.

Where a stunt-man has to be thrown through a multi-paned window it is more sensible to use the reassembly method than a construction designed to break. Glazing bars for this type of window have to be strong enough to support several sheets of breakable glass and yet sufficiently fragile to fall away as the stunt-man hurtles through. It is a good idea where possible to incorporate one whole vertical member; this is lightly wedged into position, and all the horizontal bars are held between this one bar and the sides of the window-frame.

For plastered walls that have to be broken in vision it is seldom possible to use real plaster. A scenic flat rendered in this material would certainly suffer some damage long before its debut on the screen. It is impractical to plaster once the scene is erected, as drying time is prohibitive; and there are the obvious difficulties of providing replacements for rehearsals and retakes. When, therefore, areas of plaster-work are to be torn down or broken it is more usual to employ white-painted builder's softboard which has been pre-broken and replaced. The cracks can be filled with dry plaster, talcum powder or fuller's earth, the powder being well smeared over the rest of the surface to camouflage the joins. Where this plasterwork is supposedly on battens, the softboard pieces can be secured to the battens by blobs of real plaster or melted paraffin wax.

For scenes where plaster walls have to be chipped out (by crooks, say, who are about to break into a bank vault from an adjoining cellar), the softboard method may still be used; but in this case when, after pre-breaking, the bits are reassembled they should be lightly skimmed with real plaster in the conventional fashion. They should, however, be made in individual panels which can be inserted into a larger wall where required. A large unblemished plaster wall would obviously present great difficulties, so some compromise must be made. There are many possible ways, and one is to position shelving against the wall. Even if this is removed during the action, the marks supposedly left on the wall afford camouflage for the edges of the smaller, inserted panels.

The above-mentioned crooks, having removed the plaster, will naturally find themselves confronted by a brick wall through which they will want to make a hole. To facilitate this it is feasible to use real bricks which have been bonded with a mortar of wetted sand (most building sands tend to dry hard when used in this fashion and should bond the bricks quite satisfactorily).

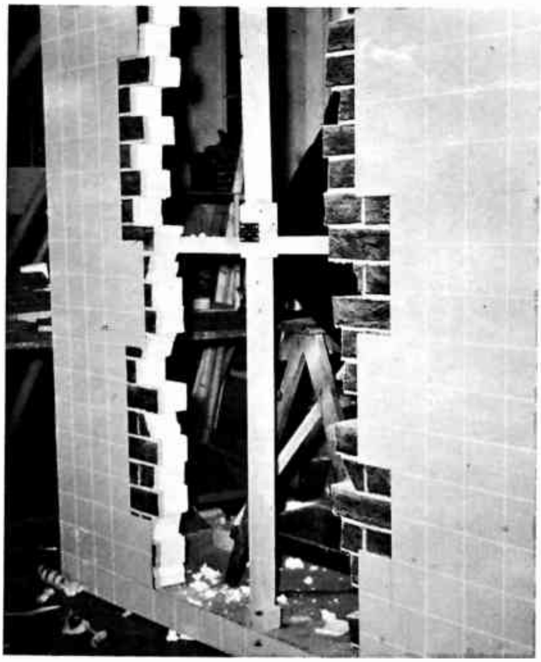
The brick wall should be built on a small boat-truck (a board with wheels or castors), and there should be duplicate walls to allow for rehearsals and retakes. The top courses must be constructed with a back support so that they do not fall when the lower bricks are removed.

In use, the brick wall is positioned behind the main flat and as close to the inserted "plaster" panel as possible. Where double-clad walls are used (a reverse angle shot of the crooks climbing into the bank vault might be called for) it can be arranged for the boat-truck to be wheeled in between the two sets of flats.

One item of scenery to suffer more than its fair share of wrecking is, of course, the door. Firemen burst in with axes, captives smash them open with chairs and stalwart policemen put down their shoulders and charge! Usually these forms of ill-treatment are confined to the panels, which is very convenient. It means that the door itself can be quite solidly constructed of heavy timber and that the replaceable panels can be prepared specially to suit the sort of breakage required. Thin panels of balsa wood should not be used: they look contrived and invariably mean that an actor must pull his punches. Splintering wood seen in close-up gives good dramatic value, and it is worth while to take a certain amount of trouble to get the best effects.

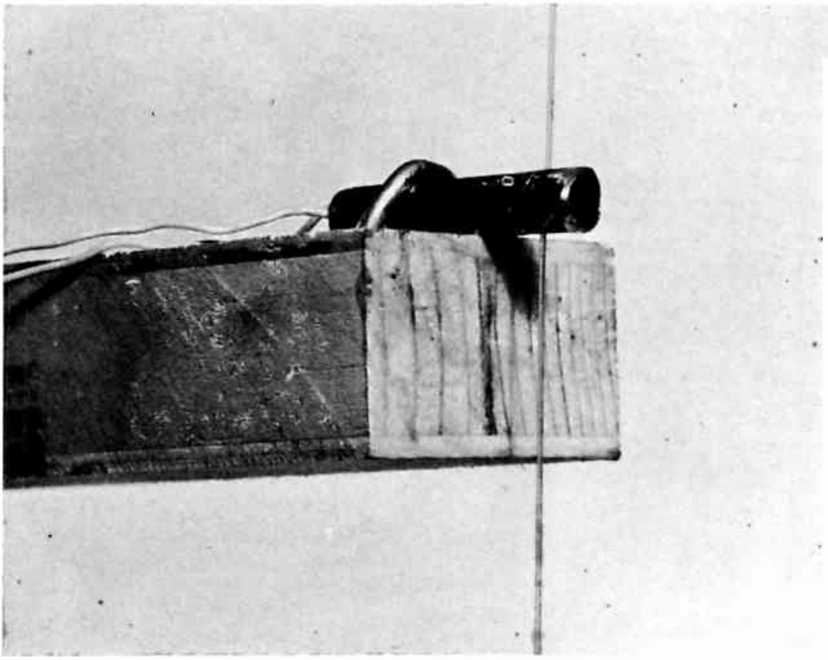
When doors are to be smashed by axes there is no reason why ordinary soft wood, such as deal, should not be used. When, however, the panels are to be smashed by a blunt instrument (policemen's shoulders might be classed thus!) it is conceivable that some form of pre-treatment may be required. In such cases the panels should be lightly scored and then broken. The broken parts are reassembled with light "tacks" of wood glue. The cracks are then filled and sanded before being painted. (When this treatment is applied it is important that the paint is not allowed to seep into the cracks, where it could mar the effect of clean broken wood.)

Walls that must collapse are often difficult to disguise around the joins. Artificial tiling is used here to camouflage the pre-broken area.



Material required to descend from above can in most cases be dropped from a board held by a member of the scene staff perched on the top of a pair of steps. Usually the top of a flat offers him a convenient resting place until the moment comes to tip. There are other times when this is not practical and a remotely operated tipping board or box has to be contrived. A board can be made from a single sheet of ply or hardboard supported at one end by two lines which are tied off. The other end of the board also has two lines, but these are run through pulleys or eyes and are merely released when the material is required to fall. One disadvantage of this system is that all the material has to be taken up and piled on the board *after* it has been hung. Another is that the trajectory of the falling material is sometimes at an angle—owing to the fact that it must slide down the board as it falls—and it is therefore better to drop the board towards or away from the camera, and not to one side. For a prolonged effect, boards may be hung in tiers.

A special hopper can be made which has a floor hinged in two sections. These flaps can be held closed either by a lever-operated catch or by a nylon line released by firing a pyro-fuse and black-



A nylon thread passed through a small metal tube containing a pyro-fuse will melt when the pyro-fuse fires. This can be employed to drop ceiling pieces, drapes, tree branches, sash windows, etc., etc.

powder (which will destroy the nylon by burning) (see above). The box can be filled *before* use and hauled above the set wherever needed.

Collapsing floors, walls, and rocks

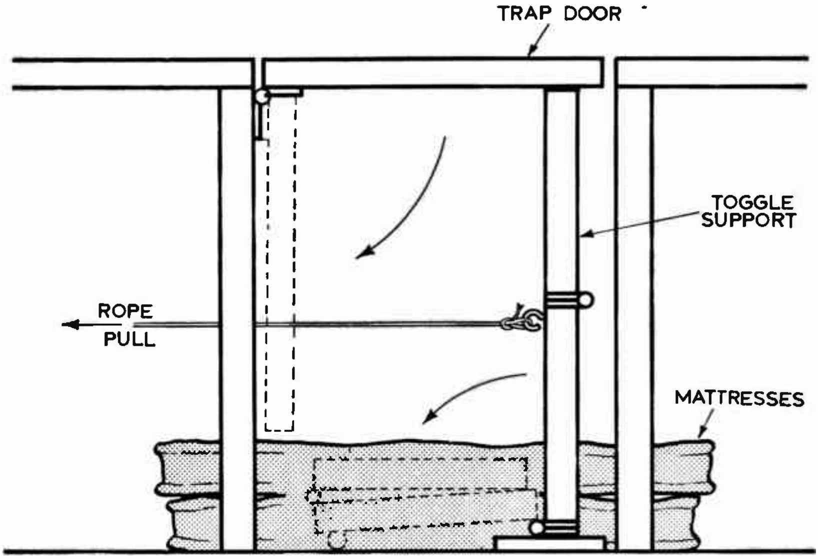
A scene in which a car is driven through a brick wall may smack more of the old Keystone Cops comedies than of modern television; but old gags die hard, and the effects man may still be asked to provide the materials for such a scene. If so, a wall has to be built of separate bricks, and present practice favours bricks made of expanded polystyrene skinned with latex. They can be bonded with dry fuller's earth and sawdust. The most expensive car may be driven into such a wall without damage (although cleaning up can be a long job).

Sometimes a wall must collapse of its own accord. In such a case the effects man has to devise a means of dropping it without the method being apparent. Visualize a scene where the comic builder slams a door and his freshly built wall tumbles down. The dropping-weight method may be applied here, but the shot must be taken clear of the floor. The lower courses of brick-work should be composed of a number of boxes, surfaced and painted to look like the bricks above (if these lower courses never appear in shot they can, of course, be plain boxes). Ring eyes are screwed into the backs of these units and a rope is taken through them round pulleys and up to a sandbag which can be positioned somewhere high above. When the sandbag is dropped the boxes are pulled out snake-fashion, allowing a gentle collapse of the wall above. It is, of course, possible merely to pull the rope by hand, but the falling weight gives a more precise constant snatch which, if set up correctly, drops the wall without any pre-jerking or wobbling. A single box positioned in the middle of such a wall and snatched away will give much the same effect, but if the base area of the falling section is too small the bricks sometimes lock, preventing a complete fall. One or two *real* bricks, strategically placed, often improve the fall.

Bricks for this sort of construction should have imitation mortar painted on two of their sides. It is laborious and unnecessary to use separate mortar. Fuller's earth and sawdust can be sprinkled on to each layer of bricks as they are laid. To speed up building, large pieces of unbroken simulated brickwork can be included in the construction—and for realism this looks much better anyway.

Rock faces may be dropped by another method. Assuming that they are built against flats or specially constructed framework, the lower rocks (lightweight facsimiles, of course) may be held in position by dowel rods pushed through holes in the backing. All other rocks, dirt, etc., can be piled on these anchor rocks so that when the rods are withdrawn the lower rocks fall, releasing all those above. This is particularly effective where progressive dropping is needed. Small areas may be built into larger areas in such a way that a few loose stones can trickle down before the main avalanche.

Large falls of rock face, tunnel-wall, quarry face, etc., can be released by building on toggle supports similar to those described for collapsing furniture (page 169). The toggle bars are also suitable for use with floors that have to cave in or tumble down. Built with solid timber props of substantial proportions, they can be made to support any weight required. Nevertheless, they give way easily when pulled in the middle. Where several of them support



The toggle support applied to a falling floor. The hinged legs fold when pulled, allowing the trap to swing down. If the floor is particularly heavy the collapse can be assisted by inserting small wedges in the hinge positions. This gives the support a premature kink which makes it easier to open.

very large areas of heavy construction they can be snatched open by combining a falling weight with the toggle bar.

As an example one can take a hypothetical scene in which men are crossing a crevasse via an ice bridge. We shall assume that they are pushing a heavy sledge, piled high with supplies, when without warning the ground over which they are travelling suddenly collapses. Into the crevasse goes the sledge, followed by one of the men. This might be prefilmed, set up over the studio tank, or it might be carried out in the TV studio, where it would be built up from wooden rostra or tubular scaffolding. In either case the same technique could be adopted.

When something like the sledge in our example has to fall into a hole it is better dramatically to drop it when it is only halfway across so as to ensure that the back part rears into the air as it goes down. Where it lands is unimportant, but the man who has to follow it will want something soft to fall on. He will also want to be reassured that nothing heavy will fall on to him. There are two approaches to this problem. One is to arrange the falling floor to hinge downwards from the side of the hole nearest the camera while putting mattresses on the floor below. The other is to drop the entire area into the pit and make the surface of the dropped portion suitably soft. If the camera is shooting from a normal or low position the first method is probably best, but if the shot is from high up the second may look more realistic.

The means of dropping either floor can be similar (i.e. the toggle support can be used in both methods). Assume that rostra have been built up to form the hole. One or more sides of the hole have to be clad and painted to resemble the wall of the crevasse, while covering the hole is a board or rostrum-top treated to look like ice or snow. For the first method (the swinging-down board), the edge of the board nearest the camera is fastened to its adjacent rostrum by strong hinges. The opposite edge is supported from below by two upright beams of suitable thickness, hinged at a cut through the middle and also hinged (reverse handed) to the floor. When supporting the board they act like solid beams, but when pulled inwards they collapse instantly, allowing the board to swing down.

Toggle-support beams may also be used for the second method (the dropping board), but four are needed, each pair hinged to pull inwards. To ensure that all beams snap open at the same moment, a line from the centre of each can be taken through a ring bolt in the middle of the lower floor. These control lines are pulled in a single action. If they are tied to a heavy weight which can be dropped on cue a better "snatch" action results and chafed fingers are avoided.

Bending metal

The favourite among "bending iron" requests is for prison bars that bend; but occasionally park railings or iron balustrades must be made to distort.

There are several ways of fabricating props which appear to look like metal and yet will bend to order. The prison bars are usually nothing more than rubber tube slipped over aluminium rod or bundles of iron wires. Square-section railings or fancy iron-work can be made by casting vinyl moulding material over a wire core. Latex may also be moulded in this way.

For sheet metal which must be made to bend (e.g. the panel being levered off the safe door) builders' sheet lead can be used. This may be purchased ready-made, but lead can be cast into a variety of shapes that will distort under pressure.

In certain circumstances silver-painted Plasticine can be used to simulate metal where props have to be bent or deformed.

A melting "metal" can be made from paraffin-wax with a metal-powder filler. The wax should be cool when poured to form the original item, because the metal powder and wax tend to separate if the mixture is too fluid. Gold, and silver-coloured sealing-wax can be obtained from most stationers and can often be used for items which must melt.

Filled polyester resin can be cast or formed where "metal" is required to be drilled. An example might be the casing of a bomb.

8

CHEMICALS AND CHEMICAL EFFECTS

A KNOWLEDGE of chemistry is an asset in effects work, but few effects men are likely to specialize in this subject. It is therefore sensible to consult the experts when chemical formulae are needed, particularly when the products are intended to be eaten or drunk by actors. Qualified chemists are usually most helpful people, and as well as vetting formulae, will often offer useful advice. Furthermore, they will, of course, make up the various potions or chemicals required, which is better policy than relying on stale or suspect chemicals kept for long periods on shelves in the effects workshop.

Chemicals can be used in a variety of ways to produce special effects, and rich sources of information are those books written for schoolboy experimenters or amateur conjurers.

On occasions chemical solutions prepared in advance fail to work as intended. There are several reasons for failure, and these should be considered before the effect is prescribed. One obvious cause is contamination of the substances. If, when making up chemicals, bottles or containers which previously contained other liquids or materials are used they should be scrupulously cleaned. Even this can lead to trouble, because incomplete washing or rinsing when detergents or strong cleansers have been used often does more harm than good. Changes in humidity and temperature can also be the cause of failure. If during the final effect these factors differ considerably from those that obtained at the time of the original experiments results may also differ. Many effects concerned with visible water vapour, fuming chemicals or gases should be tried out under similar conditions to those that will exist at the time of final use.

Another cause of failure is the making up of incorrect quantities. This can happen when it is necessary to translate from one measure to another, or when large amounts are being manufactured based on results from small experiments. It seems hardly necessary to say so, but it is always advisable to test the final chemicals fully, even when satisfactory results have been obtained from initial experiments.

Fuming chemicals

Certain chemicals have the property of vaporizing rapidly on contact with air. Unfortunately, however, they are usually injurious or corrosive, or both. One such chemical is titanium tetrachloride. Employed with discretion, it gives results that are difficult to obtain by other means. When poured from glass-stoppered bottles it

Titanium tetrachloride poured over clothing gives the effect of a smouldering body. As this liquid is corrosive it is essential that protective undergarments are worn and that it is not inhaled.

A "tear-gas" bomb: A glass ball filled with titanium tetrachloride exploded by bullet-hits.

appears to smoke copiously. It can be poured over clothing to give an effect of smouldering cloth, or it can be swilled across flat surfaces to give the effect of corrosive acid. Bottled in witch-balls (glass Christmas tree decorations) sealed with wax or Plasticine, it can be thrown to simulate tear-gas grenades or poison-gas bombs. Where throwing would be hazardous, the balls can be laid on the ground and blown up by electrically fired bullet-hits placed below or behind them.

Titanium tetrachloride works more effectively in a cool damp atmosphere.

It should be used only in the open air or very well-ventilated places, and should not be inhaled.

Foam mixtures

Foaming substances have many applications in TV, from foaming potions swallowed, say, by Dr Jekyll and Mr Hyde to vast quantities used as snow on open ground. Foam, in fact, offers a visual effect which can be either sinister or comic.

One of the most generally useful mixtures is that used in fire extinguishers. It is normally supplied as two separate powders which are mixed with water in accordance with manufacturer's instructions. When the solutions are poured together a considerable amount of frothy liquid results, forming a foam which retains its stability for quite a long time and is ideal for many of the funny cooking scenes. It can be flung about in slapstick comedy and is non-injurious but it causes smarting if brought into contact with the eyes, and consequently is not ideal for custard-pie work. It is non-poisonous, but must not be drunk. It works very well in fake chemical experiments or where industrial processes are being simulated. It floats on water and may be used to dress scenes where water is to have a filthy or scummy appearance. Studio scenes in sewers, mines or ships' bilges can be treated in this manner. It can also enhance those scenes in the studio tank where boats are rowed through dock or wharfside waters. It may be used to augment scenes on marshy ground, and can also look like foaming breakers in waters which are being whipped up to simulate stormy seas. The foam is a light fawn colour, but reads as white or near white on both monochrome and colour TV.

When large quantities of foam are needed it is advisable to use special foam-making equipment. The one described here is marketed by the Walter Kidde Co. Designed for firefighting, it pro-

Foam generated by fire-fighting equipment. This material may be used where large volumes of lightweight foam are required either in the studio or on location. Actors can wallow in this foam without harmful results. (*Walter Kidde Co.*)

duces a great deal of foam (1,000 volumes of foam for each volume of the fluid mixture) in a very short time, but needs a water supply from a hydrant or from a static source via a motorized pump. The machine itself is driven by a petrol engine (although electrically driven equipment is available). Where the petrol engine is used (and also possibly in the case of a petrol-engined water pump) the noise obviously interferes with sound recording, and so arrangements must usually be made for the foam to be created before a sound take.

The machine consists of a metal box inside which a number of tiny nozzles spray water on to a flexible plastic net. Before reaching the nozzles the water is combined with a measured quantity of foaming agent metered into the supply from a container at the side of the machine. This creates foam on the net, which is pushed through by a blast of air from a large fan rotating behind the nozzles. The air blast carries the foam forward and outward, and it is generally necessary to make use of the canvas tube which is supplied with the machine for its normal purpose of firefighting. If the tube is not used the foam, which quickly builds up around the machine, is drawn back into the air flow behind the fan.

The tube also allows the foam to be directed to a particular source or, if moved around, assists in the laying of a uniform carpet. Unfortunately the sailcloth tube must be dried before storage, and it is possible that for special purposes a throw-away hardboard arrangement (or even a disposable cloth tube) can be used.

The foam looks remarkably like snow under the right conditions and can be used on open ground on location for that purpose. It is, however, likely to blow away in windy conditions.

Foam can be freely used in the studios if adequate floor protection is provided. When actors or technicians have to work in the foam the floor covering should be hessian or some other non-slip material, because the foam tends to make surfaces slippery; and although complete immersion in foam is not dangerous, it can be quite messy. Foam of this variety is designed to be persistent, and this fact must be borne in mind when it is used in the studio. Dispersal can be speeded up by spraying the foam with water, but as this is hardly practical in the average studio the foam must be removed either by sweeping or by allowing it to collapse naturally (a process taking one to two hours), in which case provision must be made to deal with the slight amount of water which results.

It is not recommended that this type of foam be used for a "bubble-bath" scene. Instead it is better to use proprietary brands of bubble-bath essence (it is not advisable to use a stronger solution than that advocated by the manufacturers) and to foam up the bath water by inserting an air-line below the water level. If the foam has to be sustained an air-pipe drilled with small holes can be fed up the drain-hole of the studio bath.

For foaming drinks the following recipes can be adopted:

A small piece of "dry ice" dropped into water (coloured or plain) causes it to bubble rapidly and also give off "smoke". This can be drunk without harm, but obviously the dry ice must not be swallowed or even allowed to enter the mouth.

A small piece of dry ice dropped into beer causes it to froth as well as bubble.

Sugar poured into most fizzy drinks causes a release of the carbon dioxide, bringing about a rapid foaming action.

Proprietary brands of health salts may also be used as fizzy drinks, but if in the course of the action *two* solutions have to be mixed to produce the fizz, tartaric acid dissolved in water and bicarbonate of soda also dissolved in water can be mixed together to produce a drinkable foaming concoction.

Thickening agents

Some materials have the property when mixed with liquid of increasing the viscosity. This can be very useful for a number of purposes. A particular example is the jellified petrol which can be smeared on to surfaces for fire effects. A suitable material for this purpose is "Aerosil". It should be mixed with 3 parts of "Aerosil" to 1 part of petrol.

Thickening agents such as sodium alginate mixed with water can be used to simulate large amounts of any thick liquid. Colouring can be added to requirements. Bitumen, mud, molten lava, etc., can all be prepared in this way. Broken cork or wood dust provide texture. About 2–5% of Manutex R.S. (Alginate Industries Ltd., London, W.C.2) normally suffices.

Colouring agents

Water paints and vegetable dyes are often used to colour water for various effects, but where large quantities are required it is usually necessary to use special materials. One useful product is V.S. Paste brand carbon-black, marketed by ICI. Mixed with water it has the effect of turning it black to such an intensity that only a small quantity is needed for a large volume of water. This is very useful when such large-scale effects as "oil-gushers" are wanted.

Liquids that change colour when mixed with other substances may be used for various wine-to-water and water-to-wine effects. The ones explained here are NOT INTENDED TO BE DRUNK.

Wine to water: permanganate of potash crystals dissolved in water produce a purple liquid, the depth of colour being controlled by the degree of solution. A light purple "wine" turns to clear liquid very rapidly if mixed with a solution of hypo (sodium thiosulphate).

Water to wine: a small amount of ferric ammonium sulphate dissolved in water produces a pale amber liquid. A few drops of saturated solution of sodium salicylate turn the liquid to deep burgundy.

Similarly, the sodium salicylate liquid turns solutions of either ferrous sulphate or ferrous chloride (pale yellow liquids) to red.

Water to ink: a solution of ferric ammonium sulphate is a pale amber liquid. When a solution of tannic acid is added the mixture goes blue-black.

There are probably hundreds of formulae for making invisible inks, but with the invention of such sophisticated espionage aids as micro-dots, crime stories involving the use of invisible ink are becoming increasingly rare. Nevertheless, for those who may want them a few useful formulae are given here.

Copper sulphate solution. Shows very faint (almost invisible) blue trace when dry, but turns browny-black when heated.

Diluted sulphuric acid. Shows very faint (almost invisible) amber trace when dry. Turns black when heated.

Copper nitrate or copper sulphate solution. Shows very faint blue trace when dry, but goes reddy brown when painted over with solution of sodium ferrocyanide. Sodium ferrocyanide dries blue-green, so red-brown letters appear on blue-green base.

Sodium salicylate. Shows very faint pink trace (almost completely invisible). Turns cocoa-brown when painted over with solution of iron sulphate or ferric chloride.

Apart from invisible-ink manufacture, these chemicals can be used to dye or paint areas of cloth or paper for those effects where it is required to show the appearance of mysterious paintings or unsuspected marks by the use of other chemicals or fluids. Stigmata on shrouds or over-painting on works of art can be demonstrated in this way.

Similarly, the liquids can be used as mock chemical reagents, showing "effects" when mixed. An example might be a piece of metal (previously treated with one chemical) which is dipped into a liquid, the metal then changing the colour of the liquid.

Miscellaneous chemical phenomena

There are certain chemical phenomena which can provide interesting business for actors playing the roles of scientists or chemists. One of them is when two liquids are mixed to produce a solid. The chemicals required are calcium chloride (hydrated) and potassium carbonate (hydrated). Saturated solutions of each should be prepared, after which they may be combined either by stirring or shaking.

If the two liquids are poured into a vessel and stirred they thicken and turn into a substance rather like wet icing sugar. Alternatively, poured into a test tube and shaken they intermix to form a substance which resembles cellulose wallpaper paste.

Should a pyrotechnic effect be required the following procedure can be carried out. A small quantity of aluminium powder is mixed with an equal quantity of crushed iodine crystals. These should be mixed gently together with a wooden or plastic spatula. A single drop of water (from a pipette or glass rod) causes an interaction which commences by producing purple smoke. The smoke increases until the mixture eventually ignites and burns fiercely.

NOTE: *If left standing these chemicals will ignite spontaneously—they must therefore be mixed immediately prior to use. The resulting fumes are toxic.*

Appearing to develop a photographic print

There are probably several ways of achieving the effect of a photographic print being developed in a "darkroom" scene in a well-lit studio. Two are listed below. The first gives excellent results, but requires the use of a highly poisonous chemical (mercuric chloride). The second method also includes a poison (potassium ferricyanide). However, these chemicals are used in the preparation of the original bleached-out bromide paper and do not involve the actors who will later "develop" the picture.

Method 1: A photographic print on bromide paper which has been developed and fixed normally is immersed in the following solution:

Mercuric chloride	20 grams
Hydrochloric acid	10 cc
Water	to 1 litre

When the image has disappeared the print must be washed and dried and is then ready for use. To make the picture reappear it must be placed in a bath of normal developer (MQ or universal). The time taken for the print to be fully developed depends on the strength of the solution and its temperature. These should be experimented with in advance. A print will also appear if the treated paper is placed in a bath of hypo.

Method 2: The print, again on bromide paper, is bleached out in a solution made up as follows:

Potassium bromide	10 grams
Potassium ferricyanide	10 grams
Water	to 1 pint

The print must be washed and dried once the image has faded. To make it reappear it must be developed as for method 1. In the author's experience it is possible to get only partial bleaching out in method 2 and, although this is often sufficient if the print is not contrasty, some of the image remains.

Because of the nature of the chemicals used (particularly in method 1) thorough washing of the paper is essential. The preliminary bleaching should be carried out over a sink and all utensils (and hands) thoroughly cleansed in running water.

9

WIND, RAIN, SNOW, AND FOG

THE effects discussed in this chapter are the ones which simulate atmospheric or weather conditions. They range from those that can be obtained by simply superimposing stock film over the scene to those messy extravaganzas where whole studios are covered with snow or water. Such big scenes often involve people other than those responsible for the effects. The studio firemen may be required to arrange for the supply of high-pressure hoses; the electricians could be needed to supply and operate wind-machines; the house supervisor might have to alter air-conditioning and heating; wardrobe supervisors might have to make special provision for the cleaning and drying of costumes; scene staff could be faced with special clearing-up operations; engineering services might be asked to lay on special drainage—and so on and so forth. All these factors must be taken into account during the planning stage, and if economics are important (i.e. if these services are to be included in the actual programme budget and not taken as a below-the-line charge), then adequate consideration must be given to the additional costs and effort involved.

Wind-machines

The wind-machines used in television studios are similar to those used in the motion-picture industry. Some are bought from commercial sources, some are hired, and some are custom built by effects men or electricians to perform in special ways.

Wind-machines naturally vary in size and performance, but they must all conform to similar operational requirements. They must have variable speeds and they must be as silent as possible. Most machines will be silent at low speeds, but some produce quite considerable noise at high speed. Usually, of course, the high

M–R Type 1971 Wind-machine Moleffect. (*Mole Richardson Co., Hollywood.*)

speeds are required only for storm or blizzard effects, and so the sound is not unduly embarrassing.

The larger machines often make use of aircraft propellers, and will provide storm and blizzard effects comparable to the best that nature can supply. They are also capable of providing a gentle zephyr when required, and the fact that they cover a large area means that they are more versatile than smaller machines.

One popular medium-sized wind-machine has a multi-bladed fan, specially designed to operate with maximum efficiency and with a minimum of noise. It rides on three pneumatic wheels, the rear one being steerable, and is very convenient for use in the studio, particularly when conditions demand that the machine must be moved during a take.

Another very useful machine is smaller, having a blade diameter of about 18 in, and is mounted on a stand (also fully mobile). This is a particularly useful device where less vigorous or more localized effects are required. For a scene in which a girl's hair is to be seen blowing in a gentle breeze this machine is ideal. It can also be used for blizzard effects where artistes are seen in close-up.

Another type of wind-machine is totally enclosed. Incorporating a centrifugal blower instead of the propeller blade, it directs air on to the set through large-bore flexible hoses. It is extremely cumbersome, but has the advantage that it is almost completely silent, even at full output. Another advantage is that the air stream can be directed as required and can be made to follow a moving subject.

Ventilation fans have been used successfully as wind-machines for certain local effects in the studio. A typical example is the imitation camp-fire. This is an arrangement of glass-fibre logs built around the fan. Lights are used to give the glow from the hot embers, but the "flames" are short pieces of coloured silk which flutter rapidly in the moving air current (see page 32).

Hair-driers can be used as wind-machines for model work, and so, of course, can ordinary domestic fans.

There are many occasions when a quick burst of smoke or dust is to be blown into a room. There is also the flurry of snow when someone opens a window or a door. On these occasions it is often a temptation to fan the scene with a sheet of hardboard. It is certainly cheaper to waggle this sheet than to hire a wind-machine. In the majority of cases, however, it is doomed to failure because the passage of a large sheet of rigid material through the air creates pressure below and *suction* on top. This can result in the smoke being blown forward and drawn back almost immediately.

Compressed-air lines are quite often used for wind effects, and if (as in many TV studios) compressed air is obtainable at the wall it can provide a cheap and simple answer to many problems. Papers blown from a table when someone opens a window is a typical application. The drawback in using compressed air is that whether from an air cylinder or from a point on the studio wall it makes considerable noise when released in volume. Where there are no sound problems it can be used for blowing hair when an artiste is moving around, sweeping leaves across small areas of studio floor, and flickering or extinguishing candles from some distance away.

Wind-machines are most efficient in front of the blades. Around the periphery and behind there is often considerable turbulence, which can sometimes affect the passage of smoke or snow in scenes close to the machine. Naturally enough the effective area of any wind-machine diminishes in proportion to the distance away from the machine. What starts out as a blizzard can end up as a draught. Positioning of machines is therefore very important.

Wind-machines can be used to blow air for the sudden movement of such objects as curtains, papers, clothing, hair, etc., in

The M.R. 85 Wind-machine. (*Berkey Technical (UK) Ltd.*)

which case they are set up and directed towards the appropriate spot, but the bigger the machine, the longer it takes to run up to speed. For an effect that must happen on cue the machine must either be swung round or a sheet of hardboard must be held to deflect the air stream until wanted.

When they are used in blizzard scenes wind-machines are fed with material (shredded paper, expanded polystyrene granules, smoke, etc.) from in front of or behind the blades. Fed from behind, the material is spread out centrifugally, covering a greater area. Poured in front of the blades it tends to follow a narrower path. Both methods have their uses.

When the machine is used to propel water or foam, materials should *not* be poured in from behind. Special pipes or distributors should be firmly fixed to the safety guard in front of the blades.

Practical rain layouts: film and location

Falling rain is not as easy to simulate as might be expected. To create an effect in depth demands a great deal of water, which must be distributed in such a way that it falls in a uniform fashion resembling natural rainfall. The first consideration must therefore be that of supply. The second should be the method of creating the effect and the third (if indoors) the removal of surface water from the floor.

It must be appreciated that *large* rainfall effects in the television studio cannot be considered a practical proposition. All such scenes must be either set up on location or filmed on a suitable stage—the alternative being to use other methods, such as superimposed film loops while recording in the TV studio. These other methods are discussed later. This section deals only with those rain effects in which practical water is used.

For exteriors on location it is wise to seek the assistance of the local fire brigade. Hoses directed into the air can be swept from side to side, producing a rain effect indistinguishable from the genuine article. Unfortunately the wind sometimes takes a hand, and if they are within the fall-out zone the camera crew and their equipment should be protected with polythene sheeting.

In the TV film studio the fire-hose treatment for *falling* rain is impractical. Instead, water must be taken to long runs of pipe which have been drilled with holes and hung above the set. The results from a rig of this kind are not always wholly convincing, even when there are several rows of pipes. A series of sprinklers usually gives a better effect, but there are disadvantages inherent in both systems.

If the supply comes from the studio wall it must be fed to the pipes from both ends. Failure to do so means that the rain effect is strong at the connection end, but gets progressively weaker along the length of the pipe. Another cause of failure is the height of the pipes above the studio floor. If they are fed from a supply which in turn gets its water from a tank somewhere in the building they dribble pitifully unless the head of water in the pipes is considerably lower than that of the storage tank. Connection to a pressure hydrant is desirable when rain effects of any magnitude are required.

A fire hose being employed to create a mist effect on location.

Fire hoses being used to create a rain effect during filming of scenes for *The Loss of the ss Schiller.* (*Westward TV.*)

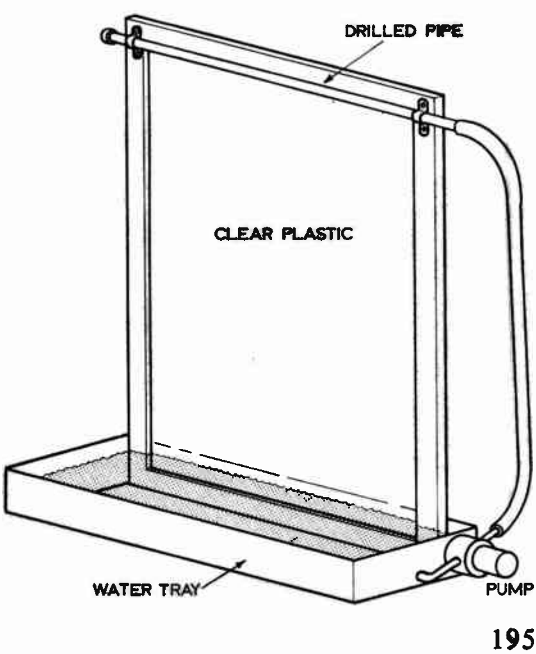
In the situations where rain cascades from pipes above it is a good idea to rock alternate pipes gently to break up any obviously static pattern. Wind-machines can be used to add a further touch of realism.

For storm effects on the studio tank, rain is almost a dramatic necessity. The lifeboat with survivors being tossed helplessly on the raging sea almost certainly has to suffer the chilling combination of wind-machine and fire-hose. The water is probably provided from a fire-hydrant source via a diffuser branch (the umbrella effect that enables firemen to press forward into flaming buildings). Unfortunately the hose and branch is operated by enthusiastic dousers from the side of the tank, and only in the rushes is it noticed that the rain is all too obviously being waggled from off-stage. This is a tricky problem, because in smaller tanks there is seldom room to manipulate such a hose to the best advantage. If the scene is a night shot the tank is surrounded with black drapes, which, if they become wet, make the sky shine in a most uncharacteristic fashion. It is important therefore to establish a working position for hoses *before* proceeding with the action. No matter how splendidly the actors play their parts, if the rain effect is comic their efforts are diminished accordingly. Where possible it is better to situate the hoses close to the camera and slightly above. They should never be squirted in from the sides unless the shot is so tight that the effect would appear to be uniform. The wind-machine should generally be placed behind or just to one side of the rain-maker.

Practical rain layouts: TV studio

Rain effects in the TV studio present problems which seldom occur in the film studio. Most film stages have some sort of a tank below floor level which can be used to accommodate large amounts of surface water. In the TV studio the floor must be covered (usually with polythene sheeting), and even when this has been done there remains the problem of how to dispose of the water which collects on the cover. For these reasons large simulated "outdoor" rain scenes, utilising practical water, are seldom recorded in the TV studio. Where the scene takes place indoors and the rain-water is to be seen only through windows or doors the problems are fewer. For one thing the water is confined to specific areas (and these usually away from the cameras), and for another, the water need not be in depth. The only real problem is one of continuity. Rain must not be shown pouring down outside one window while it appears merely to dribble outside others.

Where it is possible to make and store special rain effects equipment, a self-contained device can be constructed which may be used whenever rain is to be seen outside certain stock windows. This consists of a sheet of clear rigid plastic, mounted in a metal frame. At the bottom there is an open compartment capable of



Rain trickling down the outside of a window can be simulated by using the device shown here.

holding two or three gallons of water. This acts as a supply tank as well as a catchment area. Fixed at the top of the frame is a drilled sprinkler pipe which is orientated so that "rain" trickles down the plastic. A small electrically driven pump circulates the water continuously, the supply being regulated by a simple turncock.

Windows in TV scenery are seldom glazed, because individual panes of glass or plastic create reflection problems. This also applies to the single sheet of plastic used for the rain effect, and care must be taken to avoid reflections of studio lights, cameras, etc., when siting the window.

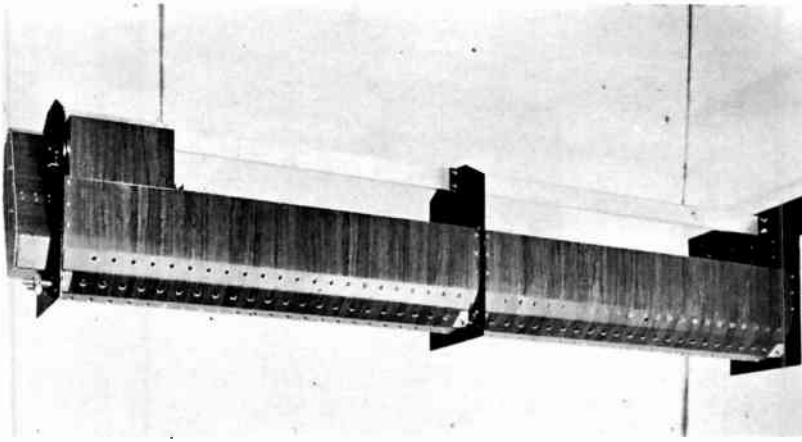
For scenes where characters are sheltering in shop doorways or under trees it is possible to create the effects of a downpour (or a drizzle) by piping water to parts of the set where it runs down or drips off into catchment areas. The simplest application is where part of the set overhangs, and the water can be allowed to drip freely between the artistes and the camera. Sometimes the branches of trees can be used in this way. If the quantity of water is slight it is possible to collect it in sawdust-filled boxes or dustbins placed below the dripping part. These can be removed quickly without having to cope with large areas of water-filled polythene or tarpaulins. Needless to say, a superimposed film effect can be added to this arrangement. This type of local effect can also be applied where practical water is raining down in the foreground but where little is happening at the back. Pipes can be led into the set to show gutters overflowing or drainpipes discharging.

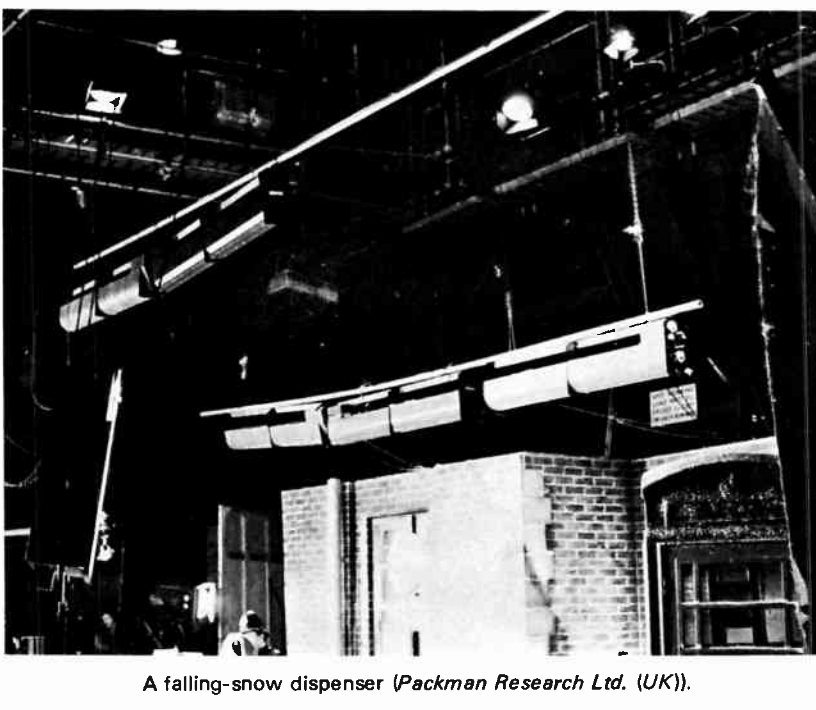
Falling snow

Many materials have been used to imitate falling snow in television productions, but few, if any, have proved to be entirely satisfactory. One that comes very close to being ideal is marketed by Packman Research Ltd., of Berkshire, England. It is a specially prepared paper shredded into tiny strips for use in a snow-dispenser machine developed by the same organization.

Among materials used in the past have been paper confetti and a crushed formaldehyde-based plastic. These have numerous disadvantages. The paper is inflammable and is frowned upon by the firemen. It has the additional disadvantage that it tends to bunch, dropping fast-moving lumps in the otherwise floating snowflakes. The formaldehyde was banned as being dangerous to health.

It is sometimes claimed that fallen snow may be reclaimed from the studio floor, cleaned, and re-used, but this is seldom if ever done





A falling-snow dispenser (*Packman Research Ltd.* (*UK*)).

in TV. The time spent in sifting, cleansing, or washing and drying is not considered an economic proposition. The storage of machinery to carry out such a process would seem to make it unworkable.

For small areas of falling snow it is possible to use a variety of different distributing methods, but it is in the big scene, where snow is needed to fall steadily for long periods, that the real problems arise. Even with the best machinery it is still difficult to obtain a snowfall that descends uniformly in depth over a large area. The difficulty lies not in the fact that the snow from any individual dispenser may be inconsistent with the others but in the distribution of the dispensers themselves. Ideally the studio ceiling should be almost covered with snow-machines, but as this is scarcely possible, those available have to be hung where they give most value. If the camera is first to record the whole scene and then track-in to a smaller central area the machines should be positioned to favour the centre, with several, one behind another, over the important part of the set. They are suspended longways across the picture.

Falling snow of this kind is not entirely realistic. It is conventionally associated with the Christmas card type of scene. More normal is the swirl effect when flakes are driven in all directions by a light breeze. This not only looks better but helps to disguise any discrepancies in the distribution. To achieve such an effect on a large set it is necessary to have several small wind-machines placed around the floor. This is one occasion where many small machines are better than one big one, but probably better still would be an arrangement where a large machine could be supported by one or two smaller models. Every set has individual characteristics in this respect. What suits one may not suit another, but generally speaking, the effects man should try to arrange the wind-machines so that the flakes are travelling round in a circle. Snow blown out of the picture is not only a waste pictorially but is also a waste of material. Another system is to put machines where they face each other, so sending a lot of material back into the air, whence it can fall again.

If only one wind-machine is available it should be placed behind or below the cameras. To put it to one side would create a storm effect on that side while leaving the other undisturbed.

Many different snow-dispensers have been designed and built for use in TV and movie studios, and one of the simplest consists of a reservoir for the loose snow, in the bottom of which are a number of slots. The snow in the area of the slots is gently agitated by a rod running the length of the machine. The rod, driven by an electric motor, has a number of spikes or pins placed at random along its length but coinciding with the slots. As it revolves, the pins, which protrude through the slots, gather up small amounts of material and push them through the holes.

Another method of distributing snow is to throw occasional handfuls into a wind-machine that has been stood to one side of the camera. It must be tilted up as far as possible, but if the angle of tilt is limited studio blocks can be placed under the front. Running slowly, it blows the flakes into the air, whence they fall gently back to earth. This technique is ideal where the snow is to appear sporadically, and it is cheaper to use expanded polystyrene granules, because the material used in snow-dispensers is an expensive item.

Not all snowfalls have to be entirely realistic. For certain stylized scenes it is possible to combine practical snow-dispensers with a projected "snowfall" lighting effect to give the effect an added depth. It is usually applied so that the projected light pattern is shone on to a large backcloth, while snow trickles down on to singers or dancers in the foreground. For verisimilitude the projected pattern should be travelling slightly slower than those flakes falling in the front.

On one occasion a mobile television unit was recording a series of plays from within a theatre, and in one of these plays it was required to stage a realistic snowfall. Unfortunately only one small pedestal wind-machine was available, and because of congested conditions it had to be situated to one side of the camera rostrum. To create the snow-flurry the wind-machine was tilted up and fed with handfuls of polystyrene granules. The scene was a long one, and an additional complication was that unlimited snow could not be allowed to build up on the actual stage because it would have fouled certain mechanical moving scenery. It was considered necessary therefore to augment the scene by combining it with an off-stage snow effect that could be superimposed on the main picture.

If a similar situation had arisen in the TV studio a snow-loop might have been used, but the mobile TV unit, having no telecine facilities, had to use something else. As a solution it was decided to build a large glass-fronted box with a capacious hopper in the bottom. The hopper contained the polystyrene snow, which was sucked out by a domestic vacuum-cleaner (minus bag) and blown back in at the top. This worked surprisingly well and ran almost continuously during a week of rehearsals.

To vary the swirling effect a small fan was placed inside the box. The back of the box was painted black, and the snowstorm was illuminated by a lamp which shone through a narrow, vertical, glass-covered slot in one side.

In use the whirling snow was recorded by a stationary camera which was able to vary the shot from an overall picture to close-ups of certain areas. This was a distinct advantage over the inflexible snow-loop-and-telecine method, because the cameraman was able to select his picture to match the scene on the stage. Surprisingly enough, no trouble arose either from static or from dust adhering to the glass front.

Another very simple but effective device for simulating falling snow for superimposition purposes can be made as follows. A rotating roller is covered with decoration-glitter and mounted horizontally behind a translucent screen. Clear light-bulbs are positioned at different distances from the roller, both at the top and underneath. The resulting picture, as the roller is revolved, is very like a snow-in-depth effect. Because the various reflected lights travel at different speeds the effect is apparently three-dimensional. The varying speed factor arises from the fact that the angles of reflection alter as the particles of glitter move from a horizontal plane on top of the roller to a vertical plane in front.

Snow on ground

Snow scenes in the television studio are set out, recorded, and cleared away within a period of a day or two. Furthermore, the scenery which appears in such scenes must usually be returned to stock without having been damaged by applications of any special material. Suffice to say that simple and clean techniques have to be adopted under these somewhat restrictive conditions. Several factors have to be borne in mind when planning large snow scenes, not the least of which is that modern TV cameras do not take kindly to being wheeled over loose material. All in all, the materials and methods available to the designer are strictly limited, although new substances are constantly being experimented with.

For snow on the ground, sawdust is still the only really acceptable material. It is cheap, easy to clean up, remains where it is put, and, for the unsuper-critical mind, performs very like the real thing. However, it is not white, and whatever else "snow" has to be, it should be white—except, fortunately, for television! White softwood sawdust on black-and-white TV needs very little treatment to make it appear absolutely white, while on colour television absolute white would be unacceptable.

The sawdust used should be from a source, uncontaminated by sawdust from plywood, hardwood, hardboard, etc. Sawdust from a mill dealing exclusively with any of the normal white softwoods is the best, and as the texture is also important, it should be as fine as possible, unmixed with shavings from planing machinery.

Once laid, the sawdust can be given a light covering of white powder to improve the tone or colour. Powdered whitening, plaster, talcum powder, flour, and many other substances can be used for this purpose. If flour is chosen it must be laid with care. It should not be scattered liberally in badly ventilated areas, because it could give rise to a dust explosion. Admittedly the chances of such a thing happening are remote, but they must be mentioned. Once in contact with the sawdust, flour picks up moisture, which renders it less likely to give off fine dust.

Vermiculite or glitter are sometimes added to the surface dressing to give sparkle, but for a combination top coat, Sno-jet (more about this later) gives excellent whitening and glitter quality.

Where large deep drifts of snow are required the bulk height can be built up from unopened sacks of sawdust before the final covering of loose material is applied. In those areas where the snow is likely to remain undisturbed the sacks can be covered by coarse or contaminated sawdust or even shavings, being given a top dressing of good white sawdust followed by a final dusting of white powder as before.

Expanded polystyrene can be shaped and placed around scenery to give realistic drift patterns. This material can also be used where snow is supposed to have built up thickly on roofs or window-sills.

The material marketed under the trade name Sno-jet can transform surfaces, making them appear frosted or snow-blown. The effect is so realistic that it is almost necessary to touch it to discover whether it is real or not. Sno-jet is a fluffy white powder, containing a certain amount of glitter. It is applied to the area by a special gun which blows it on to the spot accompanied by a fine spray of water. The mixture of water and Sno-jet builds up in a manner exactly resembling that of blown snow (or if lightly applied, frost). The powder, which is blown originally as a fine, loose material, coagulates when wetted and adheres firmly to almost any surface.

A small moulded, plastic gun is available which operates from a domestic vacuum-cleaner, the water being contained below the gun in a plastic bottle. The snow material, also suspended below the gun, is in a flexible plastic bag which must be tightly sealed to the applicator. Although this device gives good results, it is not suitable for professional studio use. Instead it is better to invest in a large self-contained machine which not only holds considerably more

The hand-held applicator for Sno-Jet. *(Sullivan Manufacturing & Sales Corp., U.S.A.).*

material but has such refinements as trigger control and an agitator to keep the Sno-jet in a light and fluffy condition.

Stored badly, Sno-jet cakes and becomes unusable, so it should be ordered in quantities large enough only for immediate use.

As well as being applied by gun or machine, Sno-jet can be scattered by hand on surfaces which have been previously wetted. To remove it is only necessary to re-wet and to wash off in an appropriate fashion. If this form of removal is undesirable areas to be treated should first be covered with some form of peel-off paper.

Snow blizzard and storm sequences

Few things are more satisfying to prepare and film than a good snow blizzard. The wind-machines howling at full-blast, the snow-flakes whirling past the struggling actors, all go to make a stimulating experience for those engaged in special effects work. This applies particularly to scenes set in the larger TV film studios, where the designers and directors are not inhibited by restrictive conditions.

In the TV studios blizzard scenes of any magnitude are just not possible. Television studios contain too much expensive equipment to permit such indiscriminate use of "snow", however innocuous the base material might be. The electronic camera, as has been previously pointed out, has its vital parts ventilated by air-blowers, and these would undoubtedly silt up in such conditions. On the other hand, the hardy film camera, whether in a blimp or unenclosed, is unaffected by this sort of treatment.

The type of studio lighting can also determine the practicability of storm sequences. If it is of the pattern where it is operated remotely, being raised or lowered by electric motors, its working parts would quite obviously suffer from prolonged bombardment by loose materials. All in all, a good old-fashioned film stage with its wooden floors, dusty gantries, and uncomplicated lighting is the best place in which to record extensive blizzard scenes.

Snow blizzards are relatively easy to stage. Wind-machines, set around the floor, are fed with expanded-polystyrene granules, which can either be shovelled in or emptied into the air stream from plastic bags. "Snow" tossed into the back of the wind-machine gives a broader pattern, but makes a noise as the granules hit the rotating blades. If the studio floor has been previously cleaned, polystyrene may be shovelled up and used again and again.

Smoke fed into the air stream of a wind-machine can resemble finely powdered driven snow, and may be used in conjunction with expanded-polystyrene granules. It has the effect of amplifying the stream of granules and making it appear far more dense than it really is. A secondary advantage is that the smoke, separated from the polystyrene blizzard, may be blown into the faces of artistes without causing discomfort. They can then indulge in natural dialogue without the fear of getting eyes or mouths full of polystyrene

Expanded polystyrene granules fed into a wind-machine produce a satisfactory snow blizzard.

pieces. There are two methods of separating the smoke from the granules. The first, an on-the-spot arrangement, is to use a smoke-machine raised to a suitable height and positioned out of shot. The smoke is blown on to the actors by an air-line or a small wind-machine. The expanded polystyrene granules are also blown past the camera, but are propelled by a second wind-machine and are confined to the area *between* the actor and the camera. For large scenes a third wind-machine (bigger than the other two) can swirl snow across the background areas.

The second method is usually employed when snow blizzards are wanted in the television studio. Smoke is blown across the shot and is coupled with previously made telecine film of driven snow, but this is only a compromise, and can seldom be adopted for large or complicated scenes.

Rainstorms are seldom as dramatic as blizzards. It is difficult to imbue them with as much visual impact. Unlike snow, rain must be carefully lit to obtain maximum density. Badly lit rain can almost disappear. Back-lighting and dark backgrounds help the effect.

Again, it is seldom practical to carry out rainstorms in the TV studio. It is better to use location filming if at all possible. Even on a film stage there are inhibiting factors. Arc lamps and camera seldom function well when sprayed with water!

Where indoor recording is essential, smoke may again be used in conjunction with wind-machines, this time to appear as fine-driven rain. It is necessary to combine the smoke as before with practical rain or with a telecine "loop". In fact, wind blizzards and sand- or dust-storms can all be simulated by this versatile smoke-gun and wind-machine combination.

Fog

In the early days of TV, fog scenes were largely hit or miss. Motion-picture experience was of little use, as the lighting in TV studios differed a great deal from that of the motion-picture stage, and the electronic cameras had a disconcerting habit of seeing right through the fog, however dense. In one memorable scene two lost airmen were trying to "read" a signpost in thick fog. The smoke-machine surrounded the two actors with a cloud apparently so dense that they fell over sandbags supporting the base of the sign-post. Technicians in the gallery were somewhat nonplussed by this performance, as they could read the name on the signpost with ease!

Fog scenes recorded on film have to be handled differently from those made in the TV studio. On film, each shot is separately and individually lit, allowing the maximum effect to be obtained. This advantage is nevertheless somewhat minimized by the fact that continuity is difficult. As with the smoke in fire scenes, it is difficult to match each change of viewpoint without the difference in density or character being apparent.

In a non-stop recording in the electronic studio the problem of continuity hardly arises, but as the illumination all comes from above, it is difficult to produce the dramatic lighting arrangements possible with film.

Lighting plays an important part in making fog scenes look realistic, and wherever possible it is a good idea to produce only local patches of light and to keep these as low as possible. One very effective device is to provide a street lamp (if the scene permits it) which serves not only to light the artistes but, by flaring into the camera, helps to reinforce the foggy atmosphere. By lighting the foreground and not the background an illusion of density is achieved.

Modern smoke-machines normally permit a certain amount of fine control when building up fog scenes, but they cannot be expected to cope with adverse ventilation conditions. It is generally advisable to have the air-conditioning plant turned off for the period during which fog scenes are required.

Fog filters can be placed over both TV and film camera lenses when the fog in the studio needs some support or even when there is no practical smoke at all. Filters of this kind have the effect of softening or degrading the image, and as they treat the foreground as well as the background to the same degree of softening, they do not give a wholly realistic effect. Should a filter not be available, it is possible to get an effect by covering the lens with one or more layers of nylon stocking.

Another way of getting a simulated fog effect is to place a white card about a foot in front of the camera lens. A hole is cut just large enough to produce a slight vignetting of the picture. Lit from behind the camera, the white card flares around the edges of the picture, producing an effect which, if not entirely like real fog, at least suggests it. If used with practical smoke the effect is much better. A similar method is to shoot through a sheet of glass which has been vignetted with a smear of petroleum jelly. Both these methods are for static pictures only, and cannot be used where camera movement is involved.

The replenishing of fog in large and small scenes alike has to be effected with care if it is not to appear contrived. Fog scenes are particularly tricky, in so far as an unexplained burst of fog rising into an otherwise static scene seems all too obvious. It is therefore better to induce some swirling motion in front of the camera in order that alternate thick and thin patches will help to disguise the replenishing action.

Film loops

Although still often referred to as loops, the lengths of film carrying recorded snow, rain, and fog effects, etc., are not really loops at all. The name "loop" is a hangover from the old days when a few feet of film were shot of the required effect and joined end to end—in fact, as a loop. The loop was then placed on the telecine machine and run for as long as was required. Provided that no great exception was taken to the sudden jump that occurred when the join came round, this was a most economic proposition. Vision-mixers would pride themselves on their ability to judge just when the jump would occur.

Nowadays it is usual to produce about twenty minutes of film when making these stock atmospheric effects. They are used either alone or in conjunction with additional practical effects in the studio. They allow snow, rain, fog, etc., to be superimposed on a scene via a telecine source and are controlled entirely by the vision-mixer.

The advantage of bringing in these various effects as and when required, without the necessity for anything messy or unpredictable in the studio, is obvious. But there are certain disadvantages. Primarily these effects, although probably filmed in depth, take place only in one plane. They must always appear in *front* of the action, but when they are accompanied by practical effects in the studio this limitation is somewhat mitigated. A greater disadvantage is that the use of a "loop" seriously interferes with the mobility of the cameras recording the scene. The atmospheric effect remains centred within the framework of the picture, and if the master camera on the scene suddenly pans across the shot the superimposed effect appears to swing with it. This is not seriously inhibiting in the case of sleeting rain, swirling snow, or blizzard effects, but when gently undulating fog or mist is shown it is essential that no camera movements take place while the effect is being screened.

Yet another disadvantage crops up when it is required to introduce a sudden transition from one camera to another or to go from long-shot to close-up. If the atmospheric conditions remain unchanged the superimposition is revealed.

The effects themselves can be extremely varied. For example, there can be snow—falling, drifting, swirling, and as a blizzard. There can be rain—light drizzle, heavy downpour, sleet, and storm. Fog—light or heavy, swirling, or drifting. There can be sand-storms and dust-storms (and, as mentioned elsewhere, there are also the various flame and fire loops).

To film a "loop", arrangements must be made to shoot for quite long periods without unwanted variations. It is, of course, unnecessary to film these effects for the total length of time needed for the eventual film; cross-fading in the laboratory serves to produce a reel of any given length.

For snow effects the flakes should either be made to fall gently from the snow-dispensing machines or blown blizzard-fashion from a wind-machine according to requirements. The effects must be filmed in front of black drapes in a darkened studio. It is usually only possible to side-light snow, because any light on the black backing softens the contrast of the eventual picture.

If snow is filmed solely for use as stock loops it is advisable to shoot it in a variety of patterns, including long-shots and close-ups. A choice of speed and of flake size is necessary when the loops are used with different scenes. The reason for this is that, unlike natural conditions where snow descends in depth, the superimposed loop always appears between the subject and the camera. It follows therefore that snow used for a wide-angle shot incorporating distance is entirely unsuitable if superimposed on a close-up of an actor's face.

The filming of rain is carried out in a similar fashion to that of snow. If drainage is a problem it can be arranged to shoot out of doors on a dark night.

Both fog and smoke are less easy to film for long periods, because the picture becomes more and more grey as the smoke builds up in the studio, and it is imperative, if filmed fog is to be of any use at all, that the smoke is clearly seen to contrast with patches of blackness. Provided this fact is observed, the smoke can be quite dense, because it is possible to control the degree of contrast during the eventual mixing in the television studio. This means that the same loop may be used for either light or dense fog scenes. When filming, one method of getting fog to perform in a satisfactory fashion is to build a large box with a front and back of glass. Into this is pumped an occasional burst of smoke with alternating jets of air.

A less complicated method of shooting fog is to film swirling smoke in front of black drapes until the air begins to thicken. Work must then be suspended until the studio can be ventilated and the operation repeated. Skilful laboratory work joins these lengths of film without apparent overlaps. Care should be taken that a particular pattern does not reappear too obviously when relying on this sort of repetition.

The glass-box technique can also be used for sand- or dust-blizzard effects. The material is placed in the bottom of the box and is blown around by a compressed-air line manipulated from outside.

The reason for having a box with both front and back of glass is so that various lighting arrangements can be adopted. Furthermore, black drapes can be placed well behind the box, where they are unlikely to be affected by spill light. If the box has an internal black-painted backing it is difficult to keep light off it while illuminating the contents.

Frosted windows

Many people are familiar with the method of "frosting" windows with Epsom salts (magnesium sulphate) dissolved in beer. Painted on glass, the solution dries out as a layer of fine crystalline patterns similar to the effect of frost on window-panes. This is a deservedly popular effect, because while the unused Epsom salts can be returned to stock, the surplus beer can be put to better use! There are, however, aerosol frost sprays available for those who prefer instant effects, and these give excellent results. Nevertheless, this form of frosting is usually reserved for the more "arty", Christmassy scenes, because the pretty patterns seldom associate themselves with stark frozen conditions. Sno-jet applied sparingly to the edges of windows more suitably implies icy conditions.

Steamed-up windows are often required for scenes in cars or railway carriages. Sometimes they are merely used to vignette the scene inside (or outside), but on some occasions they must be cleared in vision. This may be where a hand cleans an area for someone to see through, or where a child draws on the window. Two main factors govern the choice of material for this purpose. One is that it should be easy to apply, with a minimum drying time to facilitate retakes, and the other is that when rubbed from the

Misted windows that can be cleared by wiping with the hand are frequently required in TV productions. This shows a solution that can be applied by spray-gun.

window it should produce no appreciable residue. Sometimes Antiflare can be used, particularly for the vignette requirement, but this does not always clear sufficiently when rubbed by hand, although it is satisfactory for small areas of finger drawing. A solution of window-cleaning material (Windolene), thinned with methylated spirit and applied by spray-gun, gives a reasonably authentic effect. It must not be allowed to dry out, because a slight amount of powder falls away when large areas are wiped. This particular material is slightly pink, and care must be taken when it is used for colour television (the colour shows up only when the material bulks up as it is wiped around).

Icicles can be made from strips of Cellophane, Perspex, or polythene dipped into paraffin wax or polyester resin. Hung up and allowed to dry, they take on the natural shapes peculiar to icicle formation.

Ice which is required to form in various semi-comic situations (e.g. the solid block of ice in the refrigerator) or ice which is seen in close-up as a lump or even perhaps part of a glacier wall can be fabricated by using two sheets of Perspex, cemented together round the edges and riveted for strength. The top or outer sheet should first be malformed by heat treatment, the other can be flat. Together they form a shallow tank which when filled with water resembles solid ice.* Artistic treatment can be further carried out by spraying parts with Sno-jet.

* Such units must not be constructed with too great a depth, even when only small quantities of water are involved, because the hydraulic effect imparted by the head of water will burst the tank (however narrow) if the pressure exceeds the capacity of the material to restrain it.

10

USING LIGHT FOR EFFECT

THERE are a few effects which depend entirely on lighting. Of these, some are the responsibility of the lighting man, while others are provided by the effects section. Some may even be included in the set designer's scenery without involving the specialist units, such as backcloths with applied sequins which have to appear as twinkling lights.

Not all the effects discussed here can be considered as "special effects", but they have been included because they may have applications in effects as yet untried. The rain, snow, and fog effects described are those produced entirely by light projection. They can, of course, be combined with the practical weather effects discussed in the previous chapter.

Projected effects

Optical projectors for various animated lighting effects can be obtained from theatrical lighting companies. Consisting usually of a lantern, a motorized effect, and a projection lens system, they can be erected on lighting stands or hung from the grid. Two types worth mentioning are as follows.

The disc-type projector has a glass disc housed between the lantern and the projection lens and is motor-driven via an adjustable friction wheel, which allows the speed of rotation to be varied mechanically. Various glass discs are available from the suppliers, including thunder clouds, fleecy clouds, storm clouds, rain, snow, running water, smoke, flames, etc.

This type of projector is usually installed where it can shine on to a wide area of sky cloth or cyclorama. Where necessary, several can be made to cover quite large areas by slightly overlapping their territory.

These projection devices are deservedly popular because they can be left running for indefinite periods without attention, and

Two examples of lighting effects projected on to cycloramas in the studio.

their slowly moving effects are quite satisfactory for most purposes. The cloud effects are widely used in TV.

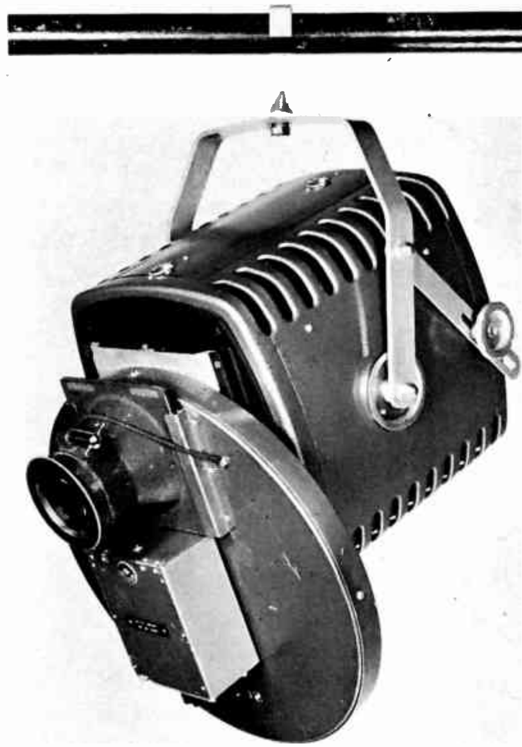
On occasions water, smoke, and flame effects can be combined to produce unusual science-fiction devices. For example, two such discs were projected on to a large translucent map to provide a

Projectors that give various still and moving lighting effects. Clouds, smoke, weather, and rolling seas are all provided by these lamps. (*Rank Strand Electric.*)

"flowing effect" to suggest that the map was appearing by some sophisticated radar signal. One effect scanned horizontally, while the other scanned vertically.

The box-type projector is similar to the disc type, but in place of the revolving disc it has a series of rippled glass plates which move slowly up and down inside a box. The plates are actuated by revolving cranks which gently lift and lower each sheet of glass out of phase with the others. Behind the moving glasses is a static transparency which provides the master image. There are three effects available—sea wave, water ripple, and under-sea. These all have a remarkably realistic ebb-and-flow effect and, although the speed of motion is uniform across the entire picture, this does not necessarily detract from the effect.

A lamp with a projection lens and a rotating effects disc.



A lamp that can be used to project patterns and silhouettes.

A projected-light effect which gives a fixed pattern is supplied by a projector having accommodation for cut-out patterned metal plates. Hung in the grid, it projects a shadowgraph on to the studio floor and can therefore be used to simulate floor-painted patterns. It is principally of interest to the designer of light entertainment programmes, but it can be used to throw sunlit patterns on the floor or walls. It has also been used to project silhouettes of roof tops and walls on to other areas of scenery.

The mirror ball used in dance halls is often used in television to create atmospheric effects. Most of these are, of course, connected with dance hall scenes, but used behind a back projection screen it can provide a backing for singers. Several coloured spots shone on to the ball give an interesting depth effect.

Polarized light

Polarization materials, now in common use, are known to most people if only through their application to sun glasses. Their application to TV is less well known, although most viewers at some time or other have seen the changing pattern effect used as a background to groups or solo artistes.

There will probably be many new methods and techniques developed in the future that will depend on the polarization of light, but at present use of the material appears to be restricted to the presentation of pleasing coloured animated patterns. This system, which derives from a method of showing animated captions, works in conjunction with a standard projector and a back-projection screen. Slides are prepared from two sheets of glass, in between which are patterns cut from clear adhesive tape. The slides are placed in the projector in the normal fashion. Situated in front of the lens system is a disc of polarizing material which revolves on the spindle of a variable-speed motor. The effect is to give a colour change to the components of the pattern. The change is presented as a fade from one colour through to another. The effect on monochrome receivers is of the various components going alternatively from dark to light.

As polarization depends on the orientation of materials, the cut patterns are mounted at different angles on the glass.

By using a revolving "slide" as well as the revolving polarized disc, both lateral and internal pattern changes are possible.*

* The United Kingdom licence for producing these effects is held by Spectrama, C.C.T. Theatre Lighting Ltd. The United Kingdom patent holders are Louis Newmark Ltd.

Mirror wheels and drums

Most effects designers can think up imaginative lighting effects by the dozen. Very often they choose mirrors, either to be used with moving lighting or in arrangements where the mirrors themselves move to produce the effects. Over the years many such devices have been invented to provide all sorts of effects for variety shows, but such things also have their uses in drama.

Some examples which might stimulate further invention are as follows:

A black revolving disc covered with pieces of mirror fastened with glue and with small wooden packing pieces to give each piece of mirror a different angle from the others. Revolved in front of the camera and illuminated by one or more lights, this has been used to produce dream effects. Speeded up and superimposed, it has been used to imply strange effects from the gun of a Martian invader.

Mirrors either on a drum or a disc can be used to imply that something is happening, although the source cannot be seen by the viewer. In a factory setting static shapes can be illuminated from a light source which moves continuously or revolves in such a way that animation is added to an otherwise immobile scene. One can imagine a scene in which characters are talking while backed by a piece of stationary equipment or machinery. Provided the equipment has polished or shiny detail, the lighting effect can be shone on to it to imply that a giant processing plant is working off-stage. If a suitable sound effect is synchronized with the lighting device the effect is even more convincing.

A motor-driven drum which may be painted to give a flame effect is described on page 76. The same drum, which is of transparent plastic, can be used in many ways to provide lighting effects which may not be obtainable by other means. One of its uses is to deflect light from a static (slide) projector on to a back-projection screen. It can be used either with the light passing through it or placed so that the light reflects back from the surface of the revolving drum. Among the effects possible are background movement for underground train windows, lights at night, seen from the window of a train or car, stylized moving-pattern effects for ballet, etc. Used in front of a lamp, it provides shadows passing across the occupants of a car in the studio.

Another drum which can be used to produce strange effects is similar to the one above, but it revolves on a horizontal axis. It sits in a cradle of four wheels, one of which is motor-driven, turning the drum. A shot taken through it provides a rotating vignette, and various applications of light and reflective material produce counter movement within the vignette. Another effect can be obtained by fastening a sheet of translucent plastic to the front of the drum while a beam of light is played on to the back from outside the drum. The revolving translucent disc is lit directly and also by reflection from the inner surface of the drum. Therefore if smears of opaque or coloured translucent paint are daubed on the outside of the drum an effect rather like swirling smoke appears. This sort of effect is very useful for providing animated background material for live studio captions.

Yet another light drum is one in which solid rollers are covered with crinkled metal foil, glitter, or screwed-up Cellophane. The rollers can be revolved behind patterned glass to give innumerable effects for caption work or for science-fiction machinery.

An intriguing effect is obtained by using a motorized turntable on which several mirrors are mounted. If the mirrors are arranged to reflect coloured lights or illuminated surfaces (or even the studio itself) they provide a linear kaleidoscopic pattern. Seen by a camera which has been defocused, they give the effect of dreamlike travel.

Reflective materials

Mirrored plastic sheet can be stretched over a frame and distorted to give all sorts of effects. One use was to provide a gruesome effect on the victim of a ray-gun. The actor, framed in a large mirror made of this flexible sheet, suddenly disintegrated on cue. The effect was achieved simply by pressing a finger into the middle of the sheet from behind. This caused a momentary break-up of picture that looked horrifying as the character's body became suddenly distorted in the stomach area.

Strips of ordinary Cellophane fastened to a backcloth and gently rustled in a light draught can be used to give the effect of sunlight on a background sea. In the author's opinion, if such effects are to be viewed for a long period it is a matter of luck whether the effect is convincing or not. Some effects men maintain that strips laid on the ground and similarly treated with illumination and a light cross-wind give a thoroughly realistic seascape. Again (in the author's opinion), with the limited amount of time available for setting up and experimentation, this sort of effect is far too chancy for television.

Coloured light and filters

Effects where coloured lighting is seen through coloured filters are now only occasionally used in TV, but once upon a time they provided a neat method of creating change. For example, it was possible to colour a person's face with green make-up and then put a green filter on the camera to neutralize the make-up. When the green filter was suddenly switched for a red one the actor's face became that of a coloured person. Other effects on monochrome TV were a face which turned into a skull and another which became suddenly aged. It is possible to use coloured lighting instead of the filters.

So far this technique has not been exploited on colour TV, but there are obvious possibilities. It must be borne in mind, however, that if any effects of this nature are to be applied to a system where compatible black-and-white pictures are *also* being transmitted the effect is unlikely to give the same kind of result on both media.

Miscellaneous lighting effects

Provided the set is suitably lit and the various gain controls of the system are adjusted to match, it is possible for performers dressed in black to remain unseen in front of a black backing. Consequently, they can manipulate props or puppets, which appear to float around without visible means of support. A favourite use of this technique is where the performers materialize one piece at a time. This is done by removing black garments, specially designed for instant removal. Another use is when a female dancer dressed normally is swung around by a male dancer garbed from head to foot in black.

Ultra-violet light has been used with fluorescing materials for novelty effects on television, but it is necessary to use a very powerful light source unless all shots are to be in close-up. So far no really worthwhile application has been found.

Sequins stuck to a backcloth or gauze can be made to appear as stars in a night sky. The lightest movement of the cloth causes them to twinkle in the studio lighting. A slow-running wind-machine can be used to agitate them sufficiently.

Similarly, sequins can be threaded on cord to simulate rows of twinkling fairy lights. They can also be stuck to the backcloth for the same purpose.

Although somewhat stylized, they have been used to imply a night seascape.

Rays from a sunlit window are often requested by directors with an eye for atmospheric effect. These can be provided either by a directional light source shone through a cut-out or by the pattern projector mentioned earlier. None of these rays will be seen, however, unless the overall lighting is suitably subdued and the atmosphere *smoked up* to establish the beams.

A lighting effect frequently used in scenes set by water or on board ship is the "sunlight-on-water" effect. This is achieved by having a tray of water, in the bottom of which are several pieces of broken mirror. A strong light shone into the tray reflects the shapes of the broken mirror, but if the water is gently agitated the patterns will break up and dance around in the appropriate fashion.

11

OPTICAL DEVICES AND THE USE OF MIRRORS

THE well-worn saying "It's all done by mirrors" has acquired a new significance for the visual effects designer. Mirrors enable him to produce illusions in many ways as baffling as those of the famous Victorian conjurors for whom the phrase was no doubt coined.

In the simplest arrangements mirrors can make vertical things seem horizontal and play havoc with gravitation, while in more complex arrangements they can be incorporated in sophisticated optical equipment, enabling one camera to do the work of two.

The mirrors which figure largely in this chapter are mostly specially prepared, having their reflecting surface on the front of the glass to eliminate the double reflection common to ordinary mirrors. Usually made from polished plate-glass they are coated either with silver or aluminium. The silver coating is inferior to aluminium because it tarnishes on exposure to the atmosphere; finger-marks oxidize rapidly, and cleaning is impractical. A mirror coated with aluminium and silicone monoxide can be handled almost as freely as plain glass, and may be washed with warm soapy water if finger-marked. It doesn't easily discolour, and if stored properly may be considered a permanent piece of equipment.

There are many effects which may be classed as optical effects—for example, those produced by front and back projection, cloud projectors, and multi-image lenses—but the ones dealt with here are those for which additional optical equipment is employed between the camera lens and the scene.

It is not always easy to decide who should be responsible for supplying the apparatus when certain optical effects are called for. Some complicated set-ups require the combined efforts of the cameramen, the effects man, and the lighting engineer. In practice, it is sensible if the cameramen and engineers make themselves responsible for all optical devices which are fitted directly to the camera (e.g. special effects lenses), leaving the effects team to design, make, and handle anything which stands in front of the camera, even though these things may fundamentally affect the picture taken by the cameraman. An exception to this rule is the free-standing periscope used by cameramen to get a lower shooting angle (not to be confused with the same device used by the effects man for other purposes).

Mirrors to change direction

Mirrors may be used in complex arrangements to bend, twist, and turn the eventual image in any direction, but even a single mirror applied in its most elementary form can be used to change the situation radically. Two examples are outlined here. The first concerns a programme requirement for a cuckoo clock that had to eject its cuckoo on a long horizontal spiral spring, where it would sway gently as suitable discordant sounds were overlaid. It can be readily appreciated that even the lightest bird would cause the spring to sag uncontrollably, and that elaborate mechanics would be necessary to overcome this. The solution, however, was simple. The clock was fastened to a board positioned horizontally above a mirror at 45° to the camera lens. The door in the face was made to open from behind, and the bird, when released, was able to drop down towards the mirror, where it bobbed up and down on its flexible spring. The camera, of course, saw all this as if the clock face was in its normal vertical plane, with the cuckoo projecting in front.

Similarly, for an amusing battle sequence the guns of a cardboard ship had to bombard a cardboard enemy, which in turn had to sink below the waves when hit. An animated picture of three layers, comprising a background, a cut-out ship, and a foreground seascape, was prepared and laid on the studio floor. Above it at lens height was fixed a mirror, again at 45 degrees, but this time looking down. A drawing of part of the attacking ship, with the rear view of two sinister cannons, was made on card and placed in the foreground just below the mirror. Two metal tubes were fixed behind this foreground piece, and from these were dropped two marbles.

Obeying the laws of gravity the marbles fell straight and true on to the unfortunate enemy ship, which was then pulled below the waves.

This sequence was designed to amuse a young audience, but without the mirror set-up the effects man would have had a difficult task to devise a method of propelling two marbles in horizontal flight so accurately that they would strike an exact spot on a target 4 ft away.

These two examples exploited a fact that is seldom appreciated. It is something of a paradox, but the camera can never look in any other direction than frontwards! It cannot look to the left or to the right. It cannot look up or down. It can only stare straight ahead.

Should the camera be pointed up at a church tower, we know that we are "looking up". This, to us, is a familiar view of a steeple seen from below. It has the right perspective. But if we were really looking up the television screen would have to be situated above our heads. As in all probability the normal TV set is slightly below our eyeline, we are paradoxically looking down while looking up!

The church tower example is immediately understood, but what impression do we get when shown the head of a screw? Is this screw holding down a floorboard, supporting a picture, or fixing a skylight? On the evidence of the screw-head alone we cannot possibly tell.

This lack of orientation can be used to advantage by the effects designer. Shown a solid object moving away from us in a tube, we have no means of telling in which direction it is travelling. Is it the back of a train going into a tunnel, the underside of an elevator ascending its shaft, or the top of a piston sliding down a cylinder?

If the object is painted to look like the back of a train we *assume* that it is travelling away from us horizontally. But the important fact here is that while appearing to be moving in one direction, the object could have been filmed or televised moving in the *opposite* direction. The usefulness of this can be appreciated if one assumes that for the purpose of some particular action an elevator is required to accelerate violently upwards from a stationary position. One method of achieving this effect might be to build the model shaft and just drop the "elevator" from the top to the bottom while televising it from a mirror placed above. No strings or mechanisms. Just a simple falling block.

Another use for this technique is when it is necessary to record objects moving freely in space. If, for example, the effects man wanted to produce a short sequence in which a shower of meteorites are seen rushing towards camera he might decide to film it in the following manner.

The meteorites (small plaster objects, or painted table tennis balls) are dropped from a gantry or tall ladder in the studio. Their fall is recorded by a camera looking into a mirror angled upwards at 45 degrees. The meteorites are released from a position whence they fall around and not upon the mirror, while the studio ceiling is covered by a black drape or star-painted backing. A slight tilt of the mirror ensures that the meteorites enter not from the centre of screen, where the operator's hands might seem a bit out of place, but from the top or bottom of frame. Usually, for the authentic feeling of space, opinion favours the bottom of frame with meteorites or stars rising into shot—although, of course, they can move from any part of the frame to another, and diagonal shots can look most effective.

The astronaut floating away into space from his rocket ship could be filmed in the same fashion. For this, although a high-speed camera would be used to slow down the motion, the dropping action from the ceiling would be the same. The film would be reversed when printed, so that the falling model would float away from the camera.

By adopting this method the effects man does not have to fly the model on control lines, and the tumbling action is therefore unhindered.

Shooting through periscopes

One of the most useful optical devices in the special effects studio is the periscope. Consisting of upper and lower mirrors, its primary function is to facilitate low-angle shots as well as allowing cameraman and director to work at a civilized height (instead of having to lie down to peer through the viewfinder of a floor-mounted camera); it can be used for model work, matte work, and underwater shots.

The periscope consists of a small mirror, positioned at 45 degrees to the lens axis, above a larger mirror also at 45 degrees, the two being housed in a free-standing, open framework. Provision is usually made for both mirrors to be adjustable for height (and some have variable angle adjustment). In practice, it is found to be convenient if the 45-degree angles are automatically retained during adjustment for height.

The periscope is particularly useful for filming model seascapes, and an example is given on page 295.

For underwater shots a periscope can be constructed in a watertight box with a plate-glass window sealing the lower aperture. A separate compartment should be provided below the periscope in order that suitable weights may be added to overcome the buoyancy.

Should it be necessary to illuminate an object under water, similar periscope devices can be made and the light beamed from above the surface via the periscope.

The advantages of working in the dry while filming below water are obvious, but in some cases the periscope provides the only practical way of getting certain shots. If, for instance, the underside of a motor boat had to be seen crossing the shot with whirling propeller and a flurry of bubbles, a watertight box containing only the large lower mirror could be made and fixed to the side of the studio tank at an angle of, say, 40 degrees. The mirror would then be slightly off the horizontal, so that the camera, pointing down into the open end of the box, would see the underside of the boat from below. The reason for the mirror's being tilted away from the horizontal is that the boat can be manoeuvred farther away from the side of the tank.

Watertight periscopes have to be soundly constructed; nevertheless, it is quite feasible to make them of timber if all joints are packed with sealing compound and the outer surfaces treated with a waterproofing paint. Mild steel bolts and straps on the outside can act as clamps, keeping all parts held firmly together. They also help to increase the weight factor. Hanging rings should be fitted, because they are often needed to secure the periscope in awkward positions. They can also be attached to studio hoists when lifting over water becomes a problem.

Uses of 50/50 mirrors

A 50/50 mirror is the description given to a sheet of glass coated with enough silver or aluminium on one surface to reflect back only 50% of the light, allowing the remainder to pass through. Such a mirror is employed when ghost or superimposition effects are required, and in the case of a filmed effect it provides the means of obtaining a composite picture without the need for later laboratory work.

A selection of mirrors of different sizes and degrees of coating can be of great value to the effects designer. Mounted in wooden frames with a short spigot on one side, they can be set up on adjustable lighting stands for use in the studio.

Mirrors coated to a greater or lesser degree are sometimes used to give other results. One of the well-known ones is the "see-through" mirror. This is usually an ordinary mirror which has been silvered, but lacking the protective layer of paint needed to stop the silver tarnishing. If one side of this mirror is in a darkened area and the other in a normally lit area it is possible to see through the mirror from the dark side to the light. As it is not possible to see through from the light side to the dark, this type of mirror can be used wherever it is necessary to see without being seen.

Sometimes it is used to hide a camera where an unusual reverse-angle shot is wanted and where the mirror can form part of the décor. A man shaving or a woman making up at a wall mirror can be seen from the mirror's point of view if a hole for the camera lens is first made in the scenery on which the mirror is fixed. The camera and the cameraman may have to be screened with black drapes to prevent stray light and reflections bouncing from the back of the mirror into the lens.

The coating of silver on a see-through mirror should be as thin as possible, as too thick a deposit can severely reduce the light passing through the mirror. To protect the surface and slow down oxidization a sheet of plain glass can be fixed to the back of the mirror by binding their edges together with adhesive tape.

Ghost effects

If a "ghost" has to appear in a particular part of a scene it is possible to superimpose him on the main set by placing him in a separate area to one side of the camera and combining the two pictures in a 50/50 mirror. The mirror, suitably mounted in front of the lens, should be angled to allow the main set to be seen through it while reflecting the picture of the ghost. Usually the "ghost" is required to appear by fading into the picture, so he must be in an area suitably backed by black drapes and shielded from any other light source than his own. Manifestation occurs when *his* lights are brought up.

This technique produces a transparent spectre. If a solid one is required other methods, such as those described in the chapter on inlay and overlay, must be used.

Composite pictures are often used in less obvious ways, but these are still basically ghost effects. A "magic sword" which had to glow on cue, for example, had its illumination provided from a superimposed source. The sword, which had previously been carried about, was laid on a table, whereupon it emitted a bright light with a surrounding halo.

Inconspicuous marks on the table enabled the artiste to register its position accurately, and the television camera which had been previously lined up for this shot looked at the table through a 50/50 mirror.

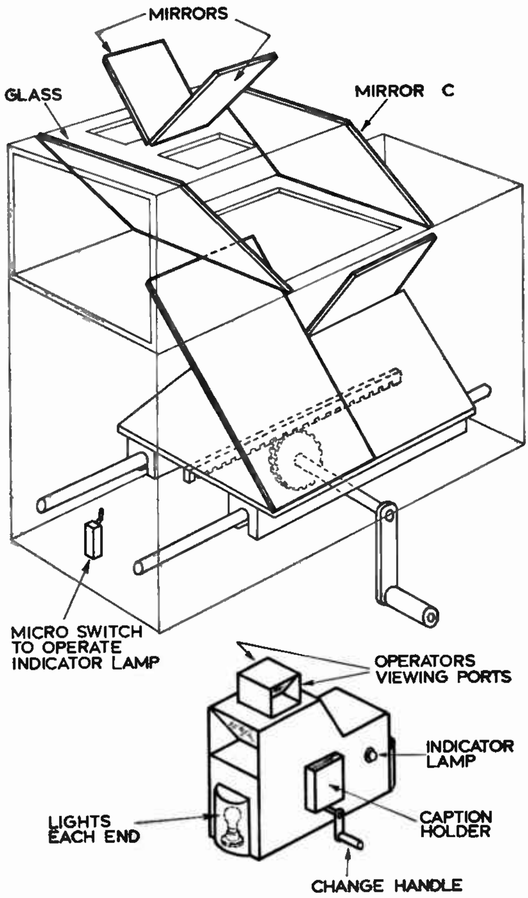
The superimposed picture was a sword-shaped cut-out in black paper placed behind a sheet of frosted glass. This in turn was put at the back of a four-sided box of black cardboard to shield it from studio lighting. A small lamp behind the cut-out was switched on when the effect was wanted.

With this method it is important to screen the back of the cut-out from any light which might produce a premature ghosting effect. For this reason it is sometimes better to leave the lamp switched on and to control the illumination by a removable mask of black paper on the front of the box or behind the cut-out.

Another ghost effect having a variety of applications is the superimposition of explosions. Where an explosion has to take place close to an actor, the 50/50 mirror can be used to provide a safe measure of separation. Consider the scene where an actor is undoing the wrapping of a parcel-bomb. At the critical moment the parcel explodes with a blinding flash, "killing" the actor instantly. To prepare this scene a large area of black drapes is hung at right-angles to the main set and the floor covered with black-painted hardboard or asbestos. An explosive pyrotechnic, painted matt black, is then positioned in this darkened area so that its reflection in the 50/50 mirror coincides with that of the parcel being handled by the actor. It can be arranged to suspend this pyrotechnic on the two wires which will be used to fire it. These must also be black.

When the explosion takes place the main picture is almost blotted out by the flash, but if the two sets are well positioned the light from the flash, as well as being superimposed, also illuminates the main action and reinforces the illusion. Black masks can be set in front of the explosion if certain areas are to be excluded from the flash. An example of this might be when a cupboard or filing cabinet stands to one side of the picture and is between the action and the camera. A mask between the pyrotechnic and the mirror prevents the superimposed flash appearing across the cabinet. It might also be desirable to erect a second mask to prevent the flash directly illuminating the back of the cabinet.

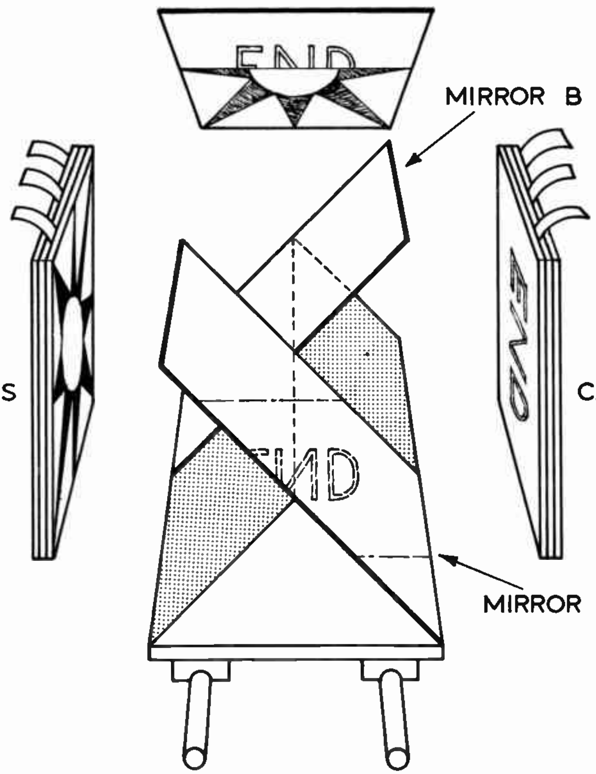
The black drapes behind the pyrotechnic are illuminated when the flash is fired, and inevitably they are superimposed across the main picture. To prevent their being seen they should be set as far



Diagrammatic view of the caption splitter showing disposition of mirrors.

back as possible from the flash, and any creases should be removed by stretching the cloth. This form of superimposed explosion has no "aftermath", and so a director well schooled in television would cut immediately after the flash and from another angle show the actor slumping to the floor in swirling smoke.

The advantages of the mirror set-up in the TV studio are that it ties up only one camera and that lining up can be carried out beforehand, the camera merely returning to its marks when the shot is required. But if there is sufficient time of course, and if cameras are available, it is more convenient to use the normal electronic method of combining the outputs from two cameras. In filming, however, the mirror offers the most sensible way of getting these results.



Diagrammatic view of the caption splitter from the front, showing the reflective paths.

It is important to remember that the main scene and the one that is superimposed should be the same distance from the lens, the superimposed scene being measured via the mirror.

Caption splitter

Sometimes, where caption scanning and mixing facilities are not available or where only two or three cameras are in use, an optical device called a caption splitter can be used to screen photos or captions. The caption splitter is perhaps better described as an "optical wiping effect". The term "wipe" is used to describe a method of substituting one picture or caption for another where the first picture is wiped out by an invisible line travelling from top to bottom or from side to side, revealing the second picture. The effect is popular with film-makers, and on television it still provides a refreshing change from the cross-fade and the straight cut.

The caption splitter consists of a box mounted on a three-legged base (for stability) in which are a number of mirrors. A window is positioned at the front, and on either side are magazines capable of holding twenty or thirty 9 × 12-in captions. A TV camera standing in front with its lens lined up at the window sees one of the captions. It appears the right way up and also the right way round. A handle at the side of the machine is turned, and caption No. 1 is wiped from top to bottom, revealing caption No. 2. At this point caption No. 1 is removed from its holder on the side of the box. Behind caption No. 1 is caption No. 3. The handle is turned back and caption No. 2 is wiped from bottom to top, this time revealing No. 3—and so on until all captions are used.

The principle of the machine can best be seen by studying the drawings on pages 226 and 227. Briefly it works as follows. Two front-surfaced mirrors are fixed to a carriage which can travel up and down the length of the box. These mirrors are at 90 degrees to each other, and each sees one side of the box. Consequently, when the carriage is at one end of its travel it sees, say, the left-hand caption. When it is in the middle it sees half of both captions, and when at the other end it sees the right-hand caption. This can best be imagined if one visualizes two mirrors, side by side, each at 45 degrees to an observer looking down at them. One mirror sees to the right, the other to the left.

The sliding carriage travels horizontally, and as the camera is looking from the front a third mirror is required to turn the image towards the camera. This mirror is situated above the two moving mirrors, and it not only serves to bend the light but also re-reverses the image (bringing it back to normal, the image having been reversed by the first set of mirrors). Other mirrors and glasses enable the operators to see which caption is on the air.

For rapid changing of captions two operators are needed. They stand one on either side of the machine, and each operates his handle in turn. Warning lights are arranged so that the operator on the side showing a red light knows that he must not withdraw a caption from the holder on his side, as it is at that moment on the air. When the handle is turned and the light goes out he removes the caption in the front of the holder. All captions have numbered tabs, and it is simply a matter of pulling out the caption with the lowest number. Odd numbers are to one side and even to the other.

The caption splitter, besides being a useful piece of apparatus, has its place in television history. It was designed and built in 1957 to screen the personal photographs of HRH the Duke of Edinburgh on the occasion of his first television appearance after he and the Queen had returned from a voyage around the world.

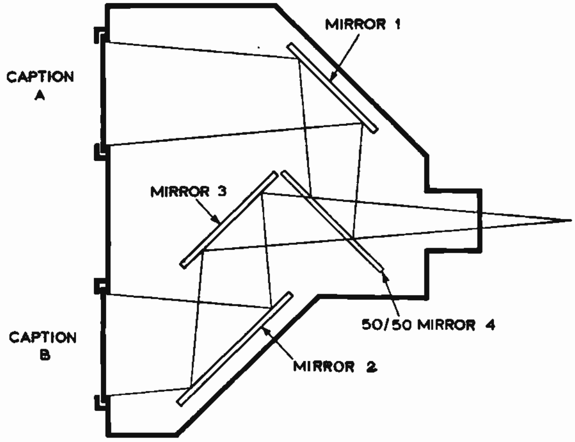
Optical fade

The fade machine, like the caption splitter, is also used for changing 9 × 12-in captions, but unlike the splitter, it changes by cross fading from one to the other. It has no moving parts, because the fade is achieved by reducing the illumination on one caption while increasing it on the other. This demands a special variable resistor balanced with the lighting so that the total amount of light remains constant.

In use, the fade machine is placed in front of the camera in the same manner as the splitter, and similarly it requires an operator to change the captions, although the fading can be controlled remotely. Details of this machine are shown below.

Essential to this device is the 50/50 mirror coated with titanium dioxide. Mirrors which have to be coated to specific tolerances in this material are best kept as small as possible, because the vacuum chambers in which the process is carried out are usually capable of handling only small pieces of glass, and to get an even deposition over the entire surface often means some preliminary failures.

Most suppliers can guarantee only an approximate 50/50 coating: 40/60 is the usual ratio. This is not unacceptable in this sort of fade because the disparity is compensated for in the lighting.



Diagrammatic view of the optical fade machine.

With colour TV, when one picture is reflected and the other is seen through the mirror, the bias changes from orange to blue. Compensation can be made by suitable colour filters on the lighting, but no formulae can be given because the correct procedure can be determined only by matching under actual conditions.

In designing and building a fade machine there are certain factors to be borne in mind, the most important being the possibility of internal reflections. Unless the lights and mirrors are positioned with care, unwanted areas of light are likely to be reflected back from the mirrors on to the captions, making some parts brighter than others. Another factor concerns the alignment of the mirrors. With two dissimilar captions the problem does not arise, but where captions are identical except for the part that has to change during the fade (this might be a weather map where the same land contours appear on both captions, but each with different weather symbols) accurate alignment is essential. Consequently, arrangements must be made for the two surfaced mirrors to be easily adjustable, and this preferably from easily accessible *external* controls. One further factor likely to affect performance is the heat generated by the internal lighting. If this is left switched on for some time there is a danger that the heat will distort the metal framework, causing misalignment of the mirrors.

Other uses for the BP mirror

Crowd scenes are more difficult to portray on television than in motion pictures. The TV director is faced not only with a smaller budget but he has less time and space at his disposal. The ballroom scene so splendidly arranged in the big motion picture may well have taken days to film on a large stage. It would probably also have employed such special effects treatment as travelling-matte, glass-shots, and split-screen, and the many other amplifying techniques which are available to the motion-picture maker. Nevertheless, faced with the problem of producing a large ballroom scene, the TV man can use a number of techniques to suggest that the occasion is much bigger than it really is. The back-projection mirror is one obvious choice. Its edges disguised by scenic columns or potted palms, it can double the number of people present and extend the apparent size of the ballroom. Two or more mirrors can multiply a few dancing couples into dozens.

Illusions of this kind depend on how the mirrors are placed. Positioned subtly in various parts of the set, they not only reflect other parts of the set but can be made to reflect from each other, giving spatial impressions unobtainable by other means. Needless to say, the effects derived must be used sparingly, but once the scene has been convincingly set, a cut-away leaves the viewer believing that great activity is taking place beyond the confines of the picture.

Evolving suitable arrangements is not always easy. Computing the angles of the mirrors and their relative positions to the camera can involve the set designer in some complicated calculations. It is, of course, obligatory to finalize their positions on the ground plan in order that they may be correctly placed in the studio, and to arrive at a satisfactory layout it is simple to utilize small pocket or handbag mirrors which can be moved around on a scale plan of the studio floor. These enable the designer to discover not only the multiple images that may be built up but also the effective distances involved.

Mirrors used for back projection range from small (3 × 4 ft) to large (12 × 18 ft), and their primary function is to reduce the distance between the screen and the projector. But where necessary they can be employed to increase the distance from camera to scene. The most popular application of this principle is probably the overhead shot, where a BP mirror is suspended above the set. Usually it is secured by pulleys or studio hoists at an angle just off horizontal, favouring the side from which the camera looks up. A second mirror (front surfaced and mounted on a stand) is placed near the lens, permitting the camera to look up without being tipped back. The eventual picture is comparable to one taken by a camera mounted twice as high as the BP mirror. Very exciting shots of crowd scenes can be obtained in this way, and some interesting patterns appear when dancers are seen from above.

BP mirrors can be arranged to amplify a scene or create multiple images of a single person. Two mirrors erected parallel to each other with their reflecting surfaces inwards and with an actor standing between them show a long line of actors with alternating left and right characteristics. The camera has to be placed against one side of either mirror to see this picture.

Another method of increasing the length of a shot is similar in principle to that used with the cuckoo clock quoted earlier, in that the direction is changed without the viewer being aware of it. If a door is opened and we see a long corridor stretching back with action taking place at the far end of it we are hardly likely to question what we see. The fact that the action could be taking place *behind* the camera would scarcely seem credible. Such a shot is possible, however, if two back-projection mirrors are used to change the direction through 180 degrees by placing one behind the door at 45 degrees and another also at 45 degrees at the corner of the studio. The term "corridor" probably confuses the issue here, as it implies that the whole length of the shot would be enclosed by parallel walls. This would be wasteful and unnecessary. It is better to consider this shot as a series of planes with only the studio floor providing a continuous path. Even this has to be broken up in some manner, as the bottom frames of the mirrors would, of course, intrude on the continuity. The best use of this arrangement can be visualized when one considers a cave scene. Cut-out flats can be erected around the perimeter of the studio, where they can also form parts of other shots seen from different positions in the studio.

This arrangement has also been used for science fiction—where, for example, openings in the set wall showed a vista of control gear stretching away for some considerable distance. The fact that the path was bent round did not, of course, alter the perspective in any way. The camera tracking or panning on to this shot saw it exactly as if it really did extend in the rearward direction. Where studio ceiling space is more plentiful than floor space, the mirror can be tilted upwards and a shot taken of stuff hanging downwards. Again it appears to be stretching backwards.

Mirror for lighting

Animated captions and diagrams made of paper and cardboard are frequently used in television (see page 327), but they need to be specially lit if they are to be seen to the best advantage. However well designed and made, their components tend to separate from the backing during movement, particularly if they are mounted vertically.

A lighting arrangement in which a sheet of plain glass is positioned between the camera and the caption can be made to remove all the tell-tale shadows by bending the light to follow a path corresponding to the axis of the camera lens. In use the glass is placed about halfway between the caption stand and the camera and is angled diagonally to both.

A lamp placed to one side shines its light on to the glass, whence it is reflected on to the caption. The camera, looking through the glass, sees the caption, and as the path of the light from the lamp and the axis of the lens are identical, all shadows on the caption are exactly behind their objects, and cannot therefore be seen. Without shadows it is almost impossible to tell that the caption is constructed from a series of planes.

A convenient housing for the glass can be made by constructing a box about 2 ft 6 in square. It should have all sides open, with a top and bottom to support the glass. Mounted on suitable legs, the whole thing should be painted black.

Most of the light from the lamp passes through the glass, and in order that it should not find its way back into the camera (reflected this time from the rear of the glass sheet), it is necessary to position the set-up well away from any reflecting objects. Possible trouble of this nature can be dealt with in two ways. If the light is broadened feeble reflections may not be noticed. Alternatively, a black drape hung in a convenient spot prevents reflections altogether.

It might be assumed that a more reflective coating than just plain glass would allow less of the light to go to waste, but it must be realized that the light from the face of the caption has to return to the camera lens through the glass, where it is attenuated by the amount of coating or reflective capability of the glass. If the glass were a pure mirror *all* the light from the lamp would illuminate the caption, but on its return journey it would *all* be reflected back to the lamp!

Revolving disc

Many effects now carried out electronically were at one time obtained from optical rigs fastened to the camera. It is worth recalling some of these, because they still tend to be used for experimental work, and in any case stimulate ideas in other fields.

The revolving disc was usually a simple wheel of transparent plastic or glass of about 20 in diameter, with a central spindle fixed to the camera, enabling the wheel to be rotated in front of the lens. The more sophisticated arrangements were motorized, or operated through gears and a handle, but quite often it was sufficient merely to spin them by hand.

These discs were used to get various fading or distortion effects which added variety to camera changes. They were popular for such things as the passing of time and other dramatic conventions. The most common was probably the fade. This was a disc around which white paint had been sprayed with increasing density. To start with, the lens looked through the clear area. Then the glass wheel was rotated slowly until the lens was obscured. This did not correspond to a fade produced normally, as the light from the back of the disc produced a fogging effect more than a diminution of light.

Another was the "wobble". This was sometimes clear plastic which had been distorted by heat, but better results were obtained from thicker sheets that had been scalloped and polished. The effect can be likened to that of a shimmering heat haze.

Patterned glass, cut-out paper, and even glue and grease can be applied to the discs to give water ripple, vignetting, light beams, and a host of other effects, but the results depend on the size of the wheel and its distance from the lens.

Mirrors for cueing and prompting

Although it is not classed as a special effect, the arrangement by which a mirror or glass sheet may be used for prompting speakers who appear before the camera is worth mentioning here. Placed in front of the lens and angled downwards, a sheet of plain or semi-mirrored glass can reflect back information to a person seated facing the camera. He or she can be shown cue lights, prompt cards, or even a complete text without having to look away from the lens, and without any of this being seen by the camera.

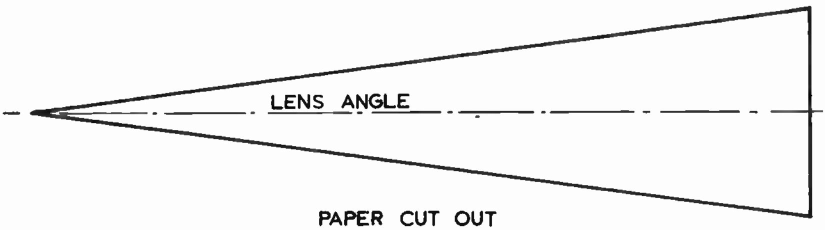
If prompt cards are required they can be printed or written on translucent paper and laid, face down, on a light box below the glass sheet. This takes care of the reversal they suffer by being seen in a mirror.

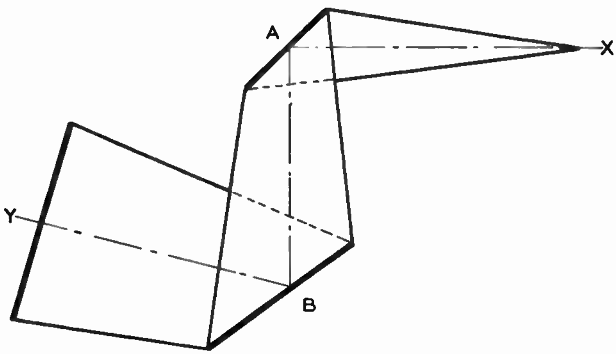
If a light box is not available the prompt details can be photographed and printed in reverse.

Calculating angles

Light striking a mirror reflects at an angle equal to, and opposite from, its line of entry, so that if its source and its point of reception are known a diagram can be drawn which establishes angles and sizes.

Let us suppose that a periscope has to be constructed to take a picture of something at floor level. Let us further suppose that the viewpoint is to be looking up. This means that there will be two mirrors in the periscope, one at the top, near the camera lens, and one at the bottom, near the floor. The lower one has to be tipped up slightly in order to achieve the looking-up viewpoint. To construct





To calculate the laws of reflection a strip of paper corresponding to a lens (or viewing) angle may be cut from paper as shown in the top picture. Folded anywhere along its length it provides a means of positioning mirrors either for use with scenic projection in the studio or for the construction of special optical devices. In the lower picture X represents the eye (or the lens). Mirrors placed at A and B will reflect all of the subject Y back to X. Conversely a picture projected from X will fill a screen Y if mirrors A and B are used in the positions shown. As well as producing the relevant angles this method also determines the sizes of the mirrors.

such a periscope of optimum dimensions it is necessary to calculate the angles of both mirrors and also their minimum sizes. The simplest way of arriving at these figures is to establish the vertical angle of the lens to be used and to draw this angle on a suitably large piece of paper, which is then cut out. This piece of paper, now a long narrow triangle, can be folded anywhere along its length, and the angles which occur conform in every way to the laws of reflection. Applied to the design of the periscope mentioned above, it could be used as follows. An elevation is drawn showing floor level, the object to be seen, and the position of the camera lens. The apex of the piece of paper is placed at the point of the lens and the triangle of paper is folded twice so that it finishes up at the object (see above). The folds correspond exactly to the sizes and angles of the mirrors.

12

INLAY AND OVERLAY

THIS chapter, which deals with electronic inlay and overlay, and the following chapter, which is concerned with scenic projection, both describe methods by which parts of different pictures or scenes may be combined. The ability to combine pictures in this fashion is an essential requirement in the production of both television and films. Clouds may have to be added to unsuitable skies, and unusual backgrounds combined with actors working in a studio. After all, if you can't film your cast in front of the Taj Mahal the Taj Mahal must be re-created behind your actors! From the earliest days in the history of both media attempts have been made to devise special methods of getting practical results. In the case of movies, back projection has provided a solution both reliable and flexible; while the perfection of travelling matte* has supplied an alternative method, albeit one which can only be carried out in the laboratories after shooting has finished.

Technicians and directors in television have also been able to make use of these methods, but as television relies upon electronics to produce the final picture (instead of the chemical and optical processes involved in film making), TV development engineers have been able to invent entirely novel methods of combining pictures for this purpose.

It is difficult to assess the comparative merits of the several different systems available to the television director. Much depends on such factors as time, costs, and studio space, and whether the scene is to be recorded on tape or film. The type of programme may also dictate the treatment. A light-entertainment programme would not require the same degree of realism as a major drama.

* Travelling matte, a photographic method of combining pictures on film, is not dealt with in this book. It is an expensive method and too time-consuming for normal TV use, besides which there are other and more immediate means of achieving satisfactory results.

These two chapters describe the systems available, giving as far as possible an unbiased exposition of their advantages and disadvantages.

Switching systems

Television offers two systems that enable a director to insert one part of an electronic picture into another. These are known respectively as inlay and overlay and are processes based on the fact that the scanning spot of light which forms the TV picture can be switched on and off. Thus, should there be two cameras (or other input sources such as video tape or telecine film), a changeover switch connecting the two inputs to one output can be made to select either one input or the other. This means simply that while the switch is in one position the picture from one input source is seen, and when the switch is changed the picture from the second source is seen. Now if this switching occurs when the scanning spot has travelled only halfway down the first picture, the remaining half of the picture will come from the second input source.

This can be better appreciated if it is assumed for the purposes of example that the input sources are from two cameras both looking at still pictures. The scanning spot coming from camera I is switched when halfway down the picture. Switching means that camera II takes over for the second half of the frame. Back at the top of the frame, camera I is again switched in and so on. The final transmitted picture is, of course, the upper half of camera I's picture and the lower half of camera II's.

What has been done to split the screen horizontally can also be done to split it vertically. If the scanning spot of camera I is switched when it has travelled only halfway across the frame the remainder of the scanned line comes from camera II. If this is repeated line after line the final picture shows the left-hand side of camera I's picture and the right-hand side of camera II's.

It can be seen from this that if the switching occurs not at the regular intervals required for a split screen but at irregular intervals the final composite picture also has an irregular shape. And what is more, the shape can be a moving one!

The switch required to operate a changeover between two electronic sources of this kind must necessarily itself be an electronic device. No mechanical unit could deal with the rapid switching required for such an operation. The switch is the heart of the equipment and has to meet very stringent specifications. It must switch from one circuit to the other without "noise" or deviation in signal, and it must operate at the highest speed so that no visible outline intrudes at the join. The switch is controlled by an electronic source in the form of a signal which can be supplied in a number of ways. When the equipment receives the signal it switches to one input source; when the signal is discontinued it switches immediately to the other. Assuming that regular pulses are applied to the switch, a regular pattern is applied to the screen. If the frequency of the pulses is altered the pattern changes in size or shape.

It requires only some suitable means of supplying the right number of pulses at the correct intervals to establish whatever combination of pictures is required.

Electronic inlay methods

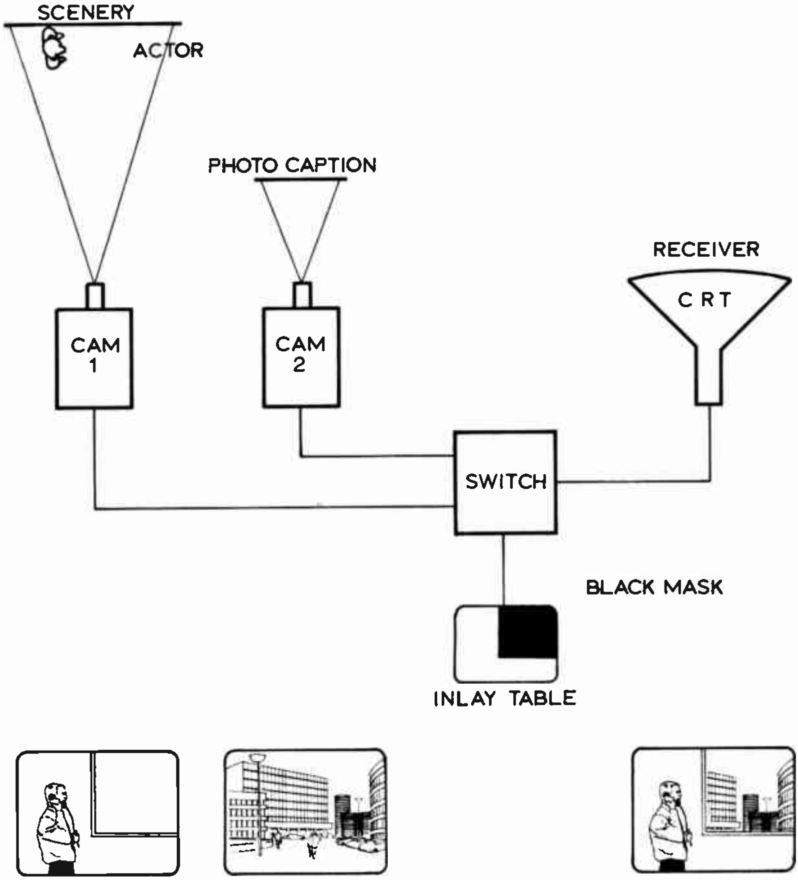
Inlay is the system whereby one part of a picture is inserted into a predetermined area of another. The size and shape of the insertion is governed by manual equipment installed in the control gallery and controlled by an operator. He determines the pattern by the use of special masks or pieces of opaque paper which he cuts to requirement. The system works as follows:

The operator sits at a table in the centre of which is a sheet of translucent glass illuminated from below by a fluorescent light source. A small videcon camera is fixed about 18 in above the table looking down on the glass. The signal from this camera is fed to the electronic switch which controls the selection of the two inputs.

While the camera sees the illuminated plane the switch is held in one position, but when the light is cut off a signal is generated, causing the switch to change to the other position. As this camera works in the conventional manner, the illuminated plane is scanned in the same way and at the same frequency as the cathode-ray tube. Therefore, with the two scans in synchronism, interference with the camera scan causes identical interference with the final picture. Hence if a piece of opaque material is placed upon the light table the camera causes the switch to respond to the silhouette of the area which is unlit.

If, for example, the mask is a square of black paper positioned in the middle of the inlay table the final transmitted picture has a square hole in the middle which is filled by a picture from the second camera. It is easy to visualize the possible applications.

Prior to the present videcon camera/light plane arrangement a



Electronic inlay provides a means of combining part of one picture with part of another. The scene outside the window is a section of the photograph being seen by camera 2. Its size, shape, and position are determined by the black mask placed upon the inlay table. The scene being taken by camera 1 has a plain background, but is provided with a painted line to appear as a window frame.

different system was used. Above the glass table on which the masks were placed was a short-after-glow cathode-ray tube. This displayed a permanent raster. Below the glass was a lens and a photo-cell which received light from the cathode-ray tube. While the light was unobscured the electronic switch was held in its first position, but when a mask was placed on the glass the scanning of the cathode-ray tube was interrupted, changing the switch. The photo cell saw not a picture but only a light source which was interrupted at intervals. This information applied to the final picture (via the switch) modified the results in the same way as the present equipment.

For caption and general programme use there is equipment capable of generating automatic inlay effects. These generally consist of "wipes" and are actuated by the vision mixer. The range of wipes is predetermined by inserted printed circuitry, and selection is by press-button, after which the movement of an adjoining fader will produce the wipe. This may be carried through as a continuous movement, wiping from one input source to another, or it can be halted anywhere in its travel to give a combined picture of the format required. Increasing/decreasing circles and rectangles, vertical and horiztonal plain wipes, and many other such effects are available. This type of installation does not rely on the videcon camera set-up outlined above, and consequently does not permit the use of purpose-built masks.

Electronic overlay methods

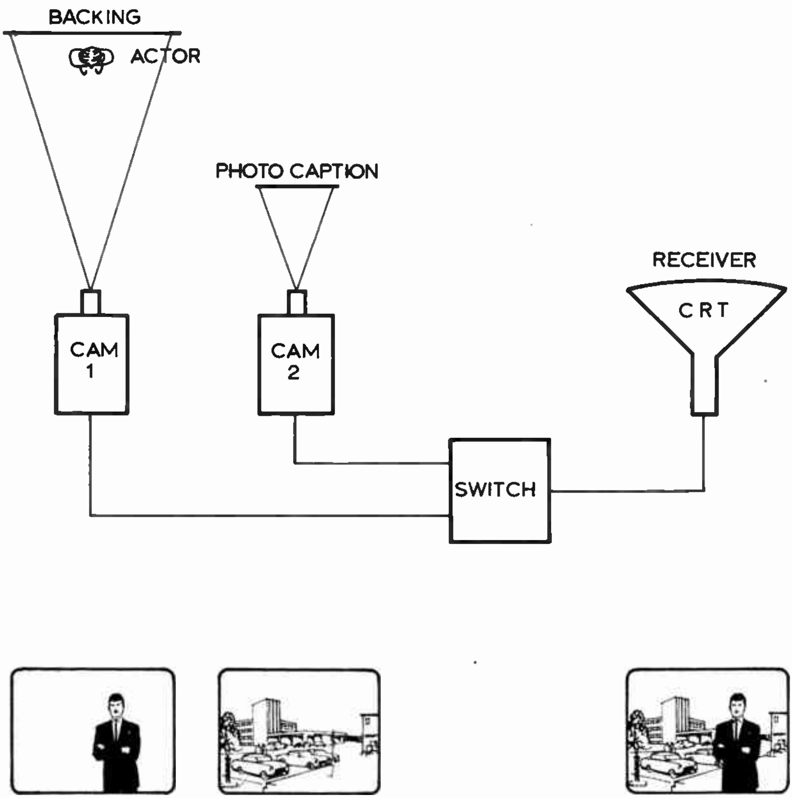
Inlay offers a facility whereby two pictures can be combined, providing the borders are pre-determined. The inserted picture, however, can be made to move—that is, the area, shape, and position can all be altered during transmission of the picture. The mark can be slid around on the glass, making the inserted portion of the picture move in the same fashion.

The movement offered by inlay, however, is suitable only for certain applications, chiefly those concerned with caption and pictorial effects. It cannot be used to provide blanking out for a moving figure. This requirement fathered the design of the equipment known as the electronic overlay system.

Overlay works in the same fashion as inlay, in so far as it has a switch able to select either of two sources of input. The difference lies in the means of supplying the controlling signal.

With overlay, a moving subject seen by one camera must appear in the overall picture seen by another. An obvious example: an actor being recorded by one camera but appearing in the final picture against a background recorded by a second camera (an economical arrangement could include a still photograph set up on an easel in front of the camera). The actor in this case must be able to move about freely without appearing as a ghost (with the background showing through his body) and without being limited to certain specified areas of action within the picture.

It has already been shown that if the inlay mask is moved around, the switch (which operates anywhere during the scan) produces an



Electronic overlay enables moving subjects to be combined with scenes from another source. The actor being screened by camera 1 can move about "in front" of the picture being taken by camera 2. He is standing against a special backing which switches the output to camera 2 whenever the scanning electron beam is not seeing him.

exact replica of the moving pattern. If, therefore, the switching could be made to operate around the silhouette of the actor's person, then he could be overlaid on to the picture from the second camera. And this, of course, is exactly what happens. The actor is made to stand in front of a plain background which is specially contrived to operate the switch in favour of the *second* camera, while the picture of the actor triggers the signal back to his *own* camera. In monochrome TV the principle employed is that of lighting the backing to peak white or leaving it black. The switch operates only when it receives the signal from the appropriate shade of black or white.

Assuming that the backing is black and that camera I is scanning it, then the switch is held in the position where it favours the output from camera II. If, however, something white or grey is placed in front of the black screen the change in scanning signal causes the switch to favour the output from camera I. This grey or white article therefore appears in the relevant part of the picture as it is being seen by camera I. Whether it moves or remains stationary does not affect the process. Providing he wears no black, an actor can be expected to produce the same effect.

Unfortunately there are certain limitations to overlay in this form. Shadows appearing as "black", particularly those under the arms and in the mouth, confuse the switch, allowing parts of the background picture to break through in a most inconvenient manner. White therefore is a better choice. Against a white backing an actor can be dressed, made up, and lit so that no white occurs anywhere on his person. Nevertheless, there are still problems—this time with reflected highlights. Perspiring foreheads reflecting back the studio lights fool the switch in the same way as the armpit shadows. Of the two, however, the rogue white is easier to cope with than the black.

Although it has been suggested that the switch operates when the camera sees white, there is in actual fact a "clipping point" where the changeover takes place. This, technically, is within a percentage of the total signal variation from black to white. What it means in practice is that areas of very light grey, being close to the white level, must be avoided in the clothing of the actor. (This, of course, refers to the monochromatic effect of the clothing—i.e. although it doesn't matter what *colour* the clothes are, they must not include any colours which, when seen by the monochromatic cameras, register as light grey or white.)

A well-designed electronic switch is capable of dealing with incredibly fast changes, enabling fine detail to appear as overlaid patterns; but hair, even when black, can occasionally give rise to breakthrough or "noisy" outlines.

Colour separation overlay*

Monochromatic overlay depends for its operation on a change of contrast, but in colour TV it is possible to utilize the fact that the cameras can sense not only differences in contrast but also differences in colour. It has been possible therefore to develop a system which is more selective than that for monochrome.

It works in the same fashion as the black-and-white overlay, in

* This method is known in the USA as chroma key.

that the subject in the foreground is placed in front of a backing designed to operate the electronic switch.

For this backing a specific blue has been chosen, the reason for this being that blue is not normally present in flesh tones and can usually be left out of any foreground design or clothing. The chosen blue is the one that produces the highest response in the blue channel of the camera. Its being specific in both hue and contrast means that the system, as well as being able to differentiate between colours, can also differentiate between hues, ignoring those which do not have the correct response.

Troubles may arise in unexpected ways, however. Shiny surfaces (and these can include perspiring foreheads, lustrous hair, and polished furniture) can reflect enough of the backing to cause breakthrough of the second picture. As with all such systems, there must be a clean cut-off between the backing and the foreground subject.

Fortunately this system has a high degree of tolerance as far as lighting is concerned, stray light on the backing being less troublesome than with scenic projection methods.

As a generalization it is true to say that colour overlay offers a very useful tool, and that it is likely to prove of greater value than the more restricted monochrome system.

The fact that all these systems provide combination pictures without the necessity for elaborate equipment on the studio floor gives them an advantage over the scenic projection systems.

Applications of inlay and overlay systems

Although the applications for inlay and overlay are almost unlimited, these systems have failed to achieve the popularity predicted for them in the early days of TV. Of the two, inlay has proved more successful, because it can be used both for the combination of pictures as well as for various visual effects, including wiping from one scene to another.

These effects, exchanging one picture for another, can occasionally be linked to studio movement. An old (but still entertaining) device is for an artiste to "pull" the next scene into place. He holds up one arm and walks off stage. The inlay operator, provided with an effects monitor, slides his card across the table in synchronization with the actor's travel.

Telephone conversations often require a split-screen including the two parties. For this it is only necessary to obscure half of the light plane on the inlay table, permitting half of the picture from each camera to be shown.

Another application is when a scene calls for a moving picture, such as a TV set or a movie screen, to be seen. The inlay operator cuts paper to match the size and shape of the screen being shown, and feeds in a picture either from another camera or from telecine. One thing that must be borne in mind when using inlay in this fashion is that the two pictures to be combined are the *same overall size.* They both occupy the full area of the frame. All that the inlay does is to permit *part* of one picture to be seen in the other; therefore the original material must be composed in such a way that the inserted portion forms a complete picture containing all that is wanted. It is not possible to compress the inserted picture to fill a given area. If the inlay is to imitate a home-movie screen, and the information is coming from pre-filmed material on telecine, the action must have been filmed in the appropriate area of the frame.

Inlay may be used when it is required to increase the area of a studio set. As in movie making, it is sometimes necessary to add a ceiling piece or to enlarge the size of buildings. In television this is not carried to the same lengths as it is in films because setting-up time is limited, and since both the real and the inlaid part of the set must have common junctions and perspective, the addition of an inlaid portion can often prove troublesome. Nevertheless, where there is time and the subject demands it, the results can be most rewarding. The cameras must both be fixed if the scene is a static one, and once aligned may not be moved until after the shot. This does not necessarily limit the technique, as such shots are usually employed merely to establish the scene before going into closer shots.

Yet another application is where a scene is to be put behind a window. In conjunction with telecine, inlay can show fire inside a house, or a rainy scene on the outside. Because inlay does not permit camera movement, such shots should be confined to windows not appearing in the normal part of the set. In fact, it is better to limit such shots to cut-aways.

As mask cutting is a finicky operation, a window used for inlaid effects should have the absolute minimum of glazing bars. Single-pane or double-sash windows are the most appropriate.

Similarly, a shot of a front door can establish an actor entering a house. The door, plus a suitable amount of surrounding flattage, is erected in the studio and inlaid into a picture of the house. In order to get a shot of the door which is small enough to integrate into the larger picture of the house, it is important to erect it at the far end of the studio.

An actor can walk from the camera and go through the door or stand and talk to the inmates. The composite scene makes it appear that he is actually standing in front of a real house. The illusion is shattered, however, if the characters move beyond the area of the flat; the flat and the door are included in the picture only because the inlay operator has cut his black paper to accommodate them, and if people go beyond the confines of the mask they disappear.

This factor can be used for various trick effects. A room can be shown with two people sitting in chairs. At an appropriate moment one person vanishes. Assuming the scene will end with this startling dènouement, it might be suitable to adopt a method where inlay is used as follows:

The scene is real, with practical props and furniture, and arranged just as it would be for normal recording. During rehearsals earlier in the day the set is photographed with full studio lighting exactly as it is to appear later during the actual recording, and from the exact spot at which the final trick shot will be televised. An enlargement is rushed off from the negative and mounted on a caption easel.

The inlay operator then arranges for the photo to be seen by a second camera in such a way that it superimposes exactly over the final scene—the photograph showing part of the set with an empty chair. It is up to the inlay operator to decide where the superimposition starts and finishes, but the designer can help him if he establishes certain emphasized straight lines as part of his dècor. The scene runs with the actor in the studio chair, and at the vital moment the vision mixer cuts to the inlay circuit. The part of the set with the actor in the chair vanishes, being replaced by the inlaid photograph showing the empty chair.

There are many other uses for inlay, and it would be possible to fill a whole chapter with examples, but before leaving the subject it is appropriate to mention its use with captions and titles. Opaque cut-out letters can be applied to a transparent sheet which is then laid on the table and used either to provide empty letters through which a moving background is seen, or solid letters floating on a moving background. For more bizarre effects both the background and the title can be from moving sources.

Overlay affords more effective use of the system in that it can achieve effects unobtainable in other ways. It can, for example, provide integrated pictures containing people of dissimilar sizes, highly suitable for the "Fairy on the hand" type of effect. It can also provide moving backgrounds, including people or vehicles, which can be put behind live action in the studio. These variations of scale and action give a wide range of effects.

A set-up which serves to exemplify the possibilities is one that might be used to get a shot of a magic carpet. Conventionally such a carpet is supposed to fly through the air transporting one or more human beings. A feasible method of simulating this form of levitation is to fix the carpet, suitably backed by blockboard, on to a tubular steel rig which when counterweighted supports the carpet plus its passengers. The rig is pivoted on a gimble joint allowing the carpet to be raised, lowered, and turned into picture. The assembly is placed in front of a screen of suitable blue, and those parts of the tubular steel arm supporting the carpet are also painted blue. (Experiment might show that sheets of blue paper attached to the supports provide better blanking; tubular sections tend to have shadows below and highlights above.)

The carpet and its occupants are then overlaid on to a moving sky or landscape film. The result is perfectly credible, with the carpet being apparently unsupported. To increase the effect of movement, a wind-machine or directional air line can be used to blow the actors' clothing.

Similarly, a person could be made to "fly" through the air without a carpet or other means of support simply by standing him or her on a studio block coloured blue against a background of the same hue.

13

SCENIC PROJECTION

THE system whereby a picture is projected on to a screen to provide background scenery must be known to most people. Pioneered in the film industry, it has proved to be almost as essential to television as it has been to the movies. It is used in the television electronic studio as well as in the television film studio. and similar equipment is employed for both types of studio.*

Pictures can be projected either from behind the action or from in front. They can be static (in which case slides are used) or they can be moving, utilizing standard 35-mm film. Each system has its advantages and its disadvantages, but the cost of the original equipment can be considerable, and this fact may easily determine the amount and type of equipment available in any television organization.

All projection systems require special screens, projectors, mirrors, control gear, etc., and these in turn demand special storage facilities. In many cases there is also a need for special transporting vehicles, particularly if studios are widely spread.

For both front and rear projection, considerable care must be taken in choosing moving projectors. Second-hand or inappropriate projectors may work well under certain conditions and yet be entirely useless under others. Light output, noise, ease of lacing-up—all these can be relevant factors, but by far the most important is the steadiness of the projected picture. If the image judders and

* A stills projector used for screening film-studio backgrounds may also be used in the electronic studio, but where moving projectors are concerned, the types must differ for films and TV. A background projector used for film work has a single 180-degree shutter which revolves in unison with an identical shutter arrangement in the camera. The television picture, however, is a constant one, and the interruption of the picture by the single-vane shutter would cause an intolerable flicker. Therefore the moving projector used in the television studio has a two-vane 90-degree shutter which, by doubling the flicker rate, renders it almost invisible.

quivers it is useless for any purpose other than those effects where the unwanted movement can be camouflaged, such as shots through the rear window of a moving car, sky backing for aircraft, seascapes around a ship, etc. In all these cases faulty projection can be tolerated, but where a street scene is shown through a shop window, unsteady projection looks ludicrous.

It is an unfortunate fact that in television, projection equipment is seldom as good as it should be. There are usually economic reasons for this, but where unsuitable equipment exists the golden rule should be "No projection is better than bad projection". For it is a fact that imperfect techniques invariably disturb a large proportion of the viewers.

The static picture is supplied from a photographic positive on a glass slide about $3\frac{1}{4}$ in square (having an image of $3 \times 2\frac{1}{2}$ in)* while the moving pictures come from ordinary mute 35-mm stock. The movie industry refers to these as a "plate", which paradoxically is the moving film, and a "stereo", which is the static slide. To the uninitiated these terms are confusing and somewhat misleading. The author, in common with many people in the TV industry, prefers to class all pictures that are projected as plates, or when needing to be more specific, as projection slides or projection films.

Back-projection equipment

Back projection is the system whereby a picture is projected from behind on to a translucent screen set behind the action. The screen, usually of a plastic material, is bound and eyeletted and held taut in a tubular metal frame to which it is laced with stout elastic bands. These screens are sometimes in one piece and sometimes fabricated from separate pieces. The joins (horizontal for TV to prevent strobing) do not show as predominant lines, however, as the blue-grey colour is sprayed on to the transparent base material only after the sheet has been made, and furthermore, the base material is planed down where the overlapping joint occurs.

The screens must be tough, able to withstand cleaning, and capable of transmitting as much light as possible. This statement must, however, be qualified. If the screen material is *too* transparent the lens of the projector appears as a bright source of light (the hot spot) in the centre of the picture. Normal transmission for a BP screen is about 50–60 per cent.

* Slides for colour TV need to be larger than those for black and white because they require greater illumination.

Back projection, like normal cinema projection, needs sufficient throw (distance between screen and projector) to give a large picture. Distance, particularly clear distance, is usually at a premium in any studio, but a mirror placed (say, halfway) between the projector and screen allows the projector to be positioned at one side of the screen. From this position it can bounce the picture from the mirror back on to the screen. The mirror in this case has to be at least half the linear size of the screen and, although a 30-ft throw is thus reduced to 15 ft, that area still has to be clear of objects likely to cause shadows on the screen.

The larger mirrors for use with back projection need not be surface-silvered, because under these conditions the amount of double image ghosting that occurs with conventional mirrors is comparatively inconspicuous. Usually these mirrors are made of polished plate glass, $\frac{1}{4}$ in thick, supported in stout wooden or metal frames. They must be on castor wheels so that they can be accurately aligned behind the screen.

There are two types of projector, moving and still. The stills projector consists of a lamphouse, a slide carrier, and the usual condenser and projection-lens systems. It also has a cooling system, without which the slide would quickly disintegrate. Cooling is provided in two ways. The light, leaving a xenon lamp, passes through a diochroic mirror placed at an angle to the main light-path. This deflects the heat rays away from the plate while permitting the light to pass through. The slide itself is cooled by a jet of air which operates continuously while the light is switched on. Apart from the slight noise of the cooling fan, there are no sound problems with still projectors.

Moving projectors are similar in principle to those used for screening motion pictures in the cinema, the difference being that the scenic projector has a more refined system of film transport and registration. The juddering effect of the normal projector is scarcely noticeable in cinema projection, but it becomes intolerable when back projection is used in proximity to static scenery.

The movements, transport, and gears of some projectors produce unwanted noise, and in order that the machines may be used in TV studios and on sound stages, the entire projector must be housed in a rugged soundproof blimp. An alternative is to set it up in a soundproof cubicle, but this takes up a great deal of room and (unless it is to be a permanent installation) is rather unsatisfactory. More sophisticated moving projectors are constructed in such a fashion that no separate sound blimping is necessary.

Projectors and film cameras, having intermittent film and shutter movements, must run in synchronism with each other during filming. Without synchronization it would be possible for the film-camera shutter to be open when the projector shutter was closed, resulting in the absence of background picture on the exposed film. Interlock is achieved electrically by the use of three-phase motors which control the phasing of the camera and projector shutters, ensuring that they operate in unison. Once speed has been reached, they remain in step until switched off.

When scenic projectors are operated in the television studio there is no need for the equipment to be synchronized in the same way. Synchronization is automatic, because the projector, working at 25 frames per second (not 24 as in movie projection), is locked to the mains supply through its three-phase driving motor, remaining always in step with the television system.

Back projection in use

Back projection is particularly useful in the field of effects. It may be used to supply backings to model shots, or it can provide enlarged pictures of models to appear as full-sized objects. This is equally true of both front-projection and overlay, and the choice of BP or one of the other methods depends more often upon the availability of equipment than other reasons. What is important, however, is whether the available studio space permits the use of back projection. Many effects shots involving models are recorded either in small studios or limited space in a studio already full of scenery and actors, precluding the use of back projection. Conversely, other shots may be so complicated or important that they are pre-recorded separately on an otherwise empty stage, in which case back projection may be considered a suitable method.

Back projection is frequently used to provide sky backings for filmed model shots. Being rear-projected, they permit any sort of arrangement to be placed in front of the screen during filming. Back projection is most useful where a lot of experimental work is to be carried out before the actual take. The sky or other scene can be clearly seen from a wide angle around the camera position, and if, for example, certain slides or films are to be examined by a number of interested parties they can all judge the effect simultaneously. When using front axial projection only the man looking through the camera eyepiece can adequately assess the final composition.

When a sky is to be placed behind a landscape model or seascape

A typical back projection arrangement in a TV studio.

tank it is important to choose a slide that is suitable—that is, one that has been originally photographed from the correct angle. Clouds and sky at the horizon are unlike those overhead, and if the final composite picture is to show prominent clouds running right out to the horizon these clouds must appear in the correct fashion on the BP plate. Moving the plate seldom suffices. Heavy cumulus clouds rising straight up from the horizon look unnatural.

With moving BP all sorts of sky effects are possible, but again, great care should be taken to select an appropriate plate. All clouds move, however slowly, but if a model shot is to be seen only for a short length of time it is hardly politic to use a film of moving clouds if a still plate will suffice. The fact that the film might possibly judder or that moving dirt and scratches might draw attention to the sky will more than offset the marginal advantages in having a moving sky. If a time lapse is to be indicated it is better to use a still plate and to cut away while the slide is racked across, or replaced with another.

It is possible to mask the light from the projector to make a day sky scene appear as an evening or twilight one. It is not a recommended practice, but can be used as an expedient when no more suitable plate is available. A sloping mask, placed in front of the projector, should cut off the top of the shot, allowing a diffused band of light to appear above the skyline. This effect can be achieved in fact without using the plate or even the projector. A light placed at the rear of a BP screen can be shaded to give a variety of soft sky effects. This method can also be used to simulate the glow of fire above a model of a burning building.

Another trick that may be brought into use when sky plates are in short supply is to project a sky scene upside down as a backing for a model aircraft. Needless to say, this does not always work, but some cloudscapes when inverted give a remarkably realistic impression of clouds seen from above. The chief advantage of such a ruse is that while it is fairly easy to obtain cloud pictures from the ground, it is an expensive business to obtain them from the air.

Back projection is used to provide background scenes in many different ways. In use the screen is either erected behind part of the scenery or stood by itself on the studio floor. The fact that the screen is laced into a frame means that there is an open area at floor level which must be hidden if the picture is to serve the purpose of providing a background contiguous with the floor. It is usual to erect a 12-in rostrum floor in front of the screen for this purpose.

The advantages of using back projection are numerous. Of paramount importance is the fact that background and foreground action can both be seen at one and the same time and that both can be adjusted. Back projection, although required to be correctly aligned, with recording camera and projector on similar axes, is not as critical as front axial projection. The projector can be crabbed across or moved up and down to shift the picture where necessary. There are, of course, limits to these manoeuvres, but these are problems for cameramen and back-projection operators.

Illumination of the BP screen should be uniform over the entire area of the picture, but occasionally there will be fall-off at the edges and hot-spots in the centre. These can be dealt with by positioning shaped, transparent filters between the projector and the screen—provided the camera is used in a fixed position.

Illumination of the foreground is apt to present special problems. To achieve maximum contrast of the BP picture it is essential that very little spill light falls on the front of the screen. Any subject appearing in front of the screen must be kept as far away from it as possible, and frontal key lighting arrangements are unsuitable.

BP can be used to great advantage in supplying movement behind model shots. The addition of movement can enhance a model shot a hundredfold. It is not necessary to make the movement either distinct or obvious. In fact, it is better to play it down to the level of mere suggestion. In this way it implies realism without predominating—pronounced movement can often draw attention to itself, detracting from the purpose of the model. Small rear-projection screens may be erected behind models or in some

Back projection in its most used form—supplying the view from the rear window of a car.

cases made part of the model itself. If no small screen is available the model can be positioned in front of an ordinary full-size BP screen. Occasionally tracing paper or ground glass can be used. If such substitute materials give a good picture, but show the "hot-spot" from the projector lens, it is sometimes possible to angle the projector round so that the "hot-spot" disappears behind part of the model.

It is important that the screen is kept within the depth of field of the recording camera, and it should therefore be placed as close to the foreground material as possible. This applies particularly where small model set ups are involved. Dirt or grease spots on the screen will *also* be in focus, and a check should be made through the camera viewfinder before shooting commences to ensure that no unwanted effects are present.

Factory models or similar busy scenes benefit from implanted movement. Usually this can be situated in such a fashion that it either appears in the background between one or more of the model buildings or is seen outside gates. Sometimes it is possible to show a complete street, with flowing traffic, alongside model buildings. At other times it is merely necessary to use a film with rising industrial smoke to bring life to an otherwise inactive scene.

On some occasions the projected part of the picture, instead of merely providing atmospheric movement, can be the item of most importance. An example would be where a pre-filmed ship at sea had been set up behind a model of a harbour or perhaps a lagoon. This is a favourite device where it is necessary to see a certain vessel from a particular viewpoint.

With all such model shots, whether movement is to be merely suggested or to be of paramount importance, it is essential that the projector is capable of giving an absolutely rock-steady picture. If this is not possible the shot should never be attempted.

Moving back projection in television is associated chiefly with simulated travel. The best known use is probably where, through the rear window of a car, the road is seen to unwind behind the vehicle. Other applications are the moving scenery viewed from a train window, clouds outside an aircraft, and underseascapes for science-fiction-type submarines. These shots lend conviction to scenes which would otherwise have to be recorded on real vehicles in motion. It is when the vehicle has to execute such manoeuvres as turning, slowing down, or stopping that problems arise, because although it is possible to pre-film stops and turns, it is not always easy to synchronize them with the studio action. Cars and trains are particularly troubled by this limitation. It is feasible to cut away, but where the action demands specific manoeuvres to be shown, only exacting control of the BP and several rehearsals will ensure precise results. There is no way in which the back-projected picture can be slowed down or stopped. Changes of speed must be dealt with during filming.

Moving back projection has been responsible for some of the most hilarious gaffes on television. Actors have stepped smartly from cars travelling at full speed, others have been suddenly deprived of their scenery, and one of the most excruciatingly funny occasions was when a train pulled in at a perfectly normal station and outside the window a guard's head appeared—three times normal size!

One of the first rules for shooting BP film is that *all* the subject matter on the film must be beyond the point where the foreground in the studio is to take over. Anything which is closer than this hypothetical line will be made to appear *behind* the constructed foreground, but will be as big as if in *front* of it. A cameraman shooting film for back projection knows that the lens angle he uses must be similar to that which will later be used to re-record the back-projected scene in the studio. For normal purposes it is not possible to shoot with a wide-angle lens in the studio if the BP plate was taken with a narrow-angle lens. Similarly, attention must be paid to perspective. The taking camera, positioned at the normal camera height, must shoot horizontally. The exceptions to this are when the viewpoint is supposed to be looking up. However, if such a viewpoint *has* been selected the resultant film cannot be used in conjunction with scenery or persons to be filmed from a normal position.

To clarify this, we can take as an example the shot where a person is seen clinging to a window-ledge or some other projection, while far below we also see the moving traffic in the street. This arrangement, used for breathtaking high shots, is a familiar one, and relies on special juxtaposition of screen, projector, actor, and camera. The original shot of the street below could have been taken with the camera pointing down. The studio camera in this case must therefore also point down. We must see the unfortunate occupant of the window-ledge from above. We cannot look at him in the normal plane without the entire perspective appearing impossible. There are two ways of achieving the shot. One is to leave the BP projector and camera exactly as they would be for normal use while sloping the scenery and the actor. If he had to be seen standing still with his back pressed hard against the window or wall this would work, but if he had to walk along a narrow parapet he would have to perform an impossible gravitational feat. This sloping-scenery device works well for climbing up mountains, where the mountainside can be set almost horizontally in front of the screen. Climbing up chimney stacks and ladders also permits the set to be sloped. Seen on the screen, it is difficult to appreciate the fact that the actor is doing anything but climbing in the normal fashion, and the fact that the BP picture further establishes the angle convinces the viewer that he is looking down.

As we have agreed, this does not work when the actor has to walk the parapet. For this he must undoubtedly perform his action in an upright position. This means that to get the correct perspective the camera in the studio must look down on him at exactly the angle from which the original camera recorded the street scene. But in that position the studio camera has to be placed up high—probably, in fact, above the top of the BP screen, and from that position not only would the light from the screen fall off considerably but the picture would be artificially foreshortened, compressing the horizontals. This means that the projector must be lowered below the screen by the same amount that the camera has been raised above, and in order that the screen can be used properly, it must be tilted backwards to keep it at right-angles to the axes of camera–projector arrangement.

This sort of set-up can usually be achieved only where there is either considerable head height or where the projector can be lowered into a studio tank.

Not all simulated height shots demand this extreme rearrangement. It is, after all, possible to point a camera horizontally out of a tenth-storey window and get a picture which shows quite clearly that the viewpoint is a high one, even if street level is not included. This sort of shot allows the action to be recorded in a horizontal plane. For instance, if the man had to be seen walking the parapet the camera could be placed at one end of it, with the actor walking towards or away from the camera. The BP picture behind him would show quite clearly that there was a severe drop on the outside of the parapet, and all would be well. If we wanted to reinforce the height illusion we could cut to a shot of the street seen from the actor's point of view.

There are many advantages to be gained by using projected backgrounds, but in television attempts to emulate certain complicated film techniques should be avoided. The sort of shot to be shunned is the one where the foreground and background are designed to appear as a single entity. This could be a corridor in which action is seen in the background (on film) coupled with action in the foreground in a practical setting. Undoubtedly such a scene is possible, but is this the best way of getting it? Is it not simpler to record a complete corridor either in the studio or on location?

Another example of this might seem to be more of a *fait accompli*. An ill-fated liner is about to strike an iceberg. The scene is composed of a construction of the liner's boatdeck in the foreground, blending at a suitable point with a BP film of a model of the forepart of the ship. The iceberg looms up and the entire forepart of the ship is embedded in the shattering, falling ice and snow. In this instance there *is* a case for attempting the matching of front and rear components, but this is far from easy. Such definite perspective must retain continuity to look convincing. But which comes first, the chicken or the egg? Does one make a model, film it for back projection, and then attempt to build the set to match?

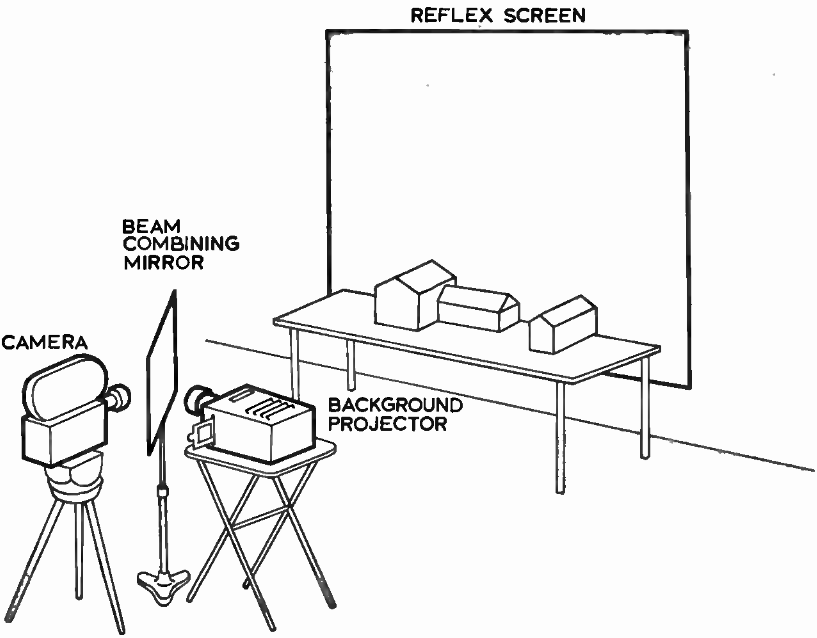
In the film world all this is worked out with great precision and attention to detail. In television, however, one person makes the model and another films it, while at the same time the main set is probably in the course of construction by outside contractors. The effects man has the responsibility of bringing these together at the time of recording, and he may well wish that he had considered a less dramatic, but more foolproof, arrangement. The model shot could be used on the BP screen, but any attempt to make foreground and background contiguous should be ruled out. Instead a conveniently positioned full-sized lifeboat or part of the superstructure could be used to establish the ship in the foreground, while the model handrails and the deck (to be smashed by the collision) should be seen on the BP screen.

Projection is not necessarily confined to full-scale background effects. It can sometimes be employed to provide such effects as a number of cathode-ray-tube displays in a control-room scene. The desk equipment can be placed against a BP screen, on which a moving picture of the "radar patterns" is projected. This can sometimes be more economical than using mechanical props, although the cost of using BP equipment and operator's must be considered. It is particularly useful in providing novel effects which in some other form could be either very costly or unusually complicated. As an alternative to the all too familiar flashing lights which figure so prominently in science-fiction scenes, it is possible to project patterns on to screens set among props or scenery. Patterns of moving light and strange "traces" can be pre-filmed as animations on the rostrum camera. Repeat printing produces sufficient length for a BP plate.

One paramount advantage that back projection has over both front-axial projection and overlay is that the *actor* can see the picture on the backing. If he is called upon to fight a monster or talk to a double of himself the second component is there for him to react to. With the other systems all his reactions must be blind. An exception to this when overlay is being used is if he can be provided with a monitor showing the combined picture.

Front axial projection

Front axial projection is similar to back projection in that it provides a still or moving picture on a screen placed behind the action. In principle, however, it is entirely different. It relies upon the properties of special reflective screen material. The screen consists of a plastic base, covered in a special adhesive in which millions of tiny glass beads are embedded. The beads have the property of reflecting light back in the direction from which it came. The latest material is so directional that almost 92 per cent of the original light is returned in this fashion. Furthermore, the screen does not have to be exactly at right-angles; light shone from the side is still reflected back to its source. However, for normal purposes right-angles should be observed, because the colour factor alters if the material is angled beyond a certain point.



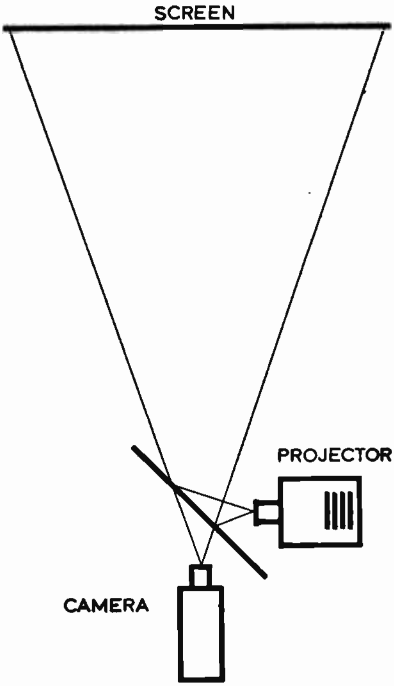
A simple camera–mirror–projector arrangement used for combination model shots. Thirty-five millimetre colour transparencies can be made to blend successfully with foreground items and many cheap and easy model set-ups can be achieved with this system.

It follows that to get the light to enter the camera lens it must leave and return by the *same path*, which *must* be along the axis of the camera lens. This is accomplished by setting up a two-way mirror at 45 degrees to the lens axis, in front of the camera. Acting as a beam-combiner, it allows a projector to be operated at 90 degrees to the camera so that both may share a common axis. The light from the projector is reflected via the mirror on to the screen, from whence it returns, a percentage of it passing through the mirror and entering the camera lens.

Even a normal 35-mm slide in a domestic projector can be used to provide a very large background area with this system. The light (seen from anywhere but the camera) is so weak as to appear non-existent. Falling on actors or scenery, it is unnoticeable, and quite incapable of being recorded on film or television camera. Nevertheless, this attenuation of the original light over so large an area does not affect the issue. As the screen reflects it all back to the source, the camera sees a brilliantly lit background.

In contrast to back projection, the screen used for front axial

Front axial projection relies upon the fact that the background projector and the camera share a common axis.



projection is not greatly affected by ambient light. Studio lighting, like the projected light, goes largely back to source. It is simpler therefore to light a scene with front axial projection than with rear projection. Nevertheless, strong light on the screen *will* produce a loss of background contrast, and where models are set close to the screen this can prove troublesome.

The fact that actors or objects are stood in front of the screen, and are therefore in the direct rays of projected light falling on the screen, does not interfere with the final picture. Their shadows are invisible from the camera viewpoint because they fall directly behind the objects—lit, as they are, from the camera-lens position. This does, of course, depend upon the accurate setting up of mirror, camera, and projector. Faulty alignment of any of these can produce dark outlines around the foreground objects.

Before shooting, it is necessary to ensure that the rig is accurately aligned; checking is carried out by holding up a small piece of screen material in front of the screen proper, at a distance from it to correspond with the position of foreground objects, while projecting white light. This piece of material should be moved around to check all areas of the screen. Perfect alignment is achieved when the material appears to be invisible. Faulty alignment shows a shadow line around it.

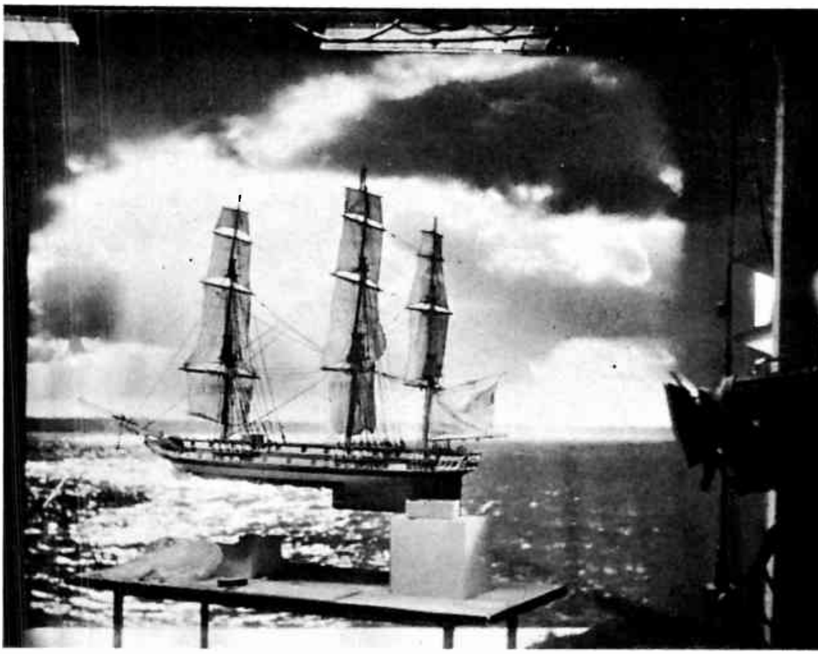
One major advantage with this system is that it allows the projector to operate alongside the camera. As the path of projection is the same as that of the camera's field of view, no additional clear space is required in the studio. Another advantage is that the light output can be a great deal less than for back projection, eliminating the need for elaborate cooling when using slides.

The main disadvantages are that the picture cannot be seen by anyone who is not looking from the immediate area of the camera and that the entire alignment is critical.

Storage of the screen material is important. It is expensive and must be protected from dust, abrasions, and fingermarks. As it is not necessary to stretch it in a frame in the same way as the BP screen, small areas can be rolled up on a spindle when stored and unrolled when required for use. In other cases it can be affixed directly to a wall and covered when not in use.

The screen material is supplied in rolls. It is a self-adhesive plastic material with a removable paper backing. At present it is not guaranteed that any two rolls will have similar tone. Thus, although the reflective properties of two rolls might be similar when assembled side by side, one can be seen to differ from the other in that it has a slightly different overall hue. It is important that screens are made up by using rolls from one batch and applying them so that they are used consecutively. If this is not possible, then the rolls should be cut up and stuck to a base material in very small pieces and in random pattern. This form of application breaks up any large areas of disparity.

It is possible to produce effects with front axial projection which would be impossible with back projection. These are effects in which pieces of screen material are applied to the fronts of foreground objects, allowing the projected picture to be seen in that area. As a simple demonstration one can visualize the effect of an actor having a piece of reflex screen material fastened to his shirt front. The background picture will be reflected, making it appear that he has a hole in his chest (this would not be entirely convincing, but serves well enough as an example). More subtle would be an effect where an actor was holding a book in which one of the illustrations came to life. It wouldn't matter in what position the book was held; if the camera could see it, then the projected picture must also be able to reach it. The angle of the page would have to be flat to the camera and would have to remain absolutely steady.



Puzzle picture: The model ship which appears to be unsupported at one end is in reality on two boxes. The front one and part of the hull are behind a piece of reflex screen material which allows the sky plate being projected on to the reflex screen at the back to take over.

In the same way an actor could appear to be holding a box containing a tiny man. In fact, faced with the problem of screening *Gulliver's Travels* the effects man would probably be able to get most of the large- and small-person composites by the use of front axial projection. It can be used in a number of arrangements, some of which are examined here.

In the "Gulliver" context one great advantage of using still plates with front axial projection is that it saves work on the manufacture of larger-than-life props, because photographs of the real items can be projected simultaneously both behind and in front of the action. One can visualize hundreds of examples, but selecting a very simple one—two objects on a table—it can be readily appreciated that one could be projected on to the main screen at the back while the second could be projected on to a separate free-standing screen at the front. The actor could therefore walk in front of one and behind the other, giving the scene a credible appearance of depth.

Because the separate screen needed for the object in the foreground would have to be cut to the profile of the projected picture, it would be more suitable if this object could have a simple shape, preferably comprising straight lines. A portrait in a frame, a candle, a jam-jar: all these would prove easy to accommodate.

Needless to say, this type of set-up limits camera movement, but quick cuts from different angles using different background pictures would disguise the lack of mobility. (This would require pre-recording or filming, as such shots require time to set up.)

Such arrangements are not limited to projection alone. They can be combined with practical props or scenery. Imagine a situation where a giant-size matchbox had to be moved in the course of the action and where several identical matchboxes had to be seen around it. The non-practical ones could be shown as a photograph (of real matchboxes) on the front-axial screen, while the one with which the actor had to perform could be a giant-size prop.

It is important when such juxtaposition takes place that the real and the manufactured items do not appear too dissimilar. In the case of the matchboxes it would minimize the disparity if the giant-size prop were made from such material as hardboard and papered over with photographic blow-ups (king-sized enlargements) of the original matchbox.

This becomes more important where (still on the "Gulliver" theme) two scenes have to share a common object, but where the two scenes are of different scale. For this example we will imagine the object to be a cart used by the little people, but later positioned alongside the gigantic Gulliver. A mistake would be to show the little people using a fully practical property cart and then to picture Gulliver with a model of the cart. A great deal of painstaking work would have to be carried out on the model cart to make it accurately resemble the life-sized one. A better way would be to arrange the shots, using front axial projection, so that either a model cart *or* a real one was used; but the two should never be used together. If it were decided to use only a model Gulliver could be shown holding it. In the other scene it would be photographed and used as a backing to the little people. They would not be able to move it, but clever use of scenery and reflex-screen material would allow them to climb up on it and also to load it. If the alternative method were used the little people would be supplied with a real cart which they could pull around. Shown with Gulliver, the cart would be a photograph of the real one projected on to some part of a main screen or even a cut-out piece applied to something in the foreground. In this arrangement Gulliver would not be able to handle the cart at all, but this time *he* could appear to remove things from it.

This single-reproduction technique applies equally to architecture. If (again in the Gulliver sense) houses are to be shown they can first be made as models, where they can be used in conjunction with the giant and then shown as enlarged photographic projected backings with the little people. Used with the giant, they can be augmented by combining pictures of them on the screen with a foreground containing the actual models. Used with the little people, the projected images could have practical doors and windows made from non-reflective material applied to the reflex screen.

Keeping to the theme of big and little people, it is easy to imagine a scene in which Gulliver seated at a table looks down at the Lilliputians. If the shot were taken from behind his back looking across the table at the floor he could converse with them as they stared up to this great height. It would indeed be a great height, as they would have been filmed previously from a relatively high viewpoint in the studio. This film would then be projected on to a reflex screen placed behind the table at which Gulliver would be sitting.

Taken from another angle they (the little people) could walk about on the table. Seen from a horizontal viewpoint, level with the table-top, they could perform in an area carefully delineated by books or other props, which would serve to disguise the edges of the screen material.

A shorter-focal-length lens on the projector provides a larger image on the screen. It is, of course, possible to use different focal-length lenses on either the projector or the camera in order to get special effects of size and perspective. Nevertheless, this must be applied with discretion, particularly when normal-sized foregrounds and backgrounds are being combined. The greater the disparity between the focal lengths of the camera and projector lenses, the greater is the chance that there will be such aberrations as shadow fringing or hot spots.

Front axial projection is an exciting and stimulating system, and it is easy to visualize all sorts of uses for it, particularly as pieces can be cut from screen material and applied to different surfaces. But it is easy to make rash assumptions when designing with front axial projection in mind. An example might be the magic carpet quoted in the chapter on overlay. One might, for instance, assume that a rostrum could be positioned bearing the magic carpet in front of the screen while a sheet of the material could be stood in

A small piece of reflex screen material held close to the screen disappears almost completely. When it is moved closer to camera it appears much brighter than the screen.

front of the rostrum to hide it. It is true that such an arrangement would appear to work. The same sky picture would be projected on the two screens, and the cut line of material would not show more than the faintest of divisions, and even this might be lost in the line structure of the transmitted TV picture. The snags are that the material nearer the camera gives a brighter picture than the one at the back (see above) and that if the separation is too wide one or other of the parts of the picture will be out of focus.

A strange phenomenon that occurs when using the front-axial process is that of halation (page 265). Anything capable of reflecting light back at the screen produces a halo of light around itself. This can often be lost on a well-lit plate, but is very apparent when

The halation effect of the reflex screen: A piece of card, black on one side and white on the other, is subjected to back lighting from the large lamp on the right of the picture. The reflex screen is unlit and the man is standing approximately halfway between the screen and the camera. When the white side of the card is turned towards the screen a distinct halo appears.

a light-coloured object is stood against a dark part of the screen. In order to eliminate this side-effect, it is necessary for the backs of objects (and particularly models made of light-coloured materials) to be painted black, or to be screened from any back light.

Front axial projection poses many problems for the cameraman. As well as having to align the equipment precisely on its correct axes, he has to balance the light between the front subject and the projected picture on the screen. He is forced to light the front subject with more light than he would need if he were filming it without the front axial equipment, because he is shooting through the beam-combining mirror. Being coated, this mirror reflects away a proportion of the light returning from the subject to the camera; or, put more simply, it acts as a filter, cutting out some of the available light. This is why the mirror need be coated only with a 20 or 30% reflection factor. Actually, plain glass would do perfectly well if it weren't for the fact that, as it reflects from both of its surfaces, it gives an obvious double image.

The light from the projector, being nearly all returned to the camera, presents a secondary problem. In spite of the fact that most of it is dissipated by passing through the lightly reflective mirror, there is usually much more than required. It can be reduced by inserting neutral-density filters between the plate and the light source. Dimming the light is not always practicable because it alters the colour temperature. Equally, stopping down is not always possible, because it sharpens up the condenser and light source of the projector, giving unwanted patterns on the screen.

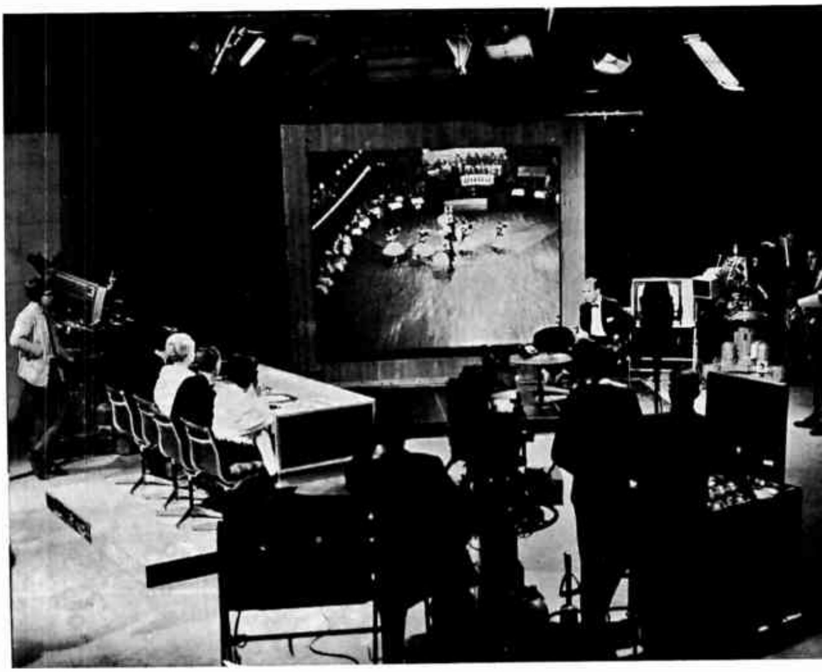
One method of getting a balance between the front and back lighting is to light the foreground subject first. Then the subject (or part of it) is removed and replaced by a white card. Next the reflex screen is lit by white light from the projector and is attenuated until it matches the light on the card.*

The Eidophor projector

There is a system of picture-projection which enables large, brilliant TV pictures to be projected either as rear-projected pictures on to conventional BP screens or directly on to ordinary front-projection (cinema) screens. This system, known by the registered name Eidophor, is used extensively in television studios because it can provide enlarged pictures straight from the TV camera or any video signal. Applications include close-up details of scientific experiments being shown on large screens behind the actual demonstrations, and large-scale pictures of events taking place elsewhere combined with shots of people participating in the studio.

The Eidophor projection system is based on an electronic optical control principle. It uses an independent high-intensity xenon arc lamp to throw a powerful light on to a thin film of oil evenly spread over the surface of a concave mirror. The oil-control layer is scanned by a beam of electrons controlled by video signals. The resulting electrostatic charge on the oil affects its surface.

* Various patents and rights exist in the use of front axial projection systems, and it would be advisable for any intending user to investigate the situation in the country concerned. In Britain equipment and details can be obtained from Rank Film Equipment.



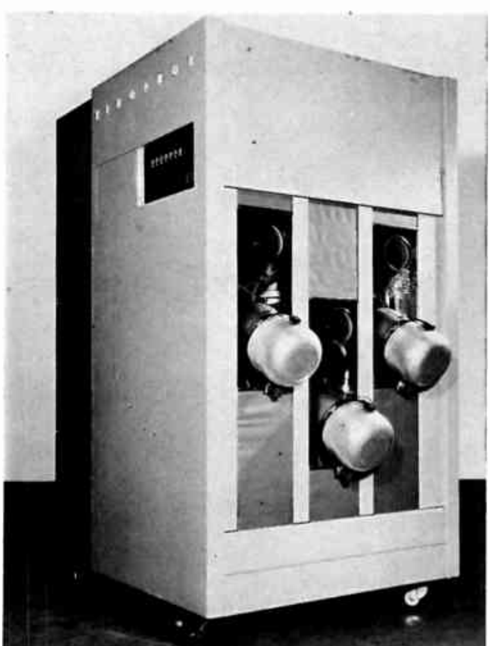
A typical Eidophor application, the screen relaying a picture from a remote studio.

The xenon light is focused through a lens system on to a series of slatted mirrors which project it on to the control mirror. If nothing alters the oil-covered surface the light is reflected back to its source, but when the oil is deformed by the scanning electron beam the main light is scattered and escapes between the slatted mirrors, where it is collected by a lens system and projected on to its ultimate screen.

Separate Eidophor systems are available for both monochrome and colour pictures.

Front and rear projection compared

It is difficult to draw comparisons between front- and rear-projection methods. In some cases back projection offers a solution to a problem that could not be solved by using front axial projection, and in other cases the position is reversed. For example, a sky behind a seascape model would reflect into the water in the appropriate fashion only if back projection were used. With front axial projection the reflection comes not from what is above the water



Monochrome and colour Eidophor projectors.

but from what would be projected below if the water were not really there! (See page 270 for an explanation of this phenomenon.)

Back projection provides a greater number of variables, in that the camera and projector can be moved about and that the equipment does not call for super-critical arrangements. Front axial projection, where the beam-dividing mirror, projector, and camera are all inter-dependent units, places greater restrictions on the movement of equipment and frame size.

Neither front nor rear moving projection systems permit trick effects to be carried out where filming must be speeded up or slowed down, because standard film projectors are geared to run only at conventional speeds. Fast- and slow-motion filming may, of course, be carried out using static plates in the background, or as previously stated the original moving plate could have been filmed with fast or slow motion—or even frozen framed.

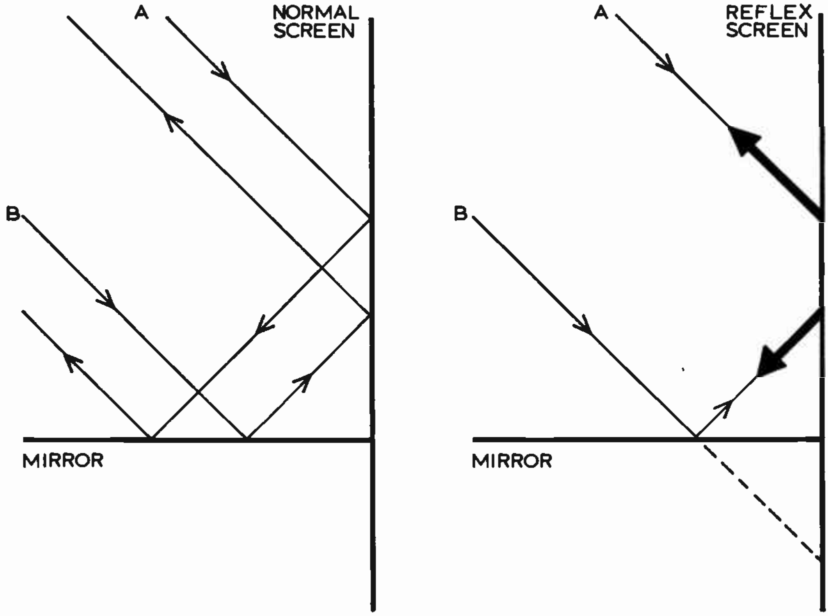
Eidophor might be considered to perform in much the same way as colour separation overlay, in that both methods provide background pictures from electronic inputs, but the essential difference between them is that with Eidophor the full-sized picture can be seen by those in the studio. To see the combined overlay picture, those in the studio must be provided with monitors.

Another difference to be borne in mind is that when Eidophor is employed to provide a big studio picture it can be seen from a number of different viewpoints. Consequently, an oblique shot gives the appropriate perspective. With overlay, similar tactics will result in the backing (which is the blue screen) being effectively angled, but the overlaid material remains as a front-on viewpoint.

The implications of this can be better appreciated if one visualizes a scene showing the simulated interior of a cinema. If a normal projection screen is set up to appear as the screen in the cinema the Eidophor picture can be projected on to it and shots can be shown of the "audience" looking at the projected picture. These shots can be taken from almost any position. Front-on shots can be freely intercut with side-on shots, and close-ups can be mingled with long shots. With colour separation overlay this is not possible.

Using TV monitors

In the early days of television a producer once wanted to show a scene in which a family was seated round a television set. The problem was how to get a picture on the tube. He suggested that they might try feeding a picture to a monitor and actually look at it



The properties of the reflex screen used for front axial projection are such that it does not conform to the normal laws of reflection. To demonstrate the effect two screens are shown here. One is an ordinary, white reflecting screen and the other a reflex FAP screen. Both have a horizontal mirror placed near the bottom of the screen and both are being provided with a projected picture of a TV test card. (See pictures opposite of the ordinary screen, *top*, and the reflex screen, *bottom*.) The ordinary screen shows that the area above the mirror is reflected upside down whereas the reflex screen shows the portion of the picture that would be there if the mirror was removed because the image is reflected from the mirror on to the screen and then straight back to the mirror. While such novel effects can be put to use (for example a mirror placed on the studio floor would extend the picture below floor level) they also have disadvantages. A sky plate used behind a model lake scene might easily show the sky continuing into and below the lake!

with a camera. This suggestion was treated as being almost too daring, and many people went to great lengths to explain why it wouldn't work. History records that it was tried and it worked. Since that day TV monitors have been used constantly in this fashion.

A trick which has allowed people to have a bit of fun with the system as well as providing some caption and effects material was

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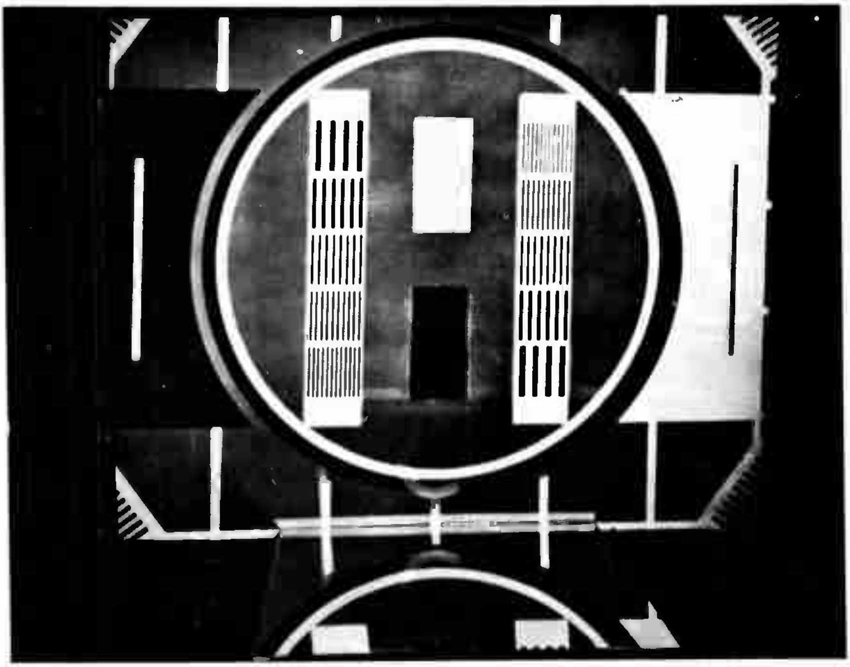
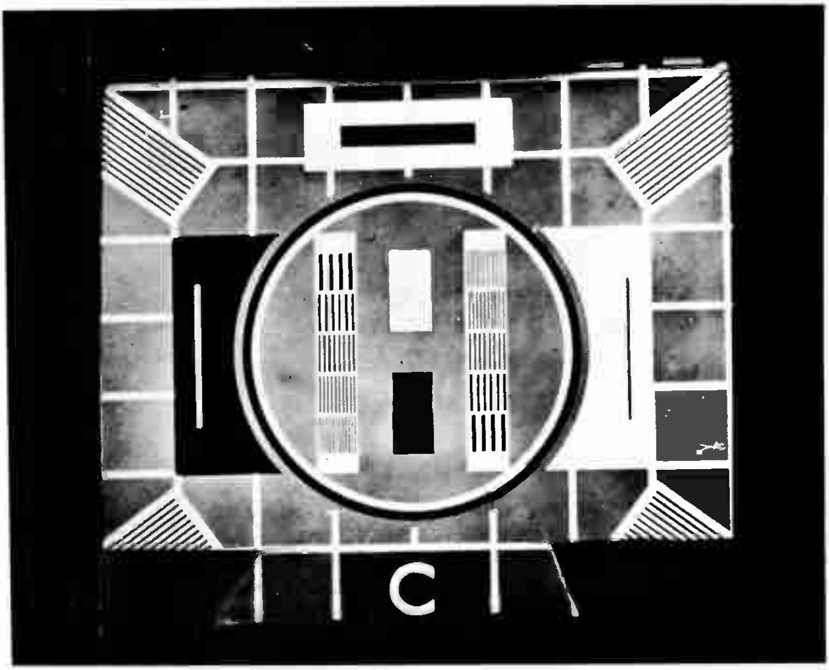
The ordinary screen, *top*, reflects an image into the mirror and back to the eye. The image projected on to the mirror is similarly reflected to the screen and is overpowered by the screen image. On the reflex screen, *bottom*, the image projected on to the mirror is reflected to the screen and then straight back to the mirror, showing the part of the screen image below the mirror. ▶





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also tried for the first time many years ago. For this trick a camera is set up where it can look at a monitor. The monitor is then fed with the signal from the camera. Most people will recognize this as a typical "ringing" or "feed back" circuit, one that in audio parlance is referred to as howl-back. (If a microphone feeding an amplifier is placed close to the speaker it produces a characteristic howl as the sound goes round and round.) So it is with the visual signal. If a torch is shone into the lens of the camera the light appears on the monitor and is seen by the camera, and so appears on the monitor, and so on *ad infinitum*. The delay in the circuit causes the effect to develop strange wavy patterns which can be made to fluctuate in sympathy with the movement of the hand-held light. Many other effects can be obtained by increasing the gain in the circuit and by altering the frame and line-scan controls.

14

HIGH- AND LOW-SPEED CAMERAS

WHEN it is required to slow down or speed up action, film cameras capable of running at speeds faster and slower than normal have to be used. Modern film cameras are driven by three-phase electric motors and the speed is governed by "locking on" to the frequency of the AC mains supply. As most silent cameras operate from battery supplies, they run "wild". This means that they are not governed by frequency control, the speed being determined from a tachometer, which shows the number of frames per second passing through the gate. Only when the camera is to be interlocked with a projector for front or back projection is it essential for frequency-controlled speed to be applied.

Most battery-powered cameras are able to operate at higher and lower speeds than normal. The voltage to the motor is either increased or decreased. There are limits, however, to the amount by which the speed can be increased. Most cameras can be expected to turn at about one and a half times normal (36 frames per second, though many are capable of short bursts of 48 frames per second).

For lower speeds the motor drives the camera at about 8–4 frames per second, after which the inertia of the camera causes the motor to hunt with fluctuating speed.

For all special work, therefore, cameras with suitable motors must be used. These cameras are available in various forms, some exposing many hundreds of feet per second and others exposing just one frame at a time.

These abnormal speeds are colloquially referred to as "over-cranking" for high speeds and "undercranking" for low speeds.

Effect of filming speed

It is sometimes difficult for people to understand fully the implications of high- and low-speed filming. They become confused by the fact that for slow-motion filming they need a high-speed camera and for fast action a camera that runs slowly. The principles are quite obvious, however. If a slow-motion action is required the camera must run at a higher speed than normal so that the action is photographed by a greater number of frames. When shown on a projector or on telecine the frames run through at the standard rate (for TV) of 25 per second, and because there are more frames the action takes longer to be seen; it is therefore slowed down.

There are many kinds of scene requiring changes of film speed, apart from the obvious knock-about comedy scenes where cars and people tear about in demented confusion. Skilful use can improve many of the effects which are to be recorded on film.

Crashes where one car hits another or mows down an unfortunate pedestrian can benefit from slight undercranking. Care must be taken when arranging the action, because by speeding up the pace of the vehicle there is a danger that the actions of the people will appear ludicrous. In a "car-hits-man" sequence it is helpful if the actor can keep all limb motions at half speed so that his eventual reactions look normal when the impact is speeded up.

Similarly with fight scenes, undercranking will improve the action. This applies particularly where amateur swordsmen are taking great care not to injure themselves.

Sometimes a scene will benefit from both slowed-down *and* speeded-up action. An example might be where, in a medium shot, a man is to be knocked through the banisters of a staircase. Slight undercranking makes it appear that he is travelling backwards through the smashing woodwork at a greater pace than he is in reality. The cut to the long shot as he falls needs to be filmed at a slightly higher speed so that the fall is slowed down, thus implying a greater height than actually exists.

The bugbear of high-speed filming is the actual amount of stock consumed. Before a camera is running at a fixed speed there is a period of time known as the "run-up". When a camera is operating at five or six times normal speed the run-up consumes vast footages of stock before the cameraman is satisfied that a constant speed has been reached. Likewise a lot more film is used while the camera slows down at the end of the take. Seen later in the viewing theatre, these rushes appear to go on for ever. If the take is a bad one the prolonged embarrassment is a painful experience.

High-speed filming is usually employed for model shots where the behaviour of water, smoke, or explosions must be slowed down, but there are other trick effects where a dreamlike quality must be imparted to objects or people. Imitation "men on the moon" or "astronauts in space" can be filmed using the high-speed camera.

Sometimes the use of an ultra-high-speed camera, normally reserved for scientific purposes, can produce novel results for eye-catching caption material. One such use was the shattering of a television cathode-ray tube over which was superimposed the title of the programme. The flying glass was seen slowly floating outwards, glinting in coloured lighting.

Whether high- or low-speed filming is required, it is important to visualize the eventual picture. Too much slowing down or speeding up gives an unreal quality which may destroy the whole purpose of the operation. It is always sound policy to shoot a number of takes at various speeds, because it is better to consume extra time and film stock during one particular session than to have to set the whole thing up again at a later date if the speed originally chosen is found to have been the wrong one.

Sometimes mistakes can be rectified by later frame-cutting or by repeat-frame printing, but these are last resorts, and results are only satisfactory for certain subjects.

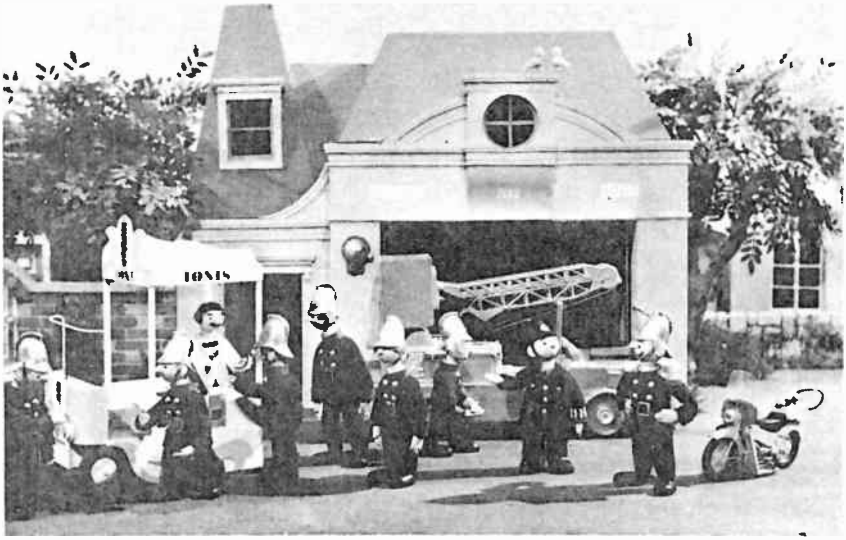
Lighting effects incorporated in the scene are also affected by the speed at which they are filmed. For example, those used with high-speed photography must be increased in intensity to compensate for the difference in exposure times. A night scene might show a model ship being tossed on a stormy sea. If the model is equipped with miniature lighting this will have to be correspondingly brighter, because the cameraman will have to increase his lighting on the overall scene.

Stop-motion filming

The technique of animating inanimate objects by exposing one frame at a time is referred to as "stop-motion" filming.

Most people associate this technique with advertising films in which the products are made to move as if by magic. Toffees that unwrap themselves and packets of cereal that, unaided, pour their contents into breakfast plates are now such a common sight on television that they scarcely create any surprise. Nevertheless, the methods involved are usually complicated and incredibly painstaking, facts often belied by the smooth and glossy end-product.

Stop-motion is an effect as old as films themselves, and even with today's sophisticated equipment, it is difficult to surpass some of



A scene from *Trumpton*, one of the many delightful animated puppet films made by Gordon Murray. Filmed and animated by Bura & Hardwick this production called for a considerable amount of skill and patience by all concerned.
The puppets are about six inches high and are both light and flexible. The heads are made from ping-pong balls, the "skeletons" of soft aluminium wire, and the feet are of balsa wood. These are fixed to the floor by steel pins. The clothing is tailored in fine foam plastic to prevent uncontrollable wrinkling.
Sixteen-millimetre cameras with zoom lenses were used and special mechanism permitting single-frame exposures of up to one second was incorporated.
Animation was carried out to the pre-recorded sound track developed in a visual form, the tiny characters being moved a fraction of an inch between each exposure. Work of this kind imposes an enormous strain on the operators. Concentration for long periods is essential, because mistakes can be rectified only by re-shooting a complete sequence. Mistakes are usually discovered only when rushes are viewed at a later date.
All scenery and props must be rigid and capable of being securely anchored into position. Even plastic trees and shrubs will wilt under the studio lights—appearing to droop suddenly in the finished film. (*Gordon Murray and Bura & Hardwick.*)

the early efforts seen in silent movies. The original version of Sir Arthur Conan-Doyle's *The Lost World* contains scenes where prehistoric monsters fight each other with remarkable conviction.

Another common use for stop-motion filming is in the production of certain puppet films where continuous action is achieved by moving or bending flexible puppets, exposing a frame after each alteration.

In the field of special effects which encompasses science-fiction drama, stop-motion has a very definite advantage over other and more prosaic methods. For one thing it can produce movement which would be incredibly difficult if not downright impossible to get by using mechanical devices. Think of a scene, for example, where a shoe-lace unties itself in vision.

For caption and novelty effects stop-motion has even more to offer. (The section on rostrum camera techniques, page 333, refers to stop-motion filming carried out with the specially mounted camera used exclusively for this type of work.)

Stop-motion would be an ideal method of getting any effect if it were not for one or two disadvantages; the most obvious being that it takes a long time to complete even the most transient piece of film, and the second that the movement, however carefully executed, is often unreal.

These disadvantages are worth examining, as it is just as important to know what should be avoided in this field of effects filming as to know what can be done.

To film an object in "motion" it is necessary to expose one frame of the film, move the object, expose the next frame, and so on. These instructions sound simple in such abstract terms, but in practice can lead to hours of hard work (and chronic backache into the bargain). We can take an actual example. It concerns a television set which had to come to life and, having walked around the room and climbed a flight of stairs, had to strangle its owner in a bathroom. Some scriptwriters, have an almost unshakeable faith in the back-room boys.

Stop-motion filming was combined with normal action in which a mechanically propelled television set was built which actually walked. This performed in a spectacular fashion on level ground, but was unable to ascend the stairs.

The scene opened with a close-up of the indoor aerial which, positioned on the top of the set, waved its antennae like a demented semaphore.

These could have been either mechanically or hand operated from within the set, but it was considered that the time taken to construct the various components, and the fact that holes would have to be cut in the top of the television set and the wall of the room, would render the stop-motion approach more satisfactory.

This decision, although it saved effort in the construction, increased it in the filming, which eventually became quite arduous. To get the movement required the aerial arms had to be moved one-quarter of an inch for each exposure. As the sequence had to last for 10 seconds, this meant a minimum of 250 separate movements. A "movement" was carried out by the operator, who walked into the scene, moved both antennae the prescribed amount in the correct direction, and then, leaving the scene, stood behind the camera. When the cameraman was satisfied that the operator was clear of shot and that nothing else had been accidentally moved he pressed the button to expose the single frame of film. The operator then walked back into the scene, etc., etc.

Filming the TV set walking up the stairs was almost torture. Attempts were made to film it in the normal position, but even though the prop was a lightweight shell, the business of slowly animating it an inch at a time proved unworkable. The legs, which were attached by ball-and-socket joints to the body, soon gave up the struggle. And so it was decided to film the entire scene on its side. This proved to be much more practical, as the body of the TV set could be laid on the floor (which had now become the back wall) supported on a packing block. It meant that it could climb the stairs without being influenced by the laws of gravity. This was useful, as it had several times slipped backwards during the vertical attempts, ruining all the preceding film of that take.

Nevertheless, those responsible for the animation had to walk into the scene, kneel down, alter the position of the prop, get up, and walk clear before the next frame could be exposed. Altering the prop was no simple business either. The body had to be moved one inch at a time, while the positions of the four legs had each to be individually arranged to produce a convincing "walking-up-stairs" motion.

There are certain pitfalls when operating on this scale. Before the cameraman exposes a frame he must be sure that there are no telltale shadows in the picture. As the animators become tired they tend to reduce their amount of travel, and if not carefully checked their shadows or the shadows of their equipment can often intrude on the action.

As already stated, the cameraman must keep an eye on all other items that might suffer from accidental movement. Such movement, however slight, jumps into prominence in the final film. Wherever possible, items should be fixed down.

Equally important is to avoid surfaces which will mark. If, for example, a light-painted floor is incorporated in a scene where stop-motion animation is to take place it might conceivably become very marked with the constant passage of the operator's shoes. Still worse is the effect on grass and vegetation. A typical example is that favourite comedy scene where a golf ball, after performing some ludicrous gyrations, drops suddenly into the hole. If this is accomplished by the use of stop-motion the grass under the operator's feet as he goes to and from the hole flattens and stands up in turn. On the finished film the grass appears to surge about as if swept by invisible brushes. The effect can be avoided if the operator provides himself with a long pole fitted with a suitable end for manoeuvring the ball. It is sometimes necessary to have a second pole by which the amount of movement can be gauged, but only if the movement is very slow and has to be particularly smooth.

Another thing likely to bedevil operations is the previously mentioned unexpected slip-up. In the case of a prop designed to perform smoothly, an accidental movement can mean that the whole sequence has to be shot again from the beginning. To mitigate such a disaster it is important to mark the position of the various moving components *before* carrying out the next move. Then, if an accident occurs, the prop can be repositioned without a jerk being inevitable. Only after the prop has been moved satisfactorily to its next position should the marking devices (blocks of wood, sticky tape, etc.) be removed.

Referring to an earlier statement which mentioned that these stop-motion effects are often unreal, it is interesting to analyse the difference between this form of motion and that normally recorded by the film camera. In real life it is impossible for certain movements to be captured in their entirety either by the human eye or by the ordinary film camera. One is aware of their start and their finish, but the travel in between is indistinct. Consider a human hand held with palm open towards the observer. A quick twist, and the hand has been turned over to show the back. On film one would see a sharp image of a hand for several frames; there would then follow a series of frames all blurred, with the hand in different positions; after which would come a further series of sharp pictures now showing the back of the hand.

To carry out a similar action with a dummy hand in stop motion would be child's play. The difference, however, would be that each frame would record a sharp image. The final film would show the same set of motions, but without the blur—and without this blur, the movement looks unnatural.

It is difficult to lay down rules to minimize these unwanted effects. It depends largely on what movement is to take place and what the time/distance relationship is likely to be. It might be considered safe to say the slower the movement, the smoother the final result, but even this is not always true. Where small movements are involved it is possible to get "jitter" owing to the difficulty in physically moving clumsy objects to fine tolerances.

To return to the credit side. Faced with the problem of getting a snake to rear up and bite a leg, stop-motion filming offers a solution hard to improve upon. This and many other sequences have been carried out quite successfully on TV without the viewer apparently being aware of a sudden change in the method of recording.

Time-lapse filming

Like stop-motion filming, time-lapse recording requires a camera which is adapted to expose one frame at a time. But for time-lapse work the exposures are carried out automatically by a timing device with an adjustable rate of operation. A favourite use of the time-lapse camera is that of showing living plants in the act of growth. Buds appear and turn into flowers, leaves writhe like snakes as they increase in size; and autumn can be seen to follow summer. Time-lapse techniques are also used where the movements of people or objects are required to be compressed into a much shorter time. Some interesting films have been made showing human activity in shops and on the street. The actions of moving bodies are either speeded up or reduced to mere changing patterns according to the amount of time-compression involved. For example, if one exposure is made every second a person walking would move twenty-five times faster than normal. If, on the other hand, exposures were limited to one every 60 seconds objects moving at walking speed would appear and disappear as flickering patterns.

This type of filming is generally employed either for trick effects or for scientific or technical demonstrations. In the latter field it is often the only feasible method of capturing certain phenomena.

Exposure problems occur if the camera is to record the natural scene (clouds may come and go), but where studio or close-up work is being recorded, it can be arranged for a light to be switched on automatically before each exposure. This is particularly important where the camera is recording such things as growing plants or the behaviour of insects, because to leave studio lighting burning for long periods might affect or even damage the subjects.

Another effective way of using time-lapse photography is to telescope a journey into a shorter period, increasing the speed to breathtaking limits. A camera mounted on a train which is travelling at fifty miles per hour can, by exposing the film at four frames per second, increase the apparent speed of the train to 312 miles per hour.

For trick effects the technique offers only limited scope, because the time taken to film even comparatively short sequences is in direct proportion to the speeding-up of the subject. Nevertheless, it has been used most effectively on the right occasions. One of these was when, for a programme caption, the title of the show was written on a candle. Filmed by the time-lapse method, the candle burnt rapidly downwards, consuming the words. On another occasion for a passing-of-time effect the hands of a stop-watch were shown flying round.

15

MODELS AND MATTE SHOTS

It is tempting to consider all model shots in the light of those used in the film studios; but this book is about television and its associated techniques, and in the realm of model shots and matte work there are probably greater differences between TV and film techniques than in all other aspects of special effects work. In the movie the story-board comes first, and the model makers and effects men are able to meet almost any demands placed upon them, whereas the TV story-board must be tailored to accommodate the limitations of the medium.

The cost of a single model for use in the film studio can equal the combined budgets for several complete TV programmes. The huge film stages and tanks are not available to TV directors, and wishful thinking must be abandoned in favour of simple, down-to-earth methods. Results are not necessarily worse on the television screen. Far from it. Television has the advantages of the small picture-size. No matter what takes place during the recording, the eventual picture is only as big as the cathode-ray tube in the receiver. Textures and materials which might appear phoney on the big screen can often "blend-in" unnoticed on the lower definition TV screen.

This does not mean that mere reduction in scale will suffice or that cheaper methods will produce satisfactory results. The movie-maker with a huge water tank in his model stage and with a perfectly built scale-model boat has a much better chance of achieving realism than his TV counterpart, who may have to set up a tarpaulin tray in a small studio. Plastic boats on shallow seas react badly, and even the camouflaging effects of the small screen do not always serve to disguise methods of this nature. TV techniques are not film effects scaled down; they are different techniques. Faced with the problem of the ship at sea, the TV man may well decide to feature only part of his ship and, instead of moving it on the water, arrange for the vessel to be held stationary while the "sea" is pumped past it.

These differences apply even more where glass matte shots are called for. Matte work employs many people in the film industry. They are the specialists. But glass matte shots are comparatively rare in television, and when they are called for the work is usually undertaken by scenic artists or effects men. It has been said that a film director on location might have trees removed by matte work merely because they appear in inconvenient places; a television director would move his camera—or film the trees!

Models in the TV studio

Models in the TV studio are used principally for one or other of two purposes: they either augment the scene or they provide a setting for a visual effect. Typical of the former is the scenic landscape model. Nothing happens on this model. It is placed in such a position that it can appear as part of the set. Very often it is used as the introduction to the scene, and for this purpose it is positioned where the camera can pan or crab past it to the set proper, giving the effect of a much larger scene than really exists. Part painting, part model, this device is quite cheap to construct and is usually well worth the additional effort. If the camera is to pan over the model there is no point in constructing it in great depth, but if the camera must crab past it the difference in planes becomes noticeable. Very often the model can be made of separate parts set back at intervals, with the studio backcloth acting as the sky. Some models need to be mounted on top of the flats in the studio so that a camera taking a high shot features the model, before craning down to the scene below. At other times the model is mounted at camera level in a convenient corner behind the scene, where it is used merely as an establishing shot prior to a cut or a mix.

A model designed to include some sort of animated effect is sometimes constructed as part of the set. It may be seen through a window or between open parts of the scenery, but it is important, if the illusion is to be maintained, that it is seen only from one particular viewpoint. There are many examples of the use of this sort of model, which is a popular TV device serving both realistic productions and stylized light entertainment. In its simplest form it may comprise a house with a window which must light up, but more elaborate arrangements have consisted of whole cities with moving transport, smoking chimneys, and apparent human activity.

On occasions something on a model may have to work in concert with some particular piece of studio business. One can visualize a scene in which the script calls for a signal light to appear, flashing from some distant building and accompanied perhaps by a commentary from one of the actors.

Many small models have been made and used in this fashion, and it is not unknown for several to be used in one programme, being set up on rostra or behind flats and even being wheeled into position as the action moves into other sets. Convincing models can be made quite cheaply, and if they save the cost of a film unit going on location they will have served their purpose well.

Occasionally there is no time or effort available to pre-film or record a particularly tricky model shot, with the result that the effects designer is asked to provide something in the television studio. If it is essential to the action there is obviously good reason to attempt it, but such a situation is fraught with danger! It is not easy to obtain good results in the TV studio. The overhead lighting arrangements and lack of studio space, coupled with the possibility of action taking place in other parts of the set, combine to make involved model work extremely difficult. Furthermore, there are very definite limits as to what may be attempted and what may not. Any sort of water or sea shot which is scaled down would be highly impractical; likewise any sort of fire shot in which actual flame has to be scaled down. There are exceptions to this, as there are to all similar examples, but generally the aim should be to keep all models used in the TV studio to certain basically simple types.

Model shots on film

There are many reasons for pre-filming model shots, but when it is required to modify the speed of the action pre-filming becomes obligatory. High and low speeds are often necessary for the filming of water and fire sequences—in fact, the majority of model shots in which movement takes place require some variation of recording speed.

Apart from these reasons there is also the fact that it is invariably more satisfactory to have any effects shots safely "in the can" prior to the studio recording of the actual programme. Pre-filming eliminates any possibility of last-minute failures, and it also makes it easier for the shot to be cued in. All in all, it is better for everyone concerned if the shot is already on film and safely laced up on the telecine machine. But there are disadvantages. The most obvious of these is that there is generally a difference in quality between the filmed sequence and the studio picture. This is not always apparent, however, if the filmed model sequence is completely divorced from the studio scenes on either side of it. Should the studio scene be an interior followed by a filmed model shot of an exterior, it is probable that the difference in quality will go unnoticed; it is when the studio scene changes to a filmed version of the same thing that the difference is most apparent.

When a model is being filmed it is essential to light it correctly. Incorrect (and that does not mean *bad*) lighting is often responsible for spoiling what would otherwise have been a perfectly convincing shot. There are two ways to light a model: one so that it *appears* as a model . . . in the same way that one would light a teacup seen in close up; and the other so that the overall *effect* is convincing. And this, after all, is what all those concerned should be striving for. The whole purpose of a model is to make the viewer believe he is seeing *something else*, and if the lighting exposes the model for what it is the intention has failed, however pleasing the eventual picture may be. Sometimes the cameraman has to suppress his natural desire for crisp, clear pictures, and instead to light a model with flat light. Although this may hide much of the detail and destroy some of the texture, it is entirely immaterial provided the shot carries conviction.

If the model includes a great deal of apparent depth (as in a town scene, looking down a long street), or if it is a scenic model with landscape over a large area, the effect is enhanced if the entire area is lightly fogged up with a smoke-gun before filming. This adds haze, which softens the background while leaving the foreground comparatively sharp. Soft focus filters can be used, but they do not give sufficient difference in depth, because they soften all parts of the picture to the same degree. A toning-down effect can also be carried out when the model is being painted. Usually a spray of light colour over the background is sufficient, but the smoke treatment allows more control because it can be altered to taste.

Another factor which often destroys the illusion of reality is to film the model from the wrong viewpoint. Generally speaking, the higher the viewpoint, the less convincing the model. People are not birds, and unless there is a specific reason for an aerial shot, the viewpoint should try to match the eyeline most commonly found in real life—which, it must be remembered, is very near the baseboard if the model is to a small scale.

The height of a model person is the "real-life" eyeline being used. This is often an inhibiting factor, and it must be carefully considered before the model is designed. The problem is how to get a camera lens low enough to obtain the correct angle without getting distortion in the foreground. Imagine a normal man to be standing in a street looking across the roadway at some buildings. His view might include the opposite pavement as well as the roofs of the buildings. With a model built to the correct scale, but of considerably smaller size, it would be found that the camera could not be put in the position of the hypothetical man because the physical size and shape of the lens and its mounting would not permit it to get that close to the base of the model. It would have to move back from the model to get the correct viewpoint, but in so doing it would either get a distorted out-of-focus view of the edge of the baseboard or, by tilting up to miss, it would be unable to see the pavement. These problems nearly always occur when the model is too small. They can sometimes be alleviated by sloping the foreground.

In theory, it is a good idea to draw an elevation of the model before constructing it; the horizontal angle of the lens can then be drawn on the plan to show how much of the model will be seen. In practice, however, this is seldom done. Scenic models tend to be designed during construction and grow to the designer's whim. If it is not possible to establish the eventual picture before filming, the various components can be made on separate bases which will allow them to be rearranged in front of the camera to get the desired effect. The spaces between can be filled with sawdust and powders to match the scene.

When small models have to go through some form of animation they cannot be expected to perform in the same fashion as their full-sized counterparts. A toy model of a car driven into a rock face looks completely unrealistic and deceives nobody. Even when some attempt has been made to reconstruct the car in appropriate materials, the effect is still unsatisfactory unless the materials have been specially prepared.

A real car striking a rock face crumples progressively from the front. Pieces are torn off, and the wheels and suspension react independently of the body. To get similar results with a model, special methods of construction have to be employed. The wheels have to be attached to the body with fine wire springs, the bonnet must be made from metal foil, and it is even possible to include sugar to fly out on impact to resemble a broken windscreen. To heighten the effect (or possibly to disguise it), the collision should immediately be enveloped in smoke or steam, pumped if possible from a hidden spot in the rock face.

Unless such measures are taken a model shot of this kind looks phoney, and—however much improvisation is applied—in this respect a television requirement is the same as a movie requirement, and only first-rate preparation and filming is good enough.

Tanks for seascape shots

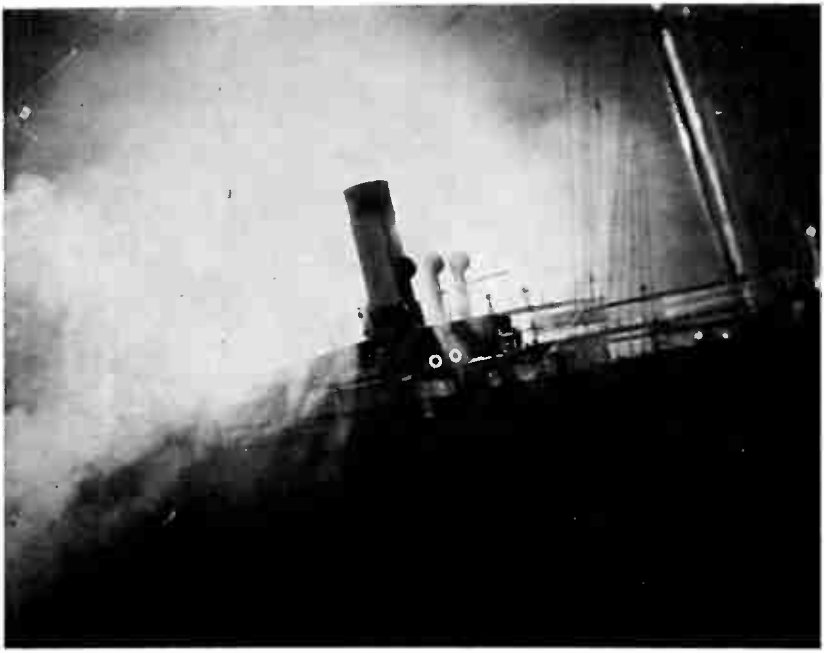
It has already been stated in this book that the average TV effects man suffers from the lack of many facilities that are generally available to his counterpart in the film industry, and although this is no great embarrassment in certain fields of model work, it applies very much to scenes featuring ships at sea or boats on rivers. Water does not scale down well: it does not react in a satisfactory way when it is reduced in volume and speed. This can manifest itself all too painfully when small seascapes are attempted in TV film studios. There are various ways in which the TV man can get round such problems, and some of them are examined here.

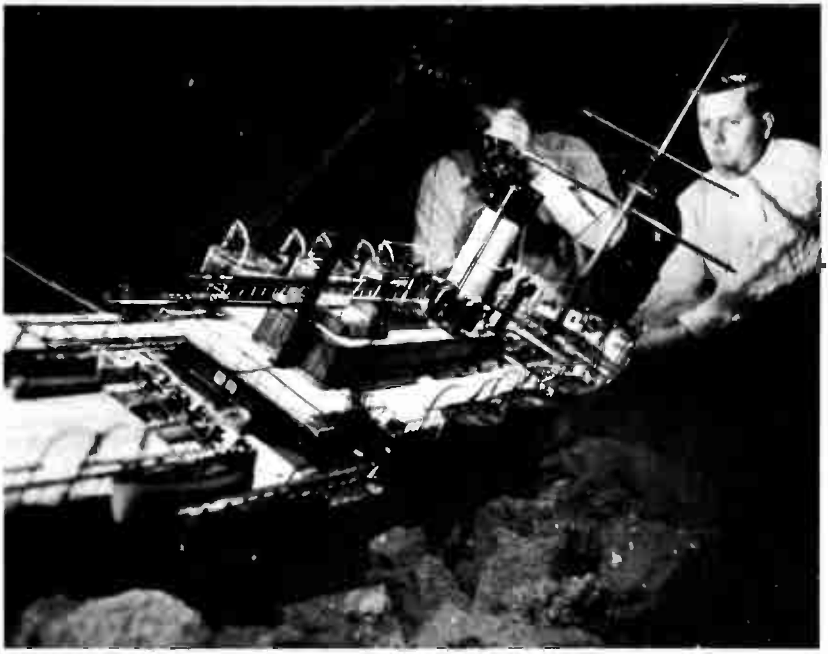
First, he must consider the feasibility of using the studio tank. If such a thing exists it is most probably in the floor of the studio, providing viewpoints only from above. If, as a consequence, it is decided that a special tank must be constructed, then there are the problems of supporting an adequate volume of water at a height suitable for filming.

If it is necessary to depict a boat on a calm sea a shallow tank will suffice; built on rostra, it can be constructed from plastic sheet with suitable retaining walls. But if the scene is to be stormy, with waves of some magnitude, the tank has to hold a much greater volume of water, and must therefore be built on the studio floor. The periscope can assist in getting low-angle shots in this situation.

With all seascapes the placing of the sky and horizon is of the utmost importance. Even for night shots it is generally necessary to provide some illumination of the sky if the scene is to have any credence. A faint night sky with a pale band of light near the horizon, silhouetting the ship, is more realistic than a black sky with front lighting on the model. (This does not apply to storm sequences, which demand different lighting arrangements.)

In order to get a convincing horizon it is essential to provide a neutral area at the back of the tank. For calm seas this is relatively easy. The tank is built with the back lower than the sides and front so that water can flow continuously out over the back. This





provides a soft delineation between sea and sky without ruckled plastic appearing in vision. Water should be added to the tank by a hidden hose-pipe, the excess flowing over the horizon and into the drain. Alternatively, it can be recirculated by a pump, which prevents dilution when coloured water is being used.

The sky (whether back-projection screen or plain backing) must be placed away from the tank so that it is unaffected by water splashing from the overflow. If it is to be a back-projection screen illuminated by a cloud plate it must remain within the depth of field of the camera. If, on the other hand, it is considered suitable to use a plain backing without detail it should be placed as far back as possible. Not only does this allow the operators to move freely between the backing and the tank but it makes it easier to light scene and background as individual items.

The overflow tank is not suitable for storm conditions. It would not do for waves to travel as far as the horizon. For storm sequences the tank must be much bigger.

Storm effects can be carried out in the studio tank, but if shot from above they preclude the use of any sort of sky. Black drapes hung around the tank so that they mask the walls prevent unwanted reflections appearing in the water. In many cases the drapes can intrude into the picture because they will not be seen if the model is small and is the only item in the scene to be illuminated. This is useful where it is desirable to include as much "dark sea" area around the model as possible. The drapes should be taken below water level and secured with weights.

Filled to a depth of two or three feet, the studio tank is ideal for big wave-making; and if the scene is to depict a small boat, revealed only in occasional flashes of lightning, this depth is quite adequate. For such scenes it is usually necessary to anchor the boat, but this fixing can sometimes serve as an operational aid. To prevent swamping the model it is necessary to limit the size of the waves—which in turn naturally limits the roll of the boat. If, however, the anchor point has a number of lines running through ring eyes the movements of the boat can be accentuated from a control point at the sides of the tank (see page 290). Even in a moderate sea the boat (or ship) can be made to roll and pitch realistically.

When large ship models are available it is often possible to record them without the use of water at all. Models shot from

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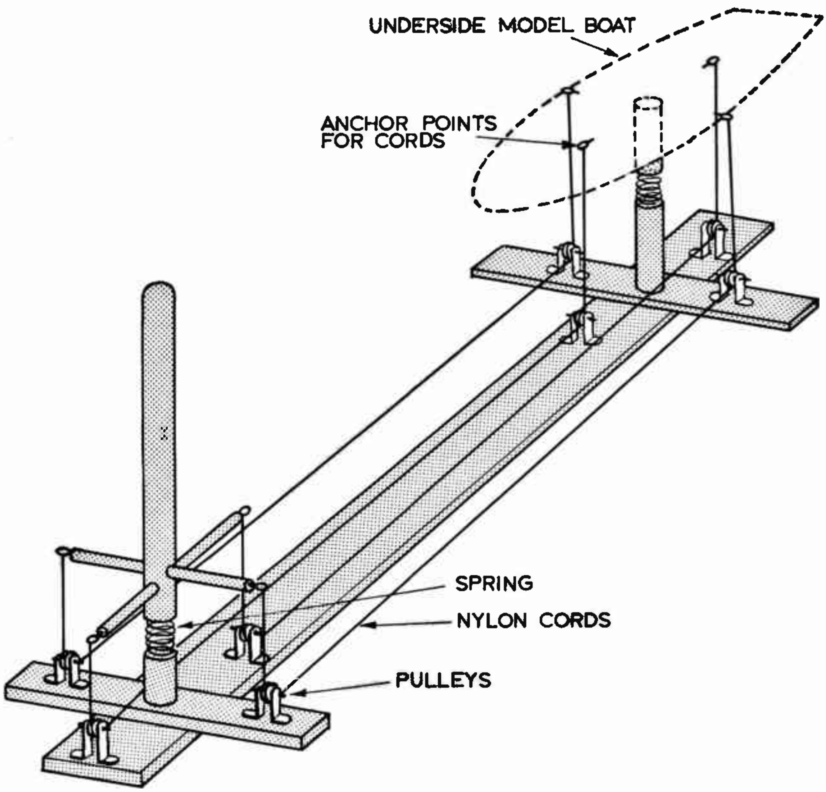
◀ A model passenger liner built for the award winning documentary *The Loss of the ss Schiller*. (*Westward Television*.)



An underwater anchoring device equipped with lines and a joy-stick control which can be used to exaggerate the roll and pitch of a model ship. If the control lines are crossed the movements of the stick correspond to the movements of the model.

below against a sky or moving-cloud backing can give quite convincing effects. If the backing is painted on hardboard it can be hand-held and moved past the vessel with a suitable up-and-down motion. A water-ripple effect shone from below enhances the scene.

Where it is required to show boat and water in a close-up, the model should be as large as possible. When showing the prow of a ship cleaving through water the texture and droplet size of the bow-wave are quite unconvincing if the model is too small. To get the effect of the hull travelling through water it is possible to fix the model and to pump water alongside. If this method is too elaborate the model can be mounted at an angle and water poured past it. Detergent added to the water gives a frothing effect and also breaks up surface tension, which might cause water to hang in droplets on the ship's side. For ships being pulled through the water it is possible to produce a false bow-wave by pumping water (containing white water-soluble paint) through pipes fixed to jets on either side of the prow. A wake can be counterfeited in similar fashion.

Wave-making is usually accomplished by prodding the water with flat boards fastened to the ends of poles. This is simple, effective, and economical, and allows different grades of wave to be produced.

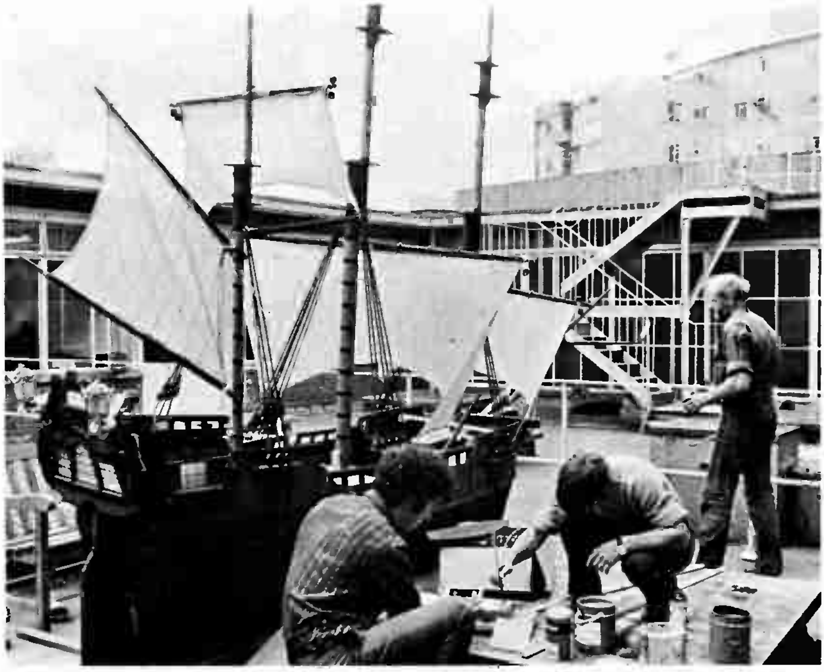
The use of wind-machines on scenes where the storm is raging around a model ship or liner is necessary to create a suitable atmospheric effect, but where sailing vessels are involved it is dangerous to use wind unless the model is very big and the sails are specially made to perform realistically. Cloth or silk sails may billow well under ideal conditions, but when saturated with water they tend to sag. It is better to pre-stiffen the sails for long-shots and take close-ups on another and larger model of sails and rigging only.

Lighting model seascapes

Model sea shots, in common with all water scenes, require special lighting. The surface of water cannot in theory be lit at all, because it is transparent. It does, however, *reflect* light in the same way as a mirror reflects. So no amount of light shone on to a water tank can illuminate the water. It must be illuminated from another source, an area which it can reflect. This is, after all, what happens in real life. The sea reflects the sky.

When set up in front of a skycloth or back-projection screen the model sea reflects the backing and no other lighting is required. (Naturally the model boat has to be separately lit.) When the tank is surrounded by black drapes or a darkened studio the water appears as a night shot no matter how it is lit. For day shots, therefore, there must be a large light-coloured area which can be seen reflected in the surface of the water.

For night shots there are fewer lighting problems. Nevertheless, it is worth remembering that as the surface of the water is a reflector, stray lighting can bounce off when the model is being lit. Sometimes this flares into the camera lens and at others it illuminates surrounding black drapes with unwanted ripple effects. This is particularly noticeable when the drapes have become wet around the water-line.



Model ships on sea or lake

Whenever possible it is a good policy to take model ships to the sea or to lakes and film them there. Real waves and sky free the designer to concentrate on other things. Furthermore, it is easier (and almost as economical) to make a large model than a small one, and with such materials as expanded polystyrene and polyester resin it is relatively simple to construct quite large hulls. The golden rule for making ships is to construct the hull in such a manner that it is as light, but as strong, as possible. All the weight required for submersion and stability should be applied *after* it is in the water. It can usually be in the form of a heavy iron false keel plate with additional weights (for fine adjustment) fixed along its length. The reason for this is that when lifting the model into and out of the water it is very easy to damage the more fragile parts of the superstructure or rigging if the model is heavy. An alternative system is to push carrying bars through holes in a fixed keel.

If a false keel is exceptionally heavy or cumbersome it can be equipped with wheels so that it can be slipped under the boat without imparting too much strain on the operators. In locations where a slipway exists the keel and boat can be married beforehand and then trundled into the water.

During the action the model boat can be manoeuvred by pulling on underwater lines fixed to the keel. The lines should be weighted at intervals to prevent their being pulled above the surface. They can be manipulated by operators standing on the shore or in anchored boats, but where applicable the model can be towed by a motor boat. It is important to ensure that the wake of the towing vessel is not seen preceding the model.

Radio-controlled model ships and boats have been made and used successfully for television filming. With the abundance of hobbyists' equipment available it is a simple matter to construct a model which has radio control of both rudder and engine. Motorized propulsion units can be driven by car batteries situated low down in the hull. It is a sensible precaution to wrap these in plastic bags with their open ends underneath to let the gas out. It is also useful to have drain holes in the hull to release water which may have been swept inboard. Some boat models can be semi-water-line

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◀ Large models are often easier to deal with than small ones. The differences in cost and construction time are minimal-factors which are usually outweighed by superior results.

Smoke can be used to camouflage unwanted backgrounds when filming model ships. By creating a false horizon it apparently changes the perspective.

constructions, open-hulled and relying on sealed areas to supply buoyancy. In fact, balloons can be used for buoyancy in many cases. A large model submarine performs much better if the hull is open to the water and the trim maintained by inflated balloons held firmly inside.

The filming of models on a lake or pond has certain disadvantages as well as advantages. The advantages are that the surface (if the water area is big enough) is generally covered by tiny ripples which pass as small-scale waves. Furthermore, conditions inland are usually more docile than those at sea. The main disadvantage is that there is certain to be a background to the picture, however big the lake (and for the purposes of this example we are not considering those lakes which correspond to inland seas). For certain high-

viewpoint shots the opposite shore may not prove troublesome—it can be kept out of frame. Nevertheless, if the intention is to simulate sea and sky seen from a normal land-based viewpoint the other shore is certain to intrude. If a mirror periscope is available there is a technique of shooting that provides a solution to some of the background problems encountered. This solution depends on the possibility of laying down a heavy white smoke screen over the background. A periscope and camera are set on the foreshore at a place where the wind, if any, blows *across* the picture. The model is then positioned and anchored. Next a trial layer of smoke is released either from the opposite shore or from a boat moored in the upper part of the frame. The resultant picture should show the model backed by thick smoke, which not only serves to hide the opposite shore of the lake but also provides a false horizon, albeit a misty one. It is unlikely that the smoke will perform so perfectly that it resembles an entire expanse of real sky, so the next step is to apply paint to the lower mirror of the periscope to extend the "sky". This should be done on either side of (and possibly above) the reflected view of the model. Seen from the camera, the ship should now appear with smoke behind it and paint on either side of it. If the paint has been chosen to match the colour of the smoke the blending is not difficult to achieve, because anything on the mirror is well out of focus.

The result of this arrangement is that the model, seen from the camera, appears to be situated in front of a neutral sky. As the "sky" is mostly paint with just a small clear area around the boat, the smoke operator has to concern himself only with keeping a uniform density of smoke behind the model.

If the smoke is being liberated from a vessel on the water it can be moored in one of the areas screened by the white paint on the mirror, but the source must be far enough away to ensure that the smoke behind the model boat is well diffused and not in sharp rolling clouds. Because of the danger of changing winds and consequent discomfort for the operator, it is better to have a moored unmanned raft on which the smoke-pots are fired, and for this to be served by a small row-boat, which can come and go as required.

The model boat in such a set-up is unable to move across the picture because it would pass behind the areas of white paint and so disappear. It is possible, however, to arrange for it to move towards or away from camera.

Optical problems with model shots

The main problem arising from filming at sea is an optical one. The correct relationship between water, sky, and vessel is of paramount importance, but where a model boat is used the balance is upset. The best way to visualize the problem is to consider a similar situation on land. If one takes as an analogy a large vehicle such as a bus behind which a man is standing it is immediately apparent that he cannot see the roof. If the bus drives off and travels any distance along the road (which we will assume to be straight and flat) the man will still be unable to see the roof. The bus can drive along the road to infinity and the same conditions obtain. What is more important is the fact that the greater part of the bus is always against the sky.

If we translate that into seascape terms it is obvious that the same rules apply. A ship near the shore towers above the observer, who is unable to see the deck. Even on the horizon, the ship is still silhouetted against the sky and it is still impossible to look down on the deck. What of the model? If it is too small the man on the shore *is* able to see the deck, while the superstructure appears not against the sky but against the sea. To remedy this it is necessary to lower the man's viewpoint, to reduce him to the same scale as the ship, but this introduces a complication.

To appreciate this, let us return to the analogy of the bus. This time we have a *model* bus on the road. Let us assume that it is a fair-sized model, say 3 ft high. A man 6 ft high would look down on it, and so we have to lower his viewpoint to correspond to the situation that existed when the bus was real. The man, or rather the camera, now has its lens just a foot from the ground. The bus looks fine, but the character of the road is all wrong. We are no longer looking down on it from a height of 6 ft, we are looking along it from the height of a foot. The area near the camera has pebbles the size of boulders. And so it is with the sea. To get the model situated nicely we have to look at the sea from a lower viewpoint, a viewpoint from which the waves in the foreground look much too large and much too close.

It would seem appropriate at this point to give a table of lens sizes, relative distances from the shore, height above sea-level, and optimum sizes for models, but it must be appreciated that this sort of filming is very much a matter of compromise. Results are governed by so many factors. A helpful sea mist, for example, lowers the horizon; the difference between gentle wavelets and a heavy swell affects the height at which one can set the viewpoint; a tall-masted schooner gives better perspective than a low oil tanker; and so on and so forth. The only rules worth remembering are, first, that the model must be as big as possible, and secondly, that a narrow-angle lens gives better results than a wide angle.

Space and rocket models

Different models present different problems. With landscape, town, or boat models the problem is to get them to resemble their full-size counterparts, but with space-ship and science-fiction models the problem is to create realism where there are few, if any, standards of reference. In landscape models a single tree sets the scale, but a Martian invasion fleet in space has no such source of

Models made for the television series UFO. The effects in this series were directed by Derek Meddings and are typical of the very fine work for which this company has become renowned. From their first venture in string-puppet television films, Gerry and Sylvia Anderson have set standards which are unparalleled in this particular field. (*Century 21 Pictures Ltd.*)

comparison. Are we looking at a big space-ship travelling at the speed of light or at a small space-platform hanging stationary in the sky? This kind of problem is difficult to resolve. Windows or portholes in a space-ship often give some indication of size, but the safest method of creating the effect of giant scale is to exaggerate the perspective while giving the craft a semi-familiar shape. A design which is too sophisticated may well be scientifically correct, but it does not impress the viewer if it looks like a bottle or a cake tin. Better on the whole to make the whole thing thoroughly "busy", with as much outside detail as permissible.

In addition to design and presentation problems there are the problems of animation. Nylon threads which glint in the light or steel wires which jerk can bedevil the effects man engaged in

filming this sort of sequence. There are so many imponderables that it is difficult to examine all the problems which can arise, but the following tips may suggest solutions to some of the more difficult situations.

The thin steel wires and nylon lines used to suspend aerial models sometimes appear in the picture. To be strong enough to support the models they are often unacceptably thick. Painting, either with a uniform coat or camouflage patches, sometimes disguises them, but one trick is to invert the model and film it with heavy underlighting and with the threads in darkness. The film is then printed upside down so that the supports are actually below. Even if they are seen, they do not immediately suggest their purpose and are not likely to give the method away.

Another way to hide the threads is to film with both the background and the model hung from the studio ceiling. The shot is filmed via a mirror at 45 degrees from the lens so that the lines are behind the object—an arrangement often used when the space-ship has to travel across the picture. It is merely swung through frame, being arrested when it has cleared the shot.

If the background must be vertical or if the model cannot be hung on wires it is possible to support it on a metal rod or tube sticking out from the backing. Care must be taken that the lighting does not cause a shadow from the support to fall across the backing. This method is useful when it is necessary to provide some visual or mechanical effect on the space-ship or rocket. Smoke can be pumped down the tube; wires and electric leads can also be attached, and the tube may even be used to supply liquid. An aircraft jettisoning fuel could be supplied by the pipe, which would also be used to control the aircraft's attitude. This is a particularly adaptable system when used with front axial projection. The iron rod or tube method may also be used when a rocket has to lift off from its pad. The tube is inserted through the backing, which then forms its fulcrum, enabling a certain amount of "lift-off" to be effected by pushing down on the other end of the support. The tube may also be used to supply smoke and compressed air to the rocket motors. Shadows from the bar are particularly troublesome in this instance, because while they may not appear on the backing, they often show up in the smoke that surrounds the rocket.

When other methods are unsuitable a model can be fixed to a glass sheet erected in front of the backing.

Jets of flame and smoke from retro-rockets and propulsion devices can often be tricky things to manage successfully. It is not always necessary, however, for these to be actually part of the rocket or space-ship. If the ship is in "space" and stationary in the frame, a convincing rocket flare can be achieved by projecting it on to the backing. If a projector cannot be used, flame can be made to appear by using a technique described earlier for firing a ray gun (page 158). For this the backing must be translucent and have a cut-out approximating to the flame and thrust-back area. A light shone from behind the backing illuminates this area and, providing it has been lined up with the business end of the vehicle, it will appear as a bright flame behind the rocket. If animation is required (to give a more convincing effect of movement) the light can be shone on to the backing via a revolving mirror drum. The actual source of flame near the end of the rocket should be separately lit so that it remains bright and constant while the "bursts of travelling hot gases" flow out behind it.

Gravitation may be utilized in this sort of shot. If, for example, a space-ship has to fire a missile it can be released by solenoid or catch from the space-ship, which is hung downwards. The shot is filmed with the camera on its side (or with a prism set-up to turn it through 90 degrees), and the missile dropping straight and true appears as if actually being fired on a horizontal path.

Rocket take-off: aerial view

Occasionally a shot is required of the ground as seen from an ascending rocket or space-ship (or even helicopter). A simple and effective method is to paint the countryside on a large flat board with the launching pad, tower, and adjacent buildings applied as tiny three-dimensional models. The board is then held vertically in front of the camera by two men, the launching site being on the axis of the lens. The board need only be walked away from the camera (with suitable slight twisting movements) to give a reasonable impression of lift-off from the rocket's point of view.

Matte shots

Matte shots are seldom used in television in the same way or to the same extent that they are used in movie making. Nevertheless they offer many advantages where grand illusions and deceptions have to be provided on the cheap.

Matte-shot technique consists of putting one static picture into part of another. Whether used in the TV studio or on film, the technique is virtually the same, although the methods may differ.

There are other means of combining parts of two pictures. These are explained in the chapters on inlay and overlay (electronic methods of putting part of one picture into another) and on scenic projection (the method by which different filmed backgrounds may be set behind the action). For all practical purposes these methods are confined to use in the studio. Only matte work is suitable for location filming or outside televising, and so the examples given all concern outdoor use.

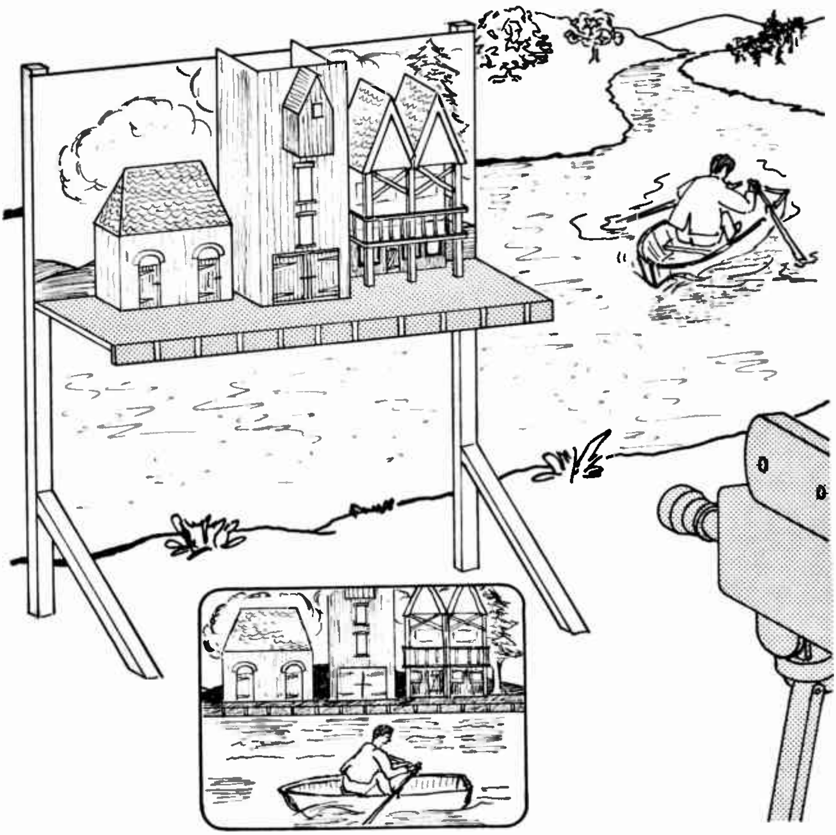
Glass-matte shots and model-matte shots are the two most usual systems.

Glass-matte shots are those in which a sheet of glass is placed between the camera and the scene. On this sheet of glass is painted an extension or addition to the scene in front of the camera. For example, a row of houses might have to be filmed on location but where a skyscraper had to appear over the line of roof tops. The skyscraper could be painted on the glass, terminating at the point where it joined the actual roof-line in the scene. It would, of course, be in front of the houses, but as the camera is monocular, it would be impossible to detect this. Alternatively, if a skyscraper was there in reality and had to be removed the glass could be painted with a false sky, which would hide everything above roof-top level.

Very often enlarged photographs can be stuck to the glass to provide a suitable matte. A practical wall featured in a scene could, for example, provide the foreground to a vast oil refinery. Providing no action takes place where someone or something is likely to move behind the matted portion of the glass, all is well. Models can also be used in this fashion. On these occasions it is not necessary to use the glass sheet, although for some purposes it provides an aid to mounting. Glass reflects whatever is in front of it, so a black cloth or board must be placed above or below the camera.

Here are two examples of matted models. The first was a Martian landscape consisting of weird rock formations against a black sky. The model, about 4 ft long, was set up on posts on the shores of a boating lake. The stranded "spaceman" had supposedly built himself a raft and was seen propelling himself across the silent waterscape. The effect was impressive. The model was placed so that it coincided with the opposite shore-line, and at no time did the man on the raft ever intrude above that line (as it was a slightly high shot this was automatically ensured). The wind fortunately broke up the surface of the water and prevented much reflection of the hidden shore and parkland being seen.

The second model was used to change a well-known London landmark into a science-fiction setting. An area of green grass surrounded by roads teeming with busy traffic was used to portray a city of the future. Where the existing road line met the grass a model was erected in front of the camera. Holes and spaces in the model were left so that traffic movement behind would be seen in the final picture. The vehicles, being sufficiently far away, could not be identified, particularly as they were seen only through the small apertures. They were essential, however, in giving the effect of busy movement within the city. Toga-clad citizens of the twenty-first century strutted on the grass in the foreground. The resulting



Composite scenes may be arranged in which models are used in conjunction with live action. The model shown here, erected in front of the camera, would appear to be situated on the far bank. It is essential that the actor never passes behind the foreground model and that the reflections from the opposite bank do not conflict with those that should supposedly emanate from the model. A major advantage with this technique is that the final picture can be seen in the camera viewfinder.

combination of model and live action gave an effect which was not only just what the author had intended but which was produced in a most economical fashion.

Construction methods

Models are used when it is impracticable or uneconomical to capture the scene by shooting the life-size situation. It follows that the model itself must be an economic proposition. Methods have to be used which speed up construction, because time is the major factor in the cost of model making. For landscape and scenic models the cost of materials can be almost negligible compared to the man-days required for building. Fortunately models for television need not be as detailed as for the wide screen. Many commonplace materials may be used to counterfeit materials and objects of entirely different scale, while toys and model figures are now so perfectly and cheaply produced that they can be used almost without further work.

To specially design and construct parts of a model is pointless if substitutes can be found which will look as good. Models of science-fiction set-ups, modern factories, oil-refineries, radar-installations, etc., can be constructed from the most unlikely materials. Electric-light bulbs, hair-curlers, salad-shakers, ashtrays have all appeared in most unusual guises. Most profitable source of bits and pieces for applied dressing is the plastic-model kit.

Basic materials for house models and town scenes of every variety are balsa wood and cardboard, with plaster, cloth, and paper for landscapes. Usually a model is built up on a baseboard (or, if there is a likelihood of rearrangement, on several baseboards). The various components are fixed to the baseboard, and the intervening areas are landscaped by laying cloth and card over wooden blocks of various heights.

The most important factors in model building are those concerning viewpoint and perspective. Any model may be seen from any viewpoint for any purpose, but it is essential to have a clear picture of what the final scene should look like before work commences. Detail which is not seen is wasted, while a model which could have been much smaller had the correct foreshortening been applied also involves waste. It is important therefore to establish the viewpoint if the camera is to remain stationary. It is of equal importance to judge the effect of any camera movement if a tracking shot is called for. Tracking or crabbing along the front of the model or movement up and down plainly shows that it is three-dimensional. Panning or zooming does not always disclose this. If a scene is to be traversed by a panning movement it is possible to use a semi-two-dimensional technique where the model is constructed from flat cut-outs. It might be argued that a picture or photograph would be as good, but the cut-out technique may be used where it would be useful to rearrange the model in front of the camera or where smoke or movement has to occur somewhere in the depth of the model. An example of this might be a harbour scene showing the masts of ships gently swaying behind a wall, flanked by buildings and backed by a sky painting.

To an accomplished matte artist, the realistic painting of a townscape would seem child's play, but for the less talented it is often easier to make a model. Moreover, whereas a model can be lit in different ways to give different effects, a painting must stay as it was originally created, shadows and all. This is why it is sometimes more convenient to construct a full model than to make a two-dimensional cut-out painting, even though nothing more than a straight-on shot is wanted.

Where repetition occurs, such as in roof tiles or identical windows or cobblestones, etc., it is possible to mould them in latex or papier mâché from plaster moulds. Alternatively, it is possible to cut rubber printing-stamps which may be used either to print colour or to impress a design into wet plaster applied to wood or card. Corrugated paper may be used as roof tiles.

Foliage plays an important part in establishing authenticity in landscape models. Even house or town models appear more realistic if natural trees and hedges are shown. There are many weeds and plants which, broken into smaller parts, can be reassembled into realistic trees and shrubs, and it is often worth making a collection of these when visiting country areas. One of the most adaptable natural materials is lichen moss. This moss can be found in many countries, but when it cannot be collected locally it can be obtained from certain flower importers. Lichen moss is grey-green in colour and fans out in branches of decreasing size from its main stem to its thousands of ends. It can be used either in small pieces the size of fingernails for distant bushes or in large clusters on a false stem to resemble foreground trees. It is virtually scaleless, and however it is used, it has a natural look unobtainable by other methods (such as those of using torn sponge or foam plastic).

If allowed to dry out the lichen moss becomes extremely brittle and crumbles when touched. It can be used either soft or hard according to requirements, but immersion in water resoftens it once it has dried out. If the moss is steeped in a glycerine and water solution it remains pliable for a long period. It can be coloured as desired with domestic dyes. Sphagnum moss is another useful natural material which can also be dyed and is a satisfactory substitute for many sorts of model greenery.

Trees and shrubs can be made by sticking dyed, coarse sawdust to wire branches. For correctly proportioned trees a bundle of wires should be twisted together at one end to form the trunk. The bundle should then be divided to form three main branches which are subdivided and twisted into other and finer branches. The wire can be covered in paste and tissue paper, after which it is coloured to resemble the bark. For the effect of foliage the branches can be coated with glue or paint and dipped into dyed sawdust, tea-leaves, or broken pieces of lichen moss. Conifer trees can be made by winding sisal in a wire core. A length of copper wire which has been bent in two has its ends held in a vice while the bend is slipped on to a cup hook held in the chuck of a hand drill. Chopped pieces of sisal are laid between the two wires and the hand drill is rotated, causing the wire to become twisted and trapping the sisal strands. The strands stick out in all directions and only need trimming to resemble a pointed conifer. Painting or dyeing should be done afterwards.

Dyed sawdust resembles grass, soil, fields of wheat, or almost any land surface needed. To get the best effects it is a good idea to dye both fine and coarse sawdust in a whole range of colours—black, blue, brown, orange, as well as all the greens and ochres. Covering a sheet of card with green sawdust does *not* make the card look like a field of grass. Many colours have to be subtly blended to get convincing results, and even afterwards the surface might still benefit from a light dottle of paint.

The most elaborate model will appear unconvincing if it is badly painted: the finish is everything. The painting does not necessarily call for the most gifted artist, however. Technique is more important, and the best method of getting results is to copy real life. The model maker should carefully study actual subjects if possible. If not, there are ample references in books and magazines. A road does not consist of flat colour, even when it is constructed from a single material such as tarmac or concrete. Passing cars leave lines of rubber from their tyres and patches of oil from their engines. Dirt collects in the gutters, and rain streaks patches from the crown. Likewise the fronts of buildings show rain-washed patterns, with obvious traces below window-sills and projections. Paintwork either glistens or appears dull according to its angle to the observer. And so on and so forth. An eye for detail and a feeling for texture are more important than architectural subtleties.

A mistake frequently encountered in the construction of realistic models is the ruination of relief work by painting. Typical are the window-frames on houses, which, if constructed in relief, are rendered completely flat when painted in a colour different from their surroundings. (This, of course, does not apply to very detailed close-ups, only to the embellishment on houses in a general shot.) It must be decided in advance whether certain features should be modelled in relief or whether they should be applied only as artwork. To mix these methods is a waste of effort. Relief work shows up best where it is of the same overall hue as its surroundings.

Surface character can often be improved by spraying with alternate applications of light and dark paint. The spray should be used sparingly and should be applied as a light dottle (spraying with reduced air pressure). These minute spatters of dark and light paint break up areas of plain colour and soften any harshly painted detail.

Buildings to be "blown-up" or "burnt down" figure high on the list of TV special effects. Both call for special construction and details. If a house is to be burnt down it could be filmed against back-lit smoke, but if real flames are to be used the model should be made with fireproof walls. The roof is often the focal point of a burning house, and if a shot showing the burning roof will suffice, the roof should be made from a replaceable unit of balsa-wood rafters. This must be covered with separate tiles or with slates chopped from metal or cast from plaster. Tiles do not burn, so corrugated paper, papier mâché, or latex will not do. As the balsa rafters burn and fall in, the tiles slide and crash in a convincing fashion. Prior to burning, they can be mounted in position with melted paraffin wax.

For a house which must be blown up it is best to start with some sort of solid internal construction which *remains* after the explosion and serves to support the other bits before they fly. These bits are made of units which can be reassembled simply. Inside the house there is lots of shattered timber which flies into the air and gives a realistic impression. The roof is made from individual tiles—merely laid in position so that the roof flies off in many pieces. For a low-angle shot only the front of the roof need be assembled. To provide an authentic final picture the part of the house which remains should be suitably dressed. The inside of the building can be partially filled with pre-blown-up furniture, planks of wood, and shattered walls. They should all be stuck firmly into position to survive the bang. The explosion can be provided by a small flatpack. The secret is to wedge pieces of timber between the flatpack and the various components which must be blown away. A good coating of flying débris may be laid on the flatpack before the "push rods" are placed in position.

For a daylight shot the various pieces must be assembled with care. Cracks in the structure must be painstakingly filled and the tiles laid in even rows. For a night shot, however, the work may be almost slipshod. Providing the roof is unlit, the tiles or slates may be shovelled on in random fashion, it being only necessary to maintain a regular silhouette.

In a model shot of this sort trees are an embarrassment, and they are best left out. Shrubs and bushes are permissible, and some should be left loose to blow away.

False perspective

No one needs to be told that perspective affects the final presentation of the model shot. Ships, houses, and fields are all subject to the rules of perspective, and these rules can be altered to suit the occasion. But it is necessary to appreciate the difference between perspective and the reduction of scale. Perspective concerns the vanishing points of parallel lines, while reducing scale gives an apparent change of picture *depth* which is often confused with perspective. A landscape model may have large houses in the front and small houses behind. These need only be a few inches apart, but the implication is that they are a long way off. By reducing the scale in this fashion it is possible to telescope a large area into a narrow band, so saving space and model-making effort.

It is easier to construct models using only natural perspective. This allows work to proceed without constant reference to the viewpoint (which is fixed where false perspective is introduced). It

A model erected in front of a back-projection screen. False perspective in the foreground increases the apparent size.

means that all right-angles can be built as right-angles and that horizontal and vertical lines remain as such. For false perspective, however, all vanishing points have to be considered, and care must be taken that the amount of exaggeration is uniform throughout the model. The chief advantage of false perspective is that small models can be made to appear very much larger. A shot of a distant landscape can have diminishing lines from the foreground to increase the distance. Assume that we are looking at a large mansion set in an extensive cultivated garden. The drive going to the house need not be a long one. It would only be necessary to taper it towards the building. Trees lining the drive could be high near the camera and short near the house. Restraint must be exercised, otherwise the mixture of distorted perspective with a straight house looks unreal.

Some models can be built in forced perspective without too much difficulty. Others may involve hours of precision drawing to get the correct results. Photographs can often assist where false perspective is essential, and very often a model can be made which is part photograph and part practical model, the perspective being carried through without interruption. Perspective models, however, do not generally permit camera movement.

16

DEMONSTRATION AIDS

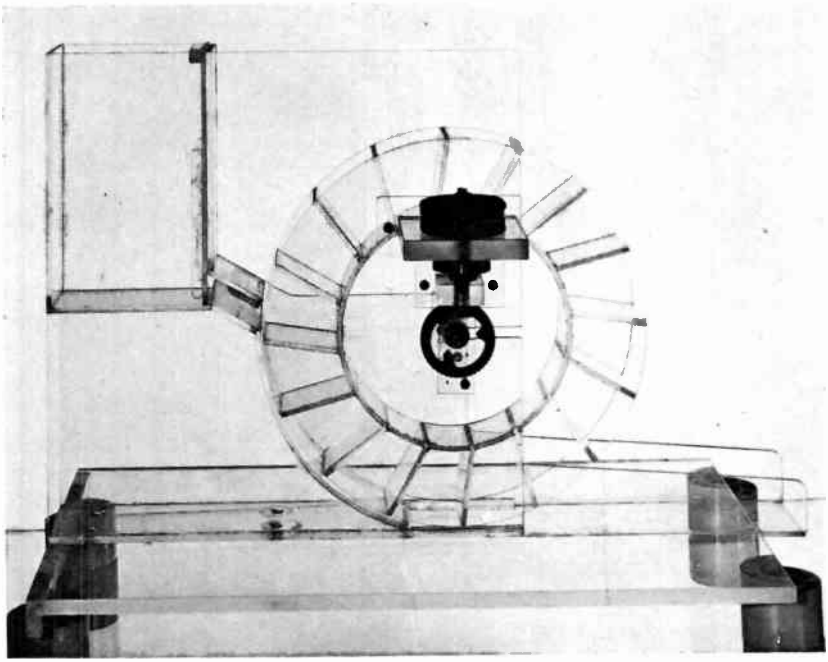
INSTRUCTION and education become increasingly important factors in the programme schedules of modern television. Languages, science, technology, and courses on "Do-it-yourself" form a substantial part of the ever-growing amount of instructive matter screened by all the major television companies (to say nothing of closed-circuit facilities installed in training colleges and universities). One thing these programmes have in common is their need for visually interesting material in the form of demonstrations, experiments, and graphic diagrams.

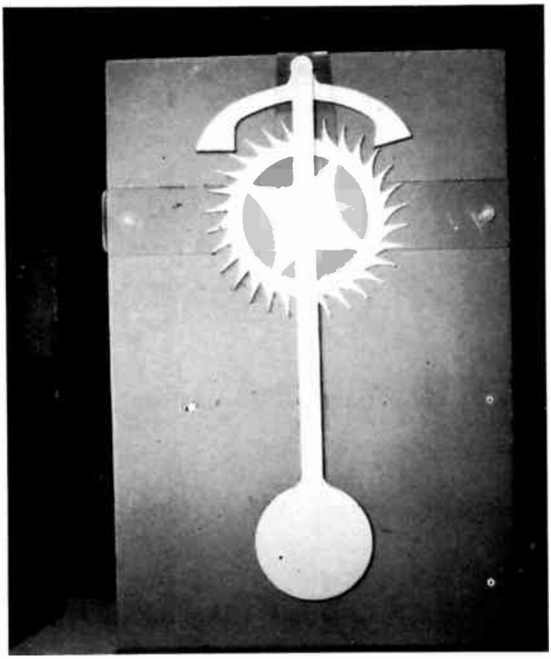
A special effects department, having personnel of varying skills and expertise, can usually be relied upon to provide most of the necessary demonstration set-ups for these programmes. Working, as they do, in so many fields, they are well able to evaluate the problems involved in presenting technical instruction. Nevertheless, if a trained laboratory assistant can be employed to liaise between the production units and the supply departments, problems are lessened.

Within reason there are few limitations to the types of demonstration model that can be used when presenting instructional television. Anything goes, provided it makes the point. There are, however, certain categories of visual aids and models which are called for over and over again, and the merits and methods of construction of some of these are examined in this chapter.

Demonstration models

Distinction has to be made between the model which is used as a demonstration device and that which has to appear realistic. A model house set in a garden can look like a model or it can seem to be the real thing. Much depends on the finish, the detail, the lighting, and the angle from which it is seen. It is just as important that the demonstration model should be seen for what it is as that the





Perspex is an ideal material for the construction of working models. Easy to cut and shape it can be cemented into robust forms which rival those made in metal.

naturalistic one should look convincingly lifelike. If a lecturer is pointing at certain significant detail in the construction of a stone bridge it confuses and irritates if the bridge appears to be life size or too realistic. Much better to make the model simple, graphic, and clean with the salient details appropriately outlined. This applies equally to medical demonstrations, where it is often better to use a stylized technique than to copy nature.

Table-top models which are to be used by the speaker for the purposes of demonstration must conform to certain specifications; for example, they must not exceed a size in which all parts can be reached from the sides or the back, particularly if sections are to be handled or removed. Usually 4 ft square is considered to be the optimum size. An overall shot showing a huge table-top model and a small partially hidden lecturer is not only awkward to manage but is also bad picture composition.

Where pieces are to be removed and replaced they should be constructed in such a way that the demonstrator can handle them easily without having to perform unnecessary contortions. Hidden marks and colour codes help if it is possible to replace a component in a variety of incorrect positions.

It is equally important for a demonstrator to make sure that while replacing one piece he doesn't upset another. This may sound obvious advice, but unfortunately many of the people who lecture on educational subjects come to television with only a slight knowledge of the medium and, unlike trained actors, who can spot a difficult situation at a thousand paces, are apt to be unduly optimistic about their ability to perform any task required.

The essential point about having a model for demonstration purposes is that the viewer shall see quite clearly what is intended —and this must be borne in mind during design and construction. Typically troublesome might be an architectural model which sets out to show a central heating system or electrical wiring circuit. Such things are usually difficult to portray, as they occupy many planes and are three-dimensional. Cross-reference to animated diagrams is often better than trying to convey all the relevant information on one model.

Colour plays an important part in such models, and this applies more to the black-and-white picture than the coloured one. It is no good showing red blood vessels on an anatomical model if they will become confused tonally with coloured symbols or lines of demarcation placed in close proximity.

There are many techniques which may be employed to make a demonstration model easy to operate. One of these is to assemble the model on a sloping board. This has the advantage of keeping the bits together by gravity while at the same time retaining them in one plane. An example might be a simple bridge model where the construction has to be explained. If the model is built up of its component parts it is easier to set them up on a board that slopes backwards than to try to erect the assembly in the upright position.

Furthermore if they are magnetized and the board is faced with steel the various components can be made to remain "suspended" wherever they are placed. A camera looking down on an inclined board sees a vertical picture.

When a lecturer using a large model is expected to remove certain parts of it it is essential to supply enough room on the table for him to put them down. If every inch of the available surface is covered with model he will either have to hold the bits or put them on an adjacent table, in which case he is certain to turn away from the microphone or get caught in an awkward manoeuvre during a camera change.

Magnets are frequently used in demonstration models of all kinds. Where pieces have to be fastened together magnets often prove superior to clips or fasteners. They are particularly useful for large block models where units have to be built up in three dimensions. It is not always safe to rely on magnets alone, however, as they may sometimes slip on smooth surfaces. The ideal situation is where a component is placed over, or in, some form of location device which positions it, while the magnet is used to keep it "glued" in position. One example would be a wooden ball to be slid on to a dowel rod. If there was a danger that the ball might fall off, then a "pot" magnet inserted into the ball and a soft metal end on the rod would keep them together. Another example might be a wooden shape which had to be positioned on a large vertical demonstration board. If the shape were designed to slip on to a tiny peg this would position it, while magnets inset into the back of the shape or the board would prevent its falling off. Without the peg the piece might be in danger of slipping down the board. It is, of course, quite possible to make the magnets strong enough to retain without slip, but this usually makes positioning more difficult and, in the case of large or heavy units, produces a considerable "clang" when they clamp to the steel plate.

Magnetic rubber sheet, now in common use, is excellent material for demonstration devices. Cut to any shape and stuck behind cardboard diagrams, it holds them firmly in position and is unlikely to slip. Magnetic rubber has the additional advantage of making no appreciable noise when placed on a metal board.

It is important to know the types of model and device to avoid as well as those to use. Complicated electrical circuits should be shunned—not because they are unsatisfactory in the visual sense, but because if trouble arises prior to recording it usually takes a great deal of technical effort to sort things out. It is better to keep things simple, and to ensure that all those parts that may need to be replaced can be got at quickly and easily.

It is equally important to avoid any form of delicate construction. Demonstration models are likely to be subjected to all sorts of rough treatment before they eventually go on the air, and it is unwise to rely on gentle handling. Pieces of delicate apparatus that depend upon fine wires or sensitive bearings should be rejected or, if they must be used, they should be put in the safe custody of one person who is able to stand by and frighten off those happy switch pullers or knob twiddlers who invariably come poking about before the recording.

Another item to avoid is the piece of apparatus which has to be carefully set up before it will work. The eminent scientist will be happy to assure you that it always works, but somehow TV often proves him or it to be as fallible as the rest of us. A wise director pre-records the effect, concentrating on the cause in reverse order.

Fluids often prove troublesome when introduced into demonstration models. In order that they can be seen, they often have to be coloured, but this sometimes turns them into a weak dye, which can, in turn, colour other components of the model.

Another difficulty which arises when using fluids is that of showing them in motion. Water, albeit coloured, in glass tubing or glass-sided tanks may be flowing freely yet have no apparent movement. For this reason it is sometimes necessary to introduce foreign matter, such as small particles of insoluble plastic or even air bubbles.

Geographical models

Geographical, landscape, and topographical models make up a large part of the hundreds of visual aids used in educational programmes each year. They can be very expensive items if specially commissioned from commercial sources, but with the cheap and easy techniques evolved for TV they need be little more expensive than the cost of the time taken to design and make them.

It must be realized that accuracy is relative. The model appears in a transitory TV programme and is not going into a museum to be studied by experts. Its purpose is to illustrate the lecture, not to serve as a standard reference. This implies that if a model of a mountain range was required it would need to be correct only in the details to be outlined in the programme. It would be sufficient for the surrounding areas merely to resemble the contours of the real thing. This can save hours of painstaking measurement and modelling.

It is only fair to say that not everyone agrees with this point of view. It is easy to become a purist in these matters and to demand accuracy in every particular, but as with all television, it is a matter of compromise; and if strict accuracy is asked for, then the director must be prepared to pay for it.

A model for TV does not usually have to last for more than one or two programmes at the most. The model maker is able therefore to use materials and methods which would not be satisfactory for long-term projects.

One of the most versatile materials for geographical work is Plasticine. It has obvious disadvantages, such as being heavy and easily deformed, but the advantages outweigh the disadvantages.

For topographical models it can be formed into contours and worked quickly and simply with conventional modelling tools. When completed it can be painted with emulsion paint. This colours it and gives a slightly protective skin at the same time. If saw-dust is added to the paint it can take on the texture of earth or grass.

To make a contour land model it is necessary to start with a firm baseboard to which has been pasted a copy of the relevant contour map. After this there are two main ways in which the contours can be formed. One is to drive nails in at the appropriate heights and the other is to fret the various levels from soft board or sheets of expanded polystyrene.

If the first approach is used the larger spaces should be filled in with pieces of wood or layers of thick cardboard stuck down firmly with glue. Only after this has dried out should the Plasticine be pressed down into shape. It is best to push it down with a heavy spatula, because the nail heads coming up through the Plasticine can cause sore thumbs and fingers. Finally, it is only necessary to smooth out the contours to suit.

The same treatment can be applied to the cut-out shapes made in board, but care must be taken that the hard edges of the shapes do not stand proud of the Plasticine.

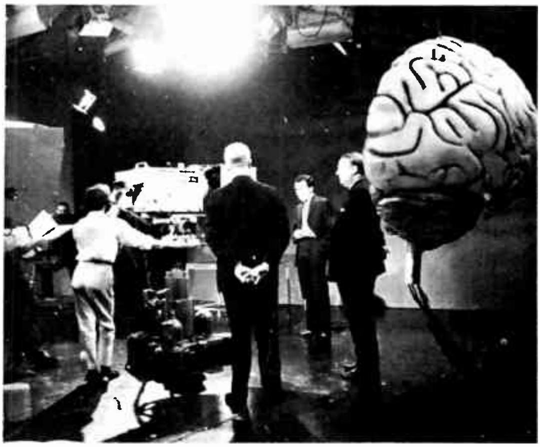
With the expanded polystyrene method, Plasticine cannot be used, as in being applied it would crush the contours. However, the polystyrene can serve as a practical base for a build up of a slow-setting plaster of Paris.

Anatomical models

As supplied commercially for use in teaching hospitals and classrooms, anatomical models are usually hand made and constructed to precise details. Nevertheless, it is not always possible to get models exactly suitable for particular TV programmes. Accordingly, many models have to be specially built for use in studio lectures. Giant teeth, ears, and eyes have all been made for various programmes, and any amount of muscles, fibres, animal cells, and skin tissues have been produced. There is little that one can say about this type of model because there are so many variants, but it is worth noting that expanded polystyrene is a favourite material when large replicas of parts of the body, such as the ears or nose, have to be carved from the solid. A coat of latex renders them suitable for studio use without adding greatly to their weight. The fact that they are extremely light makes it possible for them to be mounted easily. It also facilitates handling if they are to be held by the lecturer.

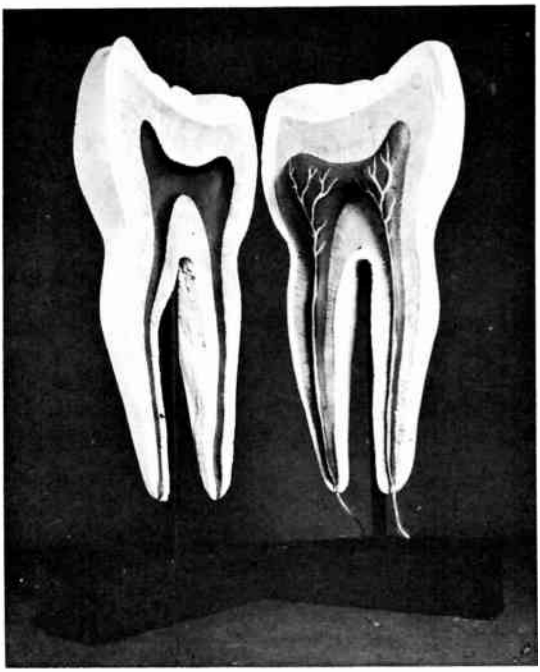
Teeth, bones, and other solid anatomical parts are best made from balsa wood coated with filler and painted. Expanded polystyrene is not satisfactory where it would be likely to snap.

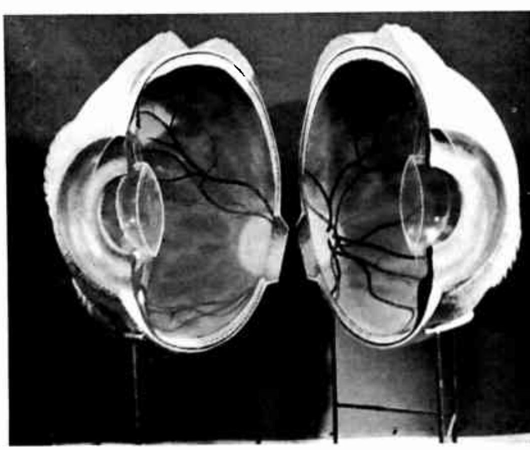
For muscles, fibres, and sinews required to stretch or distort,



A translucent glass fibre moulding containing illuminated sections to demonstrate the workings of the brain.

Models which illustrate anatomical details are often more stylized than realistic, a fact which makes them easier to understand.





sandwich assemblies of stout elastic, expanded foam plastic, and thin latex sheet provide suitable working models.

For tissue or large "micro-sections" it is often possible to use models with applied micro-photograph enlargements. This treatment of flat surfaces saves painting and gives a slightly three-dimensional impression.

Polyester resin, heat-formed Perspex, and clear polythene are all useful materials for anatomical reproductions.

Physical demonstrations

Experimental set-ups are often prescribed by the speaker himself. He is usually professionally connected with the subject and is able either to provide his own laboratory equipment or suggest how he would like the demonstrations arranged. But there are many ways in which the effects team or caption artist can provide visual aids to augment the programme. Two-dimensional paper animations are frequently used. It is often a good idea to superimpose studio animations over a physical experiment. This treatment can prove better for explanatory purposes than long verbal descriptions. As an example one might take an electrical circuit set out on a baseboard. Moving arrows, superimposed at intervals, would clearly show the direction of the current. Similarly, a concrete beam subjected to stresses could have travelling dotted lines to indicate the consequential strains. Visual flowing sound waves from audio-equipment such as speakers or bells also assist in clarifying the results of an experiment.

TV effects designers are frequently called upon to invent original experimental or demonstrational equipment to be used in programmes, and many ingenious pieces of equipment have been devised, some of which are pictured in this chapter.

The legitimate cheat

Whether one should "cheat" or not when arranging experiments or demonstrations is a question of ethics, but there are many occasions when "cheating" enables the point to be made more clearly than by sticking entirely to fact. For this reason most people would consider the "cheat" to be justified.

Geographical and topographical models are almost certain to require some exaggeration. It is useless to refer to hills and dales if the map shown appears to be as flat as a pond. It is nearly always necessary to increase the ratio of height to linear measurement considerably to give any indication of contouring at all. This applies particularly to river and coastline models, where the land is

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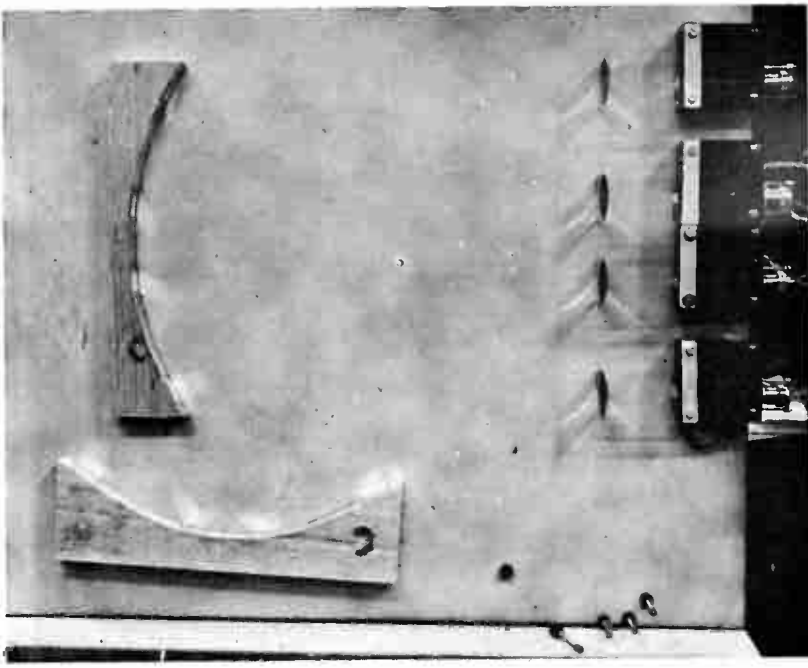
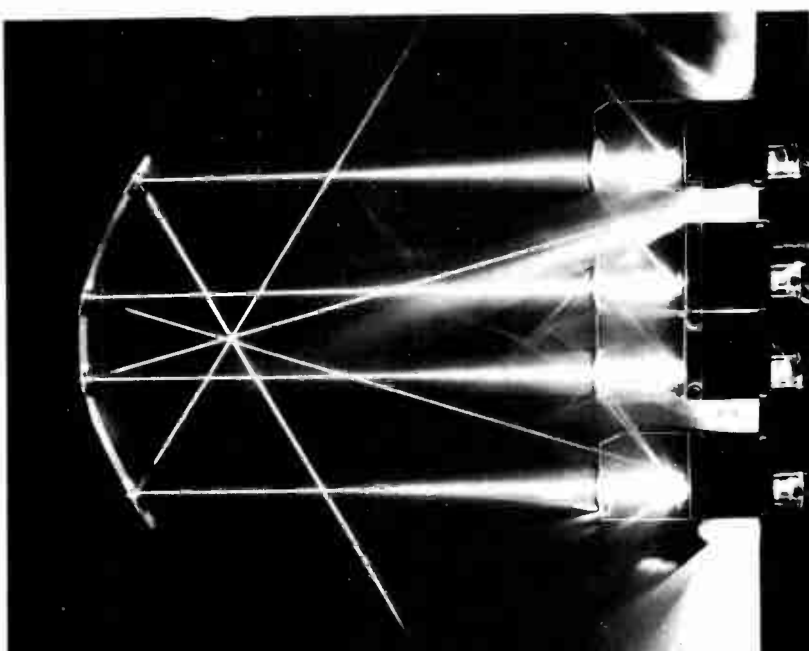
An effective apparatus to demonstrate light paths and reflection angles. ▶





often hundreds of times higher above the water than in real life, and yet still looks shallow.

In the field of scientific experiment it is less ethical to "cheat" in this way; yet certain subjects often demand contrived results. There are valid comparisons in the field of television advertising, in which slick results are often produced by means far removed from actuality. The makers of these programmes know the results they need to get, and without resort to blatant falsification or criminal misrepresentation have to use unusual methods to achieve them. If chocolate melts under the studio lights polished plastic must be used. If steam from inviting cooked meals fails to materialize, then smoke must be substituted. Cleaners which remove stains in two minutes must have their undoubted qualities speeded up, and so may be replaced by chemicals which make the point more quickly.

17

ANIMATIONS AND CAPTIONS

SOMEWHERE in every television programme there is a caption. Conventionally it occurs at the beginning, and its purpose is to show the name or title of the programme. There is usually another at the end giving the names of those who contributed to, or appeared in, the programme. The design, layout, and choice of presentation is the responsibility of the caption artist, working to a producer or director; but, as in many other activities, there is an overlapping (or rather an area of mutual co-operation) with the special effects department. A caption artist may want to film an explosion or a fire to set the mood of his programme, and quite naturally he enlists the help of the effects men, who are responsible for that side of the business.

There are also the captions used during a programme (usually documentary or educational) to explain a situation or demonstrate a process, and these quite often involve complicated animation. They may be on film or they can be manually operated in the studio. Both methods are examined in this chapter.

In the early days of TV filmed captions were rare, and most opening captions were presented on easels set in front of the cameras. In an attempt to create animation some incredibly ingenious methods were devised, although often extremely bizarre and impractical. The operators had to cope with situations that were sometimes more entertaining than the programme content. One caption used for an early light entertainment show changed a series of animated pictures each 12 × 9 in. It consisted of a slide 9 ft long pushed through a frame. It needed two men to operate it, but with the middle picture in the frame, both men were so far away that they could only guess whether it was centred or not. Another featuring a cartoon aeroplane with a rotating propeller proved so efficient that the propeller flew off during transmission.

Captions are governed by changes of fashion. What appealed

Front and back views of a picture drawn on detail paper (mounted on glass) using a felt-tipped pen containing a spirit-based black ink.

White pictures can appear on a black background by painting on glass with a brush. (Water or spirit-based pigment may be used.) For this the artist must be clothed in black and wear black gloves.

A glove puppet with a brush attached to the index finger of the artist's hand.

Examples of "magic drawing" where illustrations are drawn in vision without apparent human aid. (*Tony Hart.*)

last year is hardly likely to find favour this year. One remembers nostalgically the glossy Hollywood style when most films began with vistas of huge three-dimensional letters that were swept by searchlights, twinkled like a thousand stars, or marched boldly out of the screen.

A list of television animated captions in which special effects have figured would probably compare in size with a modern telephone directory. The growth of television advertising has made this field almost an art form. Even the most prosaic TV programme often begins with an elaborate introduction. Designers and producers are always searching for something novel, and inevitably special visual effects are involved.

Effects captions

A number of actual examples of effects captions are presented here with the necessary explanations of the way in which they were achieved.

The sea-shore. The programme required a close-up shot of a beach on which suitable titles would be imposed. The designer wanted to capture the ebb and flow of the tide as it lapped back and forth over the stones. A tray about 3 × 4 ft was built on rockers and treated with waterproof paint on the inside. Fixed to the rocking tray was a bridge supported by uprights, on which were mounted the camera and lighting. The tray was then lined with suitable pebbles, after which a gallon of water plus a little foaming agent were poured in. It remained only to set the camera running and to rock the assembly gently backwards and forwards to get the effect of surging water. As the camera, lighting, and beach were fastened together as one unit, it was the water that appeared to move.

The exploding metronome. The caption designer wished to show the action of a metronome as it ticked to the beat of the opening music, but the metronome had to blow to pieces after a few bars. It was not to be a violent explosion, but a graceful flying away of shattered parts. Consequently, a practical metronome was set up and filmed with the camera running at normal speed, after which the metronome was removed and replaced by a specially prepared one. The camera was run at high speed (five times normal), and the second metronome (which was not practical and did not tick) was exploded by a small pyrotechnic flatpack placed underneath. The second metronome had already been cut into a number of pieces and had been carefully reassembled without fixings, on the same spot as the first one. To increase the amount of material flying outwards, the inside of the dummy metronome was filled with small pieces of balsa wood.

The seascape. Various stylized sea and wave designs were required to illustrate the mood during certain passages in a televised opera. The designs were entirely static, but by utilizing moving light it was possible to give the effect a gentle animation. The designs were painted on sheets of clear glass and assembled about an inch apart in units of three. Mounted in a frame, they were lit from the side by a traversing lamp. The effect was dramatic. Waves that appeared on the front glass passed from fully lit pictures to silhouettes as the light receded, each glass in turn taking its full share of light. The effect was that of a single two-dimensional picture which changed completely without the method being apparent.

Similar pictures were painted on black gauze, by applying plaster thickly to the material in the form of the wave motif. The effect was carried out in the same way, by moving the lamp, but behind the gauze was a dark backing. This picture gave a similar dramatic change, going from thick treatment to a sort of light brush wash silhouette. Unlike the glass assembly, only one component was used for the gauze effect.

The desert. The letters of the title were cut from 1-in-thick blockboard, after which they were glued to a baseboard. Next an outline stencil of the title was made from hardboard. This stencil was the reverse of the letters, the backing being retained and the letters discarded. It fitted exactly over the wooden letters and was placed in position, supported on blocks, level with the surface of the characters. Next the surface was covered with fine sand.

The effect was obtained by televising from above while the stencil was gently lowered, the title appearing to form itself in the sand.

This technique can be adopted only where all letters are open. Closed letters (o, b, q, d, e, etc.) cannot be used because there would be no simple way of lowering their centre pieces. Changing from upper to lower case, or vice versa, will sometimes help, e.g. LIFE can be used, "life" cannot; "rust" is suitable, RUST is not.

Another method of using moving sand to reveal a title relies on the technique of reverse filming (i.e. printing the positive with the end at the beginning). The words are cut from a sheet of ply or blockboard, the letters being discarded while the stencil is retained. This is affixed to a backing and the hollow letters given a coat of glue followed by a light application of sand. The loose sand is shaken out and the caption is ready for filming. The title is held for a sufficient length of time and then filled with loose dry sand. This may be blown in or it can be shaken from above. When the words are obliterated the shot is finished. Printed backwards, the sand leaves the base, gradually revealing the title.

A title that writes itself in vision can be effected as follows. The words are left plain on a sheet of glass that is otherwise painted black. This painting should be applied to the back of the glass and the title or words used should be of linked letters (i.e. handwriting). Black tape of the normal woven-cloth variety is then stuck to the back of the glass by a thin coating of rubber adhesive such as Cow Gum. The adhesive should be applied sparingly, but the tape should cover the areas of clear glass in such a way that no light shows through from the back. When required to work, the tape is pulled off from the caption, which is positioned against an illuminated board. The words then appear as if being written. It is not necessary for the tape to follow the contours of the letters accurately. In fact, it can be applied in quite a haphazard overlapping fashion, particularly where it is necessary to obscure the light on tricky corners.

Light tray

If a glass-bottomed tank is placed horizontally so that it is possible to light it from below it can be used for various effects ranging from animated coloured caption backgrounds to the effect of sunlight being reflected off the surface of water. The tank need not be deep (a nominal 4 in is sufficient for most purposes), but should be capable of holding water. It should be mounted on sturdy legs with a mirror fastened above at 45 degrees.

There are hardly any limits to the variety of captions that one can do with this light tray, but when the picture is shot via the mirror the lettering is reversed, so if it is not possible to change it by altering the television line scan (or reverse film printing in the labs) the captions themselves should be made in reverse.

Some examples of caption effects employing the light tray considered worthy of mention are given below:

1. The tray is filled with water. The glass is illuminated from below through a sheet of translucent plastic. The water is swirled before the shot commences, and on cue coloured dyes are squirted in at the corners. On top of the tray is a sheet of glass with opaque, stuck-on, or painted letters as a caption.

2. The tray is filled with warm coloured water and small pieces of dry ice are tipped in and allowed to bubble freely. The covering of cloud should be gently blown away. This effect should be lit from both below and above.

3. The tray is used dry, with cut-out letters applied to the glass. Dry ice clouds are poured into the tray. (This can be done by having a container of warm water and dry ice situated at the side of

the tank.) The dry ice is blown away, revealing the caption. A light below can be brought up while one above is faded down.

4. Cork chippings are poured on to water lit from below. A jet of water is played across the surface, clearing and swirling the cork and giving a stream-of-light effect.

5. Thick cut-out cork letters are stuck to the glass. Opaque liquid fills the tray. The liquid (water and poster colour) is drained off, revealing the letters. This one is lit from above.

6. A stencil with the legend cut out is placed above the tray, which is filled with warm water. Dry ice pieces are put in and the fog seeps up through the cut-outs. This looks well if filmed and reversed, so that the smoke goes back into the letters. Lit from above and below.

Burning captions

The effect of fire, to either destroy or reveal the caption, is frequently called for. Some methods are simple, while others require a certain amount of preparation. The types of effect permissible depend on whether the titles are to be televised or pre-filmed.

When simple destruction by fire is called for the caption may be recorded by either electronic or film camera. It is safer to pre-film, because several takes can be made to ensure that the results match up to those required.

The simplest method of reproducing captions for these purposes is to have a number of photographic enlargements made. Photographic paper is unfortunately not the most satisfactory combustible material, and such captions may have to be treated with paraffin or turpentine to ensure adequate burning. Alternatively, the photograph can be printed with a large portion of spare paper at the bottom. This area, which would be below frame, can be given a quick dousing of petrol before ignition.

Sometimes a designer wants the flame to start in the middle and burn its way to the outside, consuming all parts of the caption at a uniform rate. For this the caption will have to be supported by an outer frame and recorded in a horizontal plane.

Where the flames are to burn across the screen, revealing the title, it is possible to ignite the caption in the previous fashion and use a reverse film technique to get the effect. It is a novelty effect and will be seen to be what it is. Burning paper returns to its normal state, and flames (and, more particularly, the smoke) go back into the material.

A sheet of paper on which the letters have been written in diluted sulphuric acid can be used for an effect where the title is written up with a blowtorch. When the letters have dried the paper is lightly fastened to a sheet of ply. The blowtorch is now passed at an even pace over the lettered area, which appears jet black under the influence of the heat.

Roller caption machine

This is a motorised device capable of winding a long roll of paper past the camera lens at a range of speeds. It consists of two rollers set in a frame mounted on a robust pedestal. Hand controls are provided locally (and sometimes remotely) to stop, start, and control the speed of the paper.

The normal function of the caption roller is to present the end credits in a programme, but it can also be used to add effects to a caption which is itself either in front of the roller or superimposed from another source. If the paper roll is painted with clouds or out-of-focus coloured washes anything placed in front appears to be falling. As an example, a parachute or a balloon on which the title of the programme is painted could be mounted on a glass sheet or on wires in front of the roller. Used horizontally (to give a feeling of travel) the caption roller can be painted to resemble the ground as seen from an aircraft. Model aircraft fixed on the sheet of glass in front of the roller appear to be flying. The title can be superimposed, or it can pass by on the caption roll.

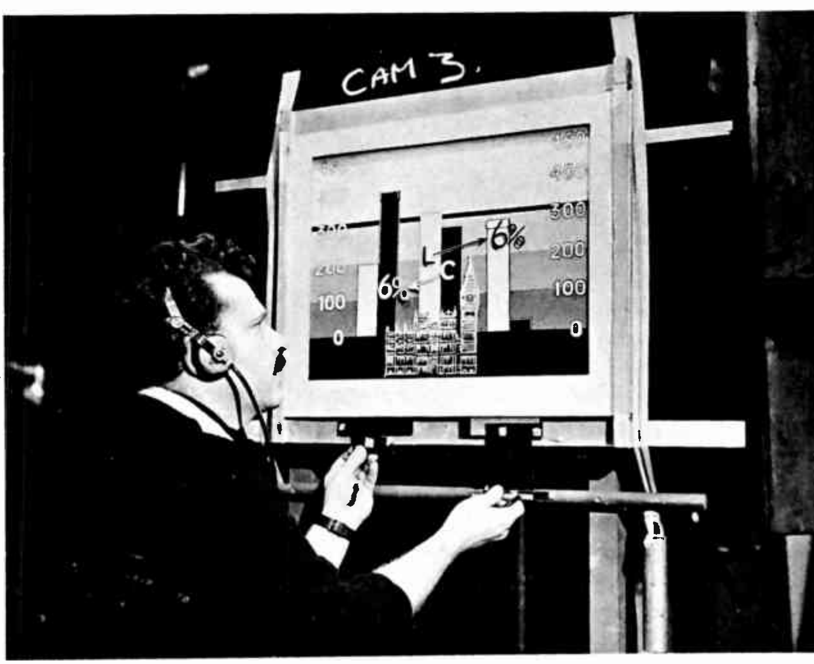
An interesting effect can be obtained by painting the caption roll in alternating colours or blocks of pattern. Run behind cut-out letters on a glass sheet, the words can be made to fluctuate or disappear according to the relation between the tones and colours of the roller and the front caption.

Paper animations in the studio

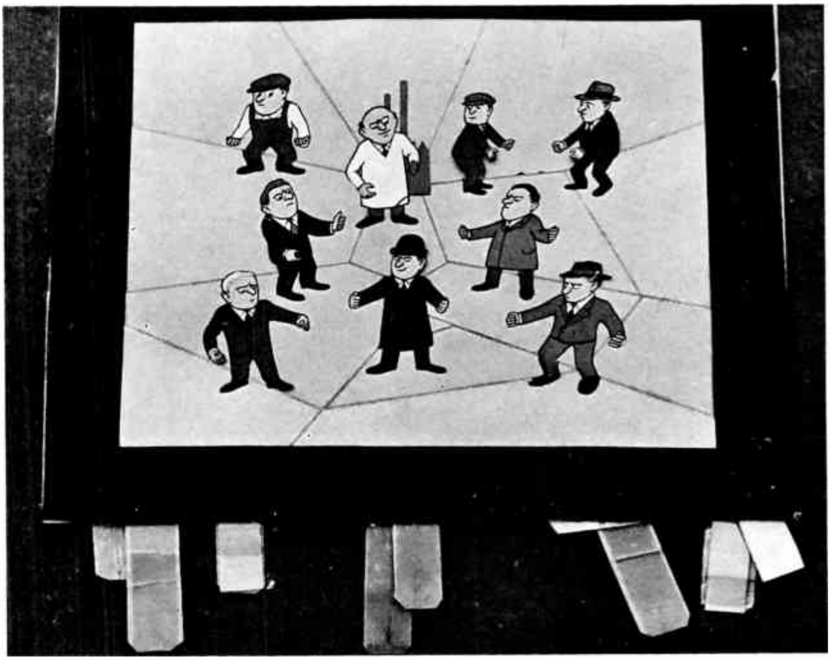
Deservedly popular for television use are the paper animated captions developed so successfully by Alfred Wurmser. Essentially this form of animation is a means of presenting information by moving pictures or diagrams made from paper and card. Ingeniously fashioned sliders and pull-outs can be operated on cue (to synchronize with dialogue) covering or uncovering various parts of the picture. They range from the simplest (the uncovering of a single word or number) to complex arrangements involving dozens of separate movements.

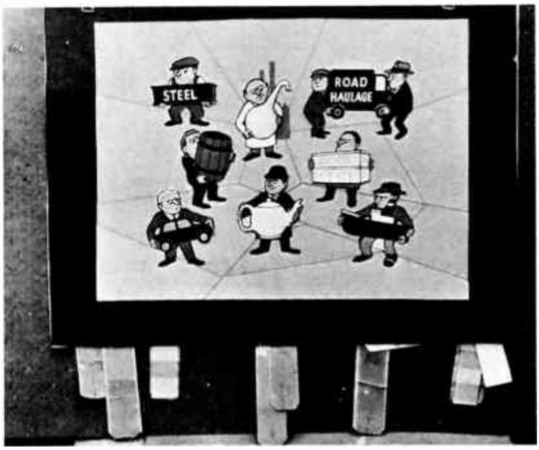
These animations are usually made from stiff paper and card mounted on caption easels which stand upright in front of the camera. They are equipped with a narrow ledge at the bottom to support the animation and two weighted straps of cloth fixed from the top of the easel which hang down and hold the caption in position. For complicated animations, where it would be necessary to operate something on the back, special individual stands must be made.

To examine the methods employed in designing and making this sort of caption we will assume that a diagrammatic presentation of a thermometer is wanted. This thermometer (a conventional mercury tube) must not only show the rising column of mercury but must also present the relevant temperatures as bold figures. The artwork is applied to a sheet of thick black paper of screen proportions. The outline of a thermometer is drawn boldly in white, and the inside area is cleanly removed with a sharp knife. Two guide strips of card are glued to the back of the caption, parallel to the slot, but set slightly back from its edges, to register the moving strip of paper which will represent the mercury. To retain the moving strip a further piece of card is stuck completely over the



Alfred Wurmser manipulating a pull-down caption.





Now you see it . . . now you don't! A cleverly designed caption where items spring into view at the touch of a cardboard lever. The spiderweb pattern on the background camouflages cut areas of paper concealing the jump-in components. (*Wurmser Aids Ltd.*)

two guide strips. Next a strip of stiff black paper is pushed up behind the slot. It should move freely in the guides. Half of this movable strip is painted a light colour to represent the mercury and if it is pulled up and down behind the cut-out it gives a credible imitation of rising and falling fluid in the thermometer. To prevent the strip falling of its own volition some sort of friction pad is applied to it. An elastic band taped lightly across the back usually suffices. Small blocks of balsa wood are stuck to both ends of the strip to prevent its being pulled out accidentally.

So much for the thermometer tube. The figures which have to appear can be operated either by separate pull-outs or can be revealed by the original moving strip. Assuming just one figure, placed alongside the tube, it is necessary to cut a rectangular window in the front sheet where the figure is required to appear. The moving strip, on which the column of mercury is painted, has to be wide enough to cover the window and must have a corresponding window of its own. When these two windows are aligned they reveal the salient figure, which is painted on the back sheet.

To examine a more complex arrangement it is helpful to consider it in parts rather than as a whole. Assume that to illustrate a talk about the weather a graph is required to show, say, monthly rainfall. Below the graph to give additional interest we could add a simple picture of two clouds. During the commentary one of the clouds could "rain", while later, from behind the other, a bright sun could appear. To press the point even further the sun could radiate "heat-waves".

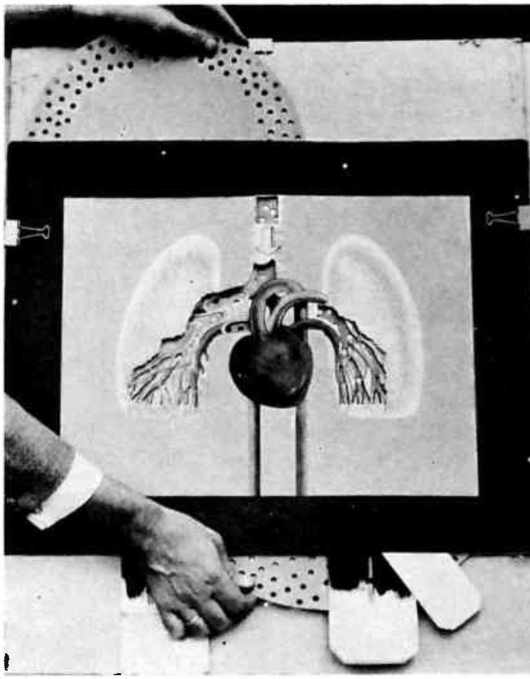
We can visualize the construction of such an arrangement as follows:

The graph. A sheet of black paper has a slot cut in it to represent the curve of the graph. Behind it is a wide pull-out slide similar to that used for the mercury in the thermometer. As half the paper is painted white, it travels along the path of the slot, appearing to weave up and down as it progresses. The cursor lines on the graph cannot be painted on the front sheet because they would be removed when the slot was cut. Instead they are applied to the front as small pieces of light-coloured elastic (the type known as shirring elastic), stretched only enough to keep them taut. If they are too tight accumulative stresses could be set up, causing the caption to warp.

Figures and details are added as artwork to the face in the normal way.

The cloud that has to rain is a painted picture on the card below the graph, but underneath it a number of parallel slots are cut on the slant to resemble rainfall. Behind the slots there is a strip of black paper in horizontal guides similar to the arrangement used for the moving graph. To cause "rain" this strip has a painted section of white lines sloping in the opposite direction to the slots

A paper animation capable of giving a continuous flow pattern. (*Wurmser Aids Ltd.*)

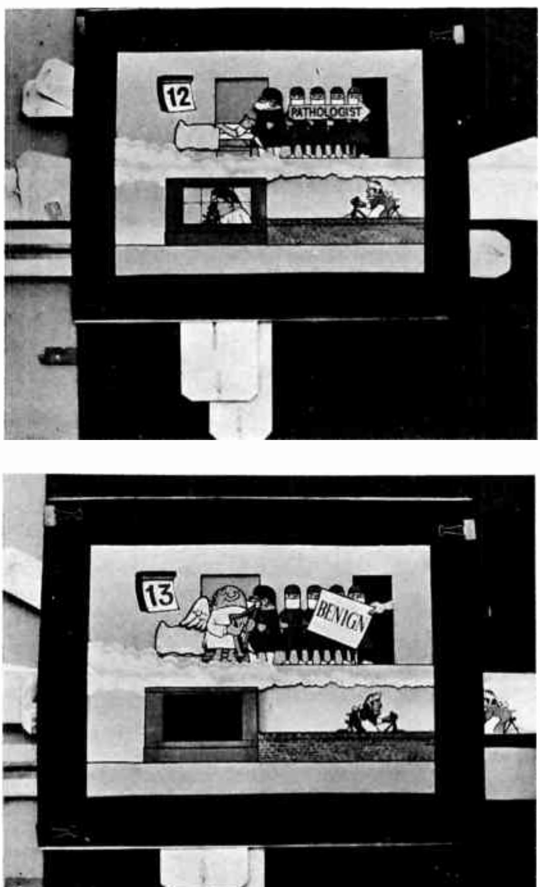


cut in the front card, but of similar thickness. When the strip of paper is pulled past the slots rain appears to travel downwards. The speed of rain depends not only on the speed at which the strip is pulled but also on the angle of the white lines. Nearly perpendicular, the "rain" is fast, but if the lines slope more to the horizontal it is slow. For neatness it is better if this strip has an all-black portion at the beginning and another at the end. The rain could be made continuous by having a wheel instead of a pull-out strip.

The sun which has to pop out from behind a cloud is a small brightly painted paper cut-out on a stiff wire (which is black to match the front of the caption). It is elasticated so that when released it pops up as an instantaneous insertion into the picture. To prevent it going too far a stop is positioned somewhere along the wire, where it is hidden from view behind part of the caption. The sun, which we will assume was originally behind a cut-out cloud raised from the surface of the caption by a small block of balsa wood, has to finish up over the centre of the radiating "heat-wave" effect. For this, wavy lines, or rather slots, are cut in the card so that they appear to radiate around the sun. Behind them is a wheel of black paper, on which have been painted radiating bars of colour. In the neutral position these bars are hidden between the slots around the sun, but on being revolved they pass behind the slots, giving an effect of flashing light.

Such a complex caption might need two or more operators if these effects were to follow in quick succession. It would be necessary to plan the handling in a way which would allow the operators to manipulate individual items without getting in each other's way.

Captions such as these are made of stout paper, but it must be of good quality and not too thick, otherwise the depth of the cut-outs give away their position before revealing their information. Each caption should be mounted on thick card to keep it rigid.



An amusing animation dealing with a serious subject. (*Wurmser Aids Ltd.*)

In Chapter 11 a lighting device is described which allows these captions to be lit to their best advantage. Another aid is to cover the front of the caption with black gauze. Stretched tightly across the artwork, it camouflages cut lines and edges of paper.

Rostrum camera

The technique of animation filming is too big a subject to be fully discussed here, and anyone wishing to study it in detail is advised to consult those books devoted entirely to this particular subject.

In special caption work the rostrum or bench camera is a most important item of equipment. In essence it is a conventional 35- or 16-mm camera which is capable of exposing one frame of film at a time. This is achieved by an electric motor which drives the film transport. It often has an exterior cam controlling a micro switch which cuts off the supply to the motor after it (the cam) has completed one revolution. This equals the travel of one frame.

The camera is mounted over a bench or animation table and is supported on two pillars. It can be raised or lowered on the pillars and is usually moved by long vertical motorized screw-threads. Like most other pieces of equipment in television production, it can be purchased as a sophisticated piece of machinery or it can be constructed out of available materials. Some of the crudest rigs have been capable of remarkably precise results.

Ideally the camera should be able to carry out a whole series of movements completely smoothly, but when constructed from odds and ends it is usually considered sufficient if the final contraption performs without overmuch flicker or judder. The camera should operate for single-frame exposure by the use of a switch or push-button. A second switch should exist to override the cam-operated limit-switch allowing the camera to tick happily away for as long as wanted. (Obviously if a long sequence of exposures is involved where the caption remains static it would be something of a chore to have to expose each frame separately by constantly pressing a button.) Focus can be controlled automatically by attaching a spring-loaded lever to the lens mount. This lever should rest against a slide which is situated between the pillars supporting the camera. It is a comparatively simple matter to profile the slide so that the vertical movement can be translated into a semi-rotary one, thus screwing the lens in and out as the camera is moved up and down.

A frame counter is a necessity. It is operated from the exterior rotating cam on the camera, which is arranged so that with each revolution it trips a simple numerical counter. As the number of frames times linear movement of the photographed object is the time factor that governs all stop-frame film techniques, accurate frame counting is obviously essential.

Lighting the animation bench is a simple matter. Lamps fixed rigidly to either side of the table should give an evenly lit surface to the entire frame area. It is highly unlikely that they can reflect back into the camera lens. For special use the lighting may be changed, and for this reason it is a good idea if the animation table can be easily replaced by a sheet of glass in order that lighting can be positioned below the table.

The rostrum camera can be used for all sorts of purposes, but as this chapter deals with animations and captions, the techniques explained will be confined to this field.

Starting with two-dimensional subjects, we can imagine a map which is being used to demonstrate a talk about a geographical area. The map is shown as a caption and, as the speaker refers to a certain location, a row of dots suddenly rings the area mentioned. Later, returning to the caption, we are shown cross-hatched areas which appear on cue, and also arrows which move to indicate certain relevant details.

It has been explained earlier in this chapter that this sort of treatment can be supplied by the manually operated paper caption in the studio, but for the purposes of example we will assume that the hypothetical programme to which we now refer is composed entirely of filmed material which has been edited with dubbed dialogue for the programme. The whole thing will therefore go out as a recorded programme and no studio will be available for a manual caption. Hence the stop-frame, rostrum-camera technique.

The map which has been selected to illustrate the programme is fixed to the animation bench by sticky tape. During the many operations which take place on its surface it is vital that it does not shift.

The first operation is the filming of the map in an inanimate form. Sufficient film is run off to cover the dialogue preceding the animation, after which the first dot is affixed to the map. (Dots for this purpose may be reclaimed from an ordinary paper punch, or they may be purchased as pre-gummed or self-adhesive dots from various stationers or suppliers.)

The time required for the dotted line to circumnavigate the mentioned area is obviously a matter of choice. If the line is to flash round quickly a dot is added for each frame exposed. If, on the other hand, it should trickle round slowly any number of frames may be exposed before adding another dot.

A story board must be produced before filming commences. For this example it would be necessary to assess the time involved in the encirclement. Assuming this to be two seconds, the animator working on the final map on the bench would have to convert the time required into the number of dots in the linear distance to be travelled. Taking a strip of paper on which he has made marks at (say) every centimetre, he folds it around the contour on the map and makes the faintest of pencil marks where the dots will be placed. It now remains for him to film it, adding a dot for each exposure. A wise operator provides himself with a calculator or table which enables him to convert frames into linear movement, showing time and distance factors.

For the cross-hatching or shading (which is to appear on cue) he has a piece of animation cel on which the lines have been pre-drawn to the shape and area required. This is laid over the map and filmed when needed.

The arrows are paper cut-outs. Their timing and movements are given to the animator in the original story board. Assuming that they merely travel across the map to end up at a certain point, they can be hand-operated across the surface. They must move cleanly along a defined path and at a smooth rate of progress, so the animator prepares a strip of card on which he inks in the rate of travel. Let us suppose that the strip bears marks at every 50 mm. It is wide and is laid across the map in such a way that one edge corresponds to the line of travel of the arrow. The end out of shot is taped to the animation desk so that the strip can be hinged back, where it lies out of the way. Returned to the map, it rests in exactly the same position as before. The technique is therefore to lay the strip on the map and place the arrow along the appropriate edge. The strip is hinged back and the exposure is made. The strip is once again folded back over the map and the arrow is moved to the next mark. This procedure is repeated until the arrow finishes at its destination.

Basically this is the method by which simple animation can be carried out, but modern rostrum cameras are provided with controls that simplify both linear and irregular movements. The table on which the animation is placed has a device known as a "peg-bar", which is used for locating a sheet of clear cel on which the animation has been drawn. The peg-bar is driven by a manually operated handle through a worm drive, so it follows that movement can be arranged for either forward or backward motion.

Three-dimensional objects may be filmed on the animation bench in much the same way as cut-outs and drawings. The sort of movement applied to three-dimensional things is usually two-dimensional, that is, they move around on the table but seldom move to or from the camera. Where up-and-down motions are involved they are usually minimal and impart no focus-pulling problems. An example might be a box of matches which opens by itself, ejecting the matches, which then form up to spell the title. Problems arise in manoeuvring the matches over the side of the tray, and it might be necessary to support them by small wires.

Animated paper captions on film

The making of animated cartoons is not part of the special effects man's job, but occasionally he may need animated drawings or figures to support material which he is preparing for educational or demonstration programmes. Such work can be done by using separate drawings filmed on the animation table, but if cartoon actions are required there is a cheap and easy method of using paper cut-outs which is a combination of the animated-caption technique outlined earlier in this chapter and stop-frame work filmed on the rostrum camera.

If we assume that an animated illustration is required to show the principle of the dynamo it might be fun to show a cartoon man actually turning the handle of a dynamo, which in turn could light an "electric lamp".

To start with, the man, the dynamo, and the light are drawn as a straightforward illustration. The second step is to cut out a number of pieces which would need to be articulated. These might be the man's arm (one piece from shoulder to elbow and another from elbow to hand), the handle of the dynamo, the man's trunk (from waist to top of head), and so on. All these pieces are then assembled with tiny rivets to link them together, but allowing for full articulation.

A time sequence is worked out, and then, with the animation fixed firmly to the table below the rostrum camera, a series of movements are carried out, each one being given one frame exposure. The advantage of this system is that only one component need be moved, because, being linked together, all the other movements follow naturally. In this particular case movement of the man's hand would cause the arm to bend appropriately while the body flexed back and forth from the trunk.

Other movements could be covered by replacing one item for another. For example, for the lamp to light it would be necessary only to remove the unlit bulb picture and to replace it with one with lines emanating from it. In colour a more appropriate change could be made by showing a brightly coloured lamp.

The man's head could turn from side face to full face by substituting one drawing for another.

This method offers a considerable saving over the conventional single frame, separate-drawing cel technique.

18

SCOREBOARDS AND SIGNALLING DEVICES

OVER the years television has been responsible for many innovations. Unique among these have undoubtedly been quiz shows and panel games. This class of programme has spawned scoring, calculating, signalling, and recording equipment of every variety, many of them becoming almost the trade-marks of their shows. While these shows remain as popular as they are today designers inevitably have to continue to invent newer and even more fascinating gimmicks to match the programmes.

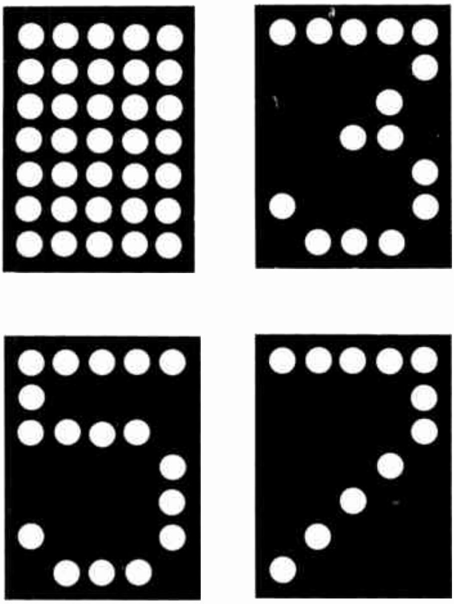
Slick presentation is the keynote. Programmes concerned with people answering questions or performing amusing tasks need embellishing with presentation devices having strong visual appeal. Not every show needs "dressing-up", however; many of the most memorable devices have been the simplest.

There are certain rules governing the design of scoring or registering equipment in a quiz show or panel game. It must, above all, be novel—it must not have been seen before (even in similar form) in other quiz shows. It should be identified with the show—many programmes long dead and gone can be remembered by their equipment, even though the format and sometimes the participants have been forgotten. It must be reliable—nothing can "throw" a quiz-master more than malfunctioning equipment. Equally, it must not present the user with complicated rules of operation; he or she has enough to think about in front of the cameras without the burden of involved instructions. Switches should not have to be returned to neutral before re-use, because it is unlikely that any of the participants will ever remember to do so. Where complicated procedures are unavoidable, they should be performed by staff out of vision.

One of the many ingenious targets used in the programme "The Golden Shot". These targets were constructed with a number of moving elements which, as well as having to travel at a regulated speed, had also to survive the impact of a steel-tipped crossbow bolt. *(ATV Network Ltd.)* ▶


DWARF
MINING


DO NOT
DISTROY
KEEP



Using a five-by-seven arrangement of lamps it is impossible to give the numerals a pleasing shape. Nevertheless this type of scoreboard display is popular where simplicity is the keynote.

Electric numeral indicators

The first types of electric counter may well have been those stage devices which were situated on either side of the proscenium arch for numbering the acts in variety shows. Whether this is true or not, this multi-lamp type of presentation is almost as popular today as it was then. It is, after all, an easily appreciated format and is probably the simplest form of putting up a series of digits by electrical switching. It consists in essence of a number of horizontal rows of electric lamps, each lamp being taken to individual switch contacts. A popular arrangement is 7 lamps high by 5 lamps broad. With this it is possible to form all the digits from 0 to 9, and combinations of this format can be used to build up numbers of any length required.

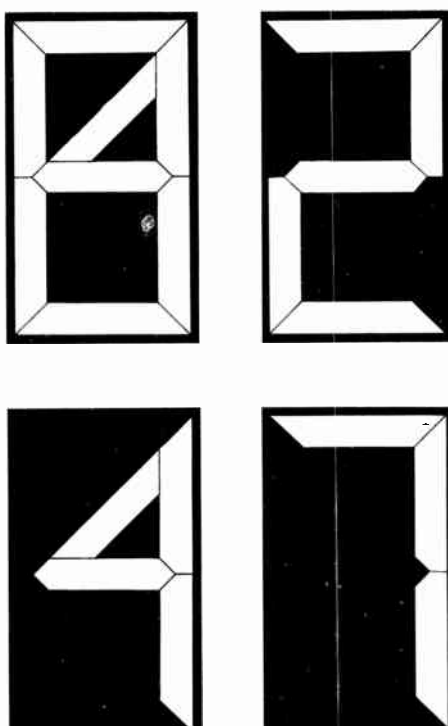
It should be noted that as well as 0 to 9 each indicator should be capable of being switched off (or in the case of other types of scorer, having a blank position). The blank must appear before the figure one. Nought (zero) comes after nine. Hence a two-digit counter would read 9 and not 09.

The switching of the lamps can be done in one of two ways. Each lamp may be switched separately or they can all be linked in groups, each group forming a separate and individual part of a digit (see page 341). The switch itself must have enough contacts to cover these conditions and must have a minimum of eleven positions. Switches can be built from multi-wafer assemblies, or they may be specially made. One of the simplest devices is a metal drum which can be revolved under a series of contacts, the number of contacts being equivalent to the number of lamps (or the number of component groups). The drum, covered with insulating lacquer (any commercial printed can will do), is scraped clean in the places where contact is required.

The spindle or a separate contact on the drum must be connected to the common return lead.

In order to locate a drum switch of this kind it is possible to drill holes around its circumference to receive a spring-loaded ball. It is also necessary to fit a knob and/or a dial with numbers corresponding to the ones that will light up on the display.

A system of display that has been used in many forms is known as the "edge lit" method. A sheet of clear plastic with sides and edges that have been polished transmits light through the material without dispersal. Should the surface be scratched, however, the



An arrangement of illuminated segments and the types of numeral it produces.

Edge-lit digital indicator. This unit contains a pack of numbered, clear plastic sheets which can be individually illuminated, the number which is lit being seen through those in front of it. (*K.G.M. Electronics Ltd.*)

light in that area disperses in all directions. Consequently, an engraving in a sheet of Perspex can be illuminated almost uniformly by placing the source of illumination at the edge of the sheet. For use as a scoring device this is usually arranged by having ten sheets one behind the other in a pack. Each sheet has a numeral engraved on it, the figure being in outline only, and composed of small partially drilled holes. Each engraved sheet is illuminated by small, low-voltage lamps, and the whole assembly can be mounted in a compact case with a short lead and a multi-pin connector allowing combinations of units to be fitted into different scoring arrangements.

Illumination of sheets in a pack must be specially arranged. The sheets must be kept close together so that the separation between the last number and the first is minimal, but this means that the small lamps used for illumination have to be positioned on impossibly close centres. Fortunately the properties of clear acrylic plastic are such that it can be bent without affecting the flow of light. Therefore if each sheet is made with an extended tongue the tongue can be bent to allow reasonable housing of the lamp. In a four-sided arrangement, sheet I might have a tongue at the top, sheet II, a tongue at the side, sheet III, one at the bottom, and so on, allowing a suitable disposition of lamps.

It is essential that light from one sheet must not reach another, so hoods must be placed around the lamps, restricting their illumination to the edge with which they are in contact.

In use, the system is switched via a ten-position and off switch. As each sheet is an individual unit, the switch needs only one contact per numeral, even if more than one lamp is used per sheet (this is sometimes necessary for even illumination on larger displays).

There is, of course, a limit to the number of sheets that can be built up in this sort of arrangement, but for the numbers one to zero it is quite possible to distinguish clearly the one at the back despite the fact that it is being seen through nine other sheets all engraved with small holes.

An advantage of any such electrically illuminated counting device is that it relies entirely upon switching for its operation. Very little can go wrong. The worst that can happen in normal use is that a lamp will fail—and this is another good reason, in the edge-lit method, for having two lamps to illuminate each digit. Another advantage with non-mechanical scoring devices is that in operation there is no noise at the display.

Mechanical counters

Mechanical counting devices are more likely to give trouble than purely electrical ones, but nevertheless to ring the changes (or sometimes for reasons of economy) mechanical devices are often used.

In the simplest form a mechanical counter could be a numbered wheel rotated behind a cut-out. Unfortunately this system is limited, because it occupies a disproportional amount of frontal space. For simple displays, however, it offers a cheap and easy solution.

Another simple device is an endless belt of paper or cloth which has been numbered in the appropriate fashion. Pulled past a cut-out, it can be arranged to occupy very little space on the front panel. One disadvantage is that when it is operated from behind, the operator finds difficulty in knowing what is being shown in front. This can be taken care of by putting tiny numbers on one edge of the band corresponding with whatever appears in front. It is more difficult if tens and hundreds have to be included, because multi-digit figures read in reverse order from behind.

A derivative of this system is the belt of numbered cards joined together by cloth hinges. If a belt of this kind is placed over a rectangular block with a horizontal axle the block can be turned through 90 degrees every time a fresh number is required. This formed the basis of the scoring device used in the British version of "What's My Line". The belt of cards was hung below a revolving box, and as the unused part of the belt was in the quiz-master's table, the apparently four-sided box appeared to have ten numbers on only four sides. In this version it was necessary for the box to be self-locating, with the front face that presented the number always in an upright position. This was achieved by having a second box inside the first, but turned through 45 degrees. The corners of this inner box corresponded with the flat sides of the outer one. A heavy rubber ball in the inner box rolled automatically into the corners, where it acted as a counterweight, keeping the outer box upright. Other types of belt arrangements have been used on scoring devices. One had a series of rectangular wooden blocks behind a series of cut-outs. From these blocks ran belts of hinged cards to identical blocks set farther back. A large display of numbers was built up in this fashion. It was found necessary to couple the front blocks to the back ones by sprockets and chains to prevent belt-sag tilting the front blocks.

Such systems as this are usually hand operated from behind, which again makes it difficult for the operator who has to transpose from right to left.

Electro-mechanical scoring methods

Electro-mechanical devices provide some efficient and pleasing presentations for scoring. Typical of these is the falling (or turning) leaf type of display. A drum with thin hinged metal leaves rotates within a housing which supports all the leaves at the top while allowing those below to hang down. It resembles the principle on which all those delightful "What the Butler Saw" peep-shows depended. When the drum is notched round, a leaf from the top swings down, revealing the next numeral, which is painted half on the front of the top leaf and half on the back of the bottom leaf. This system (revolving horizontally) is widely used for numerical clocks in public buildings.

In operation this type of equipment is usually reliable, but for a weekly quiz show the scoring device may have to be moved and

A falling leaf indicator. Remotely operated, it presents a neat appearance with well-designed figures. (*General Signal and Time Systems Ltd.*)

handled frequently, with predictable results. It is also necessary to use this sort of device only in the plane (usually vertical) recommended by the makers.

Problems of design

However clever a scoring device is, its primary function is to convey information. The numerals or letters or other information must be well designed within the space available, which is not always easy. For example, the electric scoreboard discussed at the beginning of this chapter imposes conditions which make good design almost impossible. Most people are familiar with the tortured attempts to show a conventional figure "seven" with this set-up. Olympic games have come and gone using this form of presentation, and it has been interesting to observe the styles of design used.

With the lamp display it is possible to use a diffusing screen in front which softens the crudity of the figures, but only a non-linear lamp arrangement will take care of the design problem.

Other problems occur in designing graphics for use with panel-game devices. Those which "appear" by being illuminated from behind are often unduly softened by the translucent screen in front. This determines their relative size and character, as fuzziness can cause confusion if the characters are too bold. Equally, characters that are too slender lose a high proportion of their contrast. Where characters are set back into machines or are operated behind cut-outs it is particularly important to ensure that parts of the characters are not shadowed by the escutcheon.

Overhead projection

There are many overhead projection machines which, marketed as teaching aids, have been found useful for panel games. They have been used to present material in vision, but more often to present subject matter not seen by the viewer. They can be used in rehearsals where it would be time wasting to set up an elaborate transmission device. Word-game clues can be pencilled in by hand during a run-through, leaving the prepared graphics for the actual show.

These projectors have an optical system situated above a small translucent table, below which is a light box. Anything placed on the table is therefore projected as an enlarged picture on to a screen usually positioned high up and behind the operator. The set-up can be modified to suit other requirements. It can, for example, be coupled with mirrors so that the final display appears as a back-projected picture in front of a desk. For this the graphics must be reversed.

Articles placed on the presentation table (nominally 10 × 10 in) appear as silhouettes if they are solid and with full detail if they are transparent. Thus, special slides or transparencies can be made from inexpensive materials. Self-adhesive cut-out letters may be used to supply caption material, and if words are to be built up in vision stamped-out cork or vinyl letters can be slid around.

It should be remembered that the operator's hand shadows the picture when it passes over the table. Likewise pens and pencils appear as silhouettes. Where information is to move it is possible to use sheets of animation cel or glass sufficiently large to enable them to be operated from outside the illuminated area. If words are to be written in vision and the shadow of pen or pencil cannot be tolerated it is sometimes possible to write the words on a sheet of glass which has first been sprayed with black ink. The words appear as white as the ink scrapes off. A stylo or sharpened piece of wood should be used.

Audience participation

In certain types of programme the studio audience are required to participate by acting as a sort of instant poll. In light-entertainment shows they are asked to vote on such things as the merits of contestants, or performers, or whether chosen discs of pop music are likely to get into the top-ten ratings. In more serious shows they are required to provide comprehensive information regarding the subject under discussion. Sometimes the answers are obtained from a sample of the audience by focusing on those in the front rows, while at other times the entire audience is asked to vote.

One of the first methods of measuring audience reaction (by means other than a show of hands) came from sound radio. A meter which registered the volume or duration of applause was connected to the studio sound system and the results were announced by the quiz-master. When used on television the meter was set up in front of a camera.

There are now many systems with which a director can involve the audience, but before any system is chosen the relevant factors should be fully examined. These factors do not necessarily confine themselves to the programme requirements. Consideration must be given to cable layout and storage, as these factors also dictate the choice of equipment. It is no use having an elaborately wired circuit if the studio management condemn it because the mass of cables cannot be adequately stored after each performance.

One of the simplest systems was designed for use in a programme needing only a sample opinion. Each voter was given a press-button which illuminated a single lamp behind the scenes. As there were only two small rows of lamps, it was easy for an assistant to count those that were alight and to show the total on a simple indicator (in this case a moving pointer on a dial).

To those unaccustomed to television practice this system might seem to border on the absurd, but investigation will show that it is not without merit. For a series of six programmes with only a small budget the cost of the wiring, press-buttons, and lamps was negligible. The assistant (who had other responsibilities besides operating the pointer) was already paid for on the show, and was therefore able without cost to take the place of an expensive piece of electronic equipment. The viewer who saw people in the audience pressing buttons followed by a shot of a dial registering the result was hardly likely to ponder on the method. This was not a deception. It was economical planning.

Such a system is necessarily limited to the number of people whose votes can be quickly counted. Where an entire audience is required to vote, something automatic must be incorporated.

A simple system with many advantages operates by measuring the resistance of a circuit. This circuit is calibrated by the audience, each member of which has a single press button. The buttons are connected in parallel with a suitable length of wire between each

An instrument to measure audience reaction. Operated from any number of push-buttons it shows the "yeas" or "nays" as a percentage of the number of people participating. For television purposes the dial can be calibrated to suit. For dramatic effect it can be projected via an Eidophor unit on to a large screen. *(Votometer—Gt. Britain.)*

and are biased in the normal open position. In each press-button there is a resistor in series with the open terminals. It follows that if the total resistance of the circuit is read by the use of a battery and an ohm-meter the reading can be easily translated into terms of percentages (i.e. with all buttons pressed the meter reading will be at maximum, while with no buttons pressed the needle will point to zero).

The advantages of this system are that only twin flex is called for and that consequently it is easy to connect rows of seats with simple robust plugs and sockets. Also it works on low voltage and is therefore safe.

A further advantage is that, being wired up with lightweight cable, it is easy to handle, and if used with steel-framed chairs it can easily be threaded through the framework with the push-buttons hanging at the side of each chair.

One disadvantage is that when a result is called for all buttons which are pressed must be *kept* pressed in order that a steady meter reading can be taken. The result is unlikely to be accurate to 1%, even when using close-tolerance resistors, but even plus or minus 2% is still usually good enough for this sort of voting.

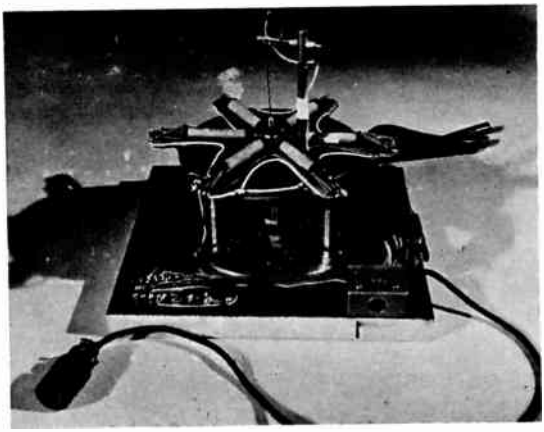
Panel games: interlocks and registers

Contestants in certain panel games register their intentions by using equipment on the table in front of them. Ranging from simple lights and bells to numerical counting devices, these can sometimes involve quite complicated circuitry. One example is the press-button equipment that enables a contestant to indicate that he is first with an answer. In order that there shall be no doubt as to who gets in first, the circuitry must isolate all the other contestants' buttons. When the contestant presses a button relays isolate the other contestants' circuits while switching on a light to indicate the successful person. A bell rings only while his finger is on the button, but the light remains on and the circuit is locked until cancelled by the chairman.

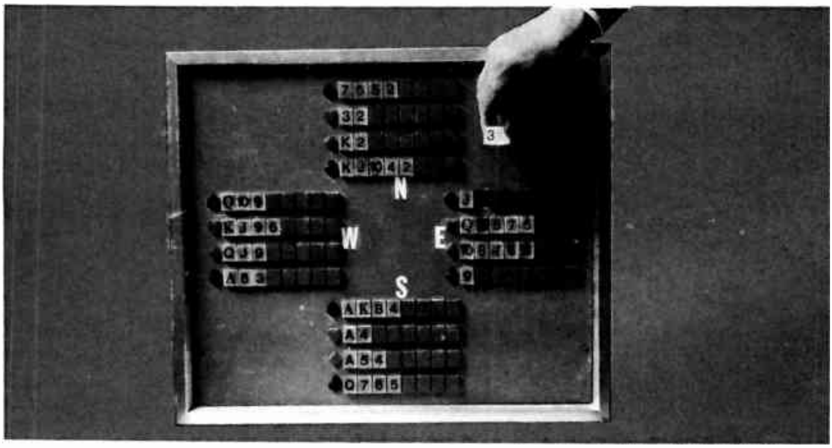
In passing, it is worth mentioning a novel device that was once built for the purpose of isolating one contestant from the others in the manner described above. The selector unit was made from six solenoids, spaced around in a circle. All the cores faced inwards and were placed fairly close together. In the centre of the ring hung a metal slug which formed part of the circuit. Whenever a button was pressed its related solenoid was energized, pulling the slug on to the end of the core, where it made contact. This contact put up a light on the contestant's table and at the same time energized a secondary coil on the solenoid, so locking it on. The circuit could only be broken by the cancelling button held by the quiz-master. It would have been impossible for the slug to contact more than one solenoid core at a time even if all contestants pressed their buttons at exactly the same time. The question of the slug being held in a balanced state between the equally energized fields is academic. It would have been as possible to balance a ball bearing on the point of a needle!

Where bells, buzzers, lamps, switches, etc., are used on desks, care must be taken that they do not place unreasonable demands on desk microphones.

The use of multiple-pin plugs and sockets to connect desks or equipment is to be avoided wherever possible. These things get roughly handled and if they are used for a series can be responsible for a disproportionate amount of trouble.



A selector unit for six contestants. The first to press a button locks-on his own indicator light and makes other circuits inoperable. (See above.)



A method of showing the hands played during a televised game of bridge. The card details are applied to small blocks of Perspex which can be rearranged to suit the hands dealt. These can be seen quite plainly, but when a card has been played the appropriate block is illuminated from behind.

Rear-illuminated read-outs

Many panel games call for "read-out" displays which must be lit from behind to reveal the information. This applies particularly where words must appear one letter at a time. If the "read-out" is away from the contestants it may be constructed without regard to anything other than presentation, but if it is to form part of the scenery or be situated on a desk it will be subjected to lighting conditions which may not be particularly favourable. Front and back lighting must be balanced to give the most legible presentation, but this may mean some loss of definition. Wherever possible, therefore, such displays should be kept away from the main area.

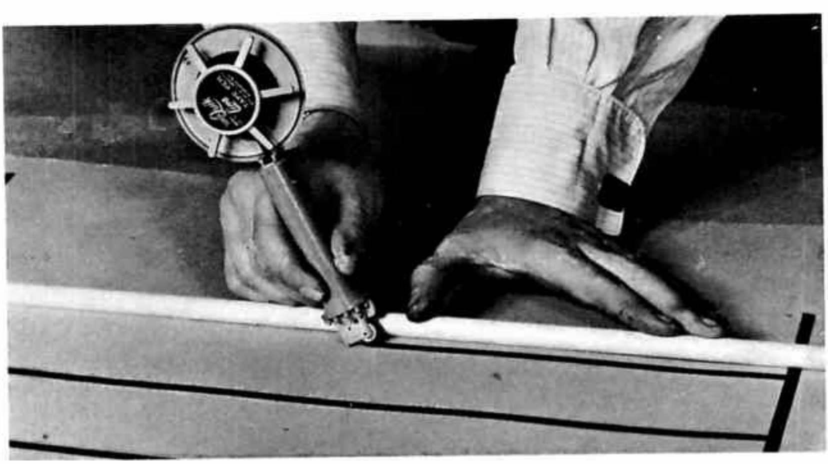
Some games require different symbols to be alternately illuminated from behind, with the additional complication that the symbols must share a common position. For example, in "Noughts and Crosses" it would be necessary for the read-out display to show either a nought or a cross in any of the squares. If the cross and the circle were of the same size, an arrangement of light-tight boxes would have to be constructed so that the parts where cross and circle overlapped could be illuminated for both conditions.

Where symbols must be more complicated they may be presented by using "domestic" 35-mm slide projectors situated behind a screen with their pictures beamed on to a common spot. Switching from one to another changes the symbol.

Some games have special problems. The crossword-puzzle format is a particularly difficult one to present. Remembering that a conventional crossword on paper has only two conditions, white squares and black squares, it can be appreciated that to make black letters appear on an illuminated square that is already white poses something of a problem. One solution that can be adopted is outlined as follows:

Each square consists of a light-tight box, the white squares containing lamps operated from separate switches. In front of this assembly of boxes is a sheet of clear Perspex on which are stuck the letters providing the solution to the puzzle. Covering these is a sheet of opalescent white Perspex to the front of which is applied the crossword pattern of lines, black squares, and numbers. Illuminated by normal studio lighting, the white squares should in fact be a light grey, but the contrast between the black and the grey is sufficient to make it appear as a conventional black-and-white crossword puzzle.

When the time comes for the words to be revealed the operator switches on the appropriate lights, but this time a third condition comes into play. The erstwhile grey squares become white, while the letters, which are in reality shadows, are the same light grey as the squares which are still unlit. This is not too troublesome, however, because the contrast between the letters and their illuminated backgrounds makes the characters seem very much darker than they really are. (This phenomenon can be understood if one



The Quickline tape pen facilitates the drawing of neat lines on graphs and display units. (*W. H. Brady Co.*)

considers a television set operating in a moderately lit room. Turn it off and the black-and-white picture becomes a grey screen.)

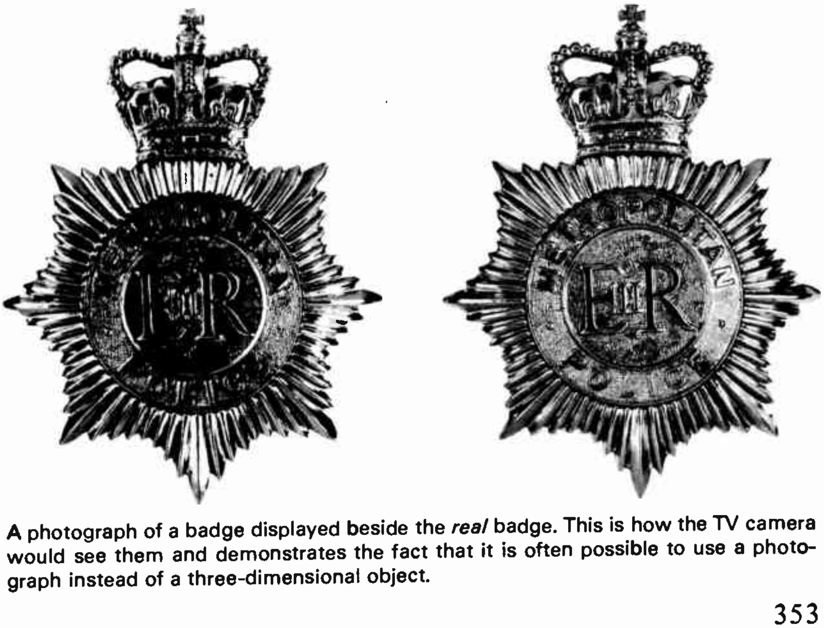
In big displays of this sort there is occasionally trouble from unwanted reflections on the front screen, particularly if it is translucent plastic. The cure is to use plastic with finely modelled surfaces which break up reflections without reducing transmission of light. One such is Perspex Pinspot.

19

MATERIALS AND FABRICATION METHODS

THE special effects man works with a wide range of materials. His props and effects embrace such diverse subjects that he must necessarily be familiar with a variety of processes and techniques. Some of those most commonly used are outlined in this chapter.

In the presentation of items on TV, fabrication methods can sometimes be ultra-simple, particularly if something is to be shown only briefly. For example, photographs are commonly shown purporting to be something else. Scenic backings and oil-paintings are often merely tinted photo blow-ups, but photographs can also be used to simulate three-dimensional objects. An ornate silver picture frame standing on a desk and the brass handles on a coffin have both been screened in this fashion.



A photograph of a badge displayed beside the *real* badge. This is how the TV camera would see them and demonstrates the fact that it is often possible to use a photograph instead of a three-dimensional object.

Expanded polystyrene

Expanded polystyrene is one of those "Whatever should we do without . . .?" materials. The scenic designer concerned with providing a big cave scene is as grateful for this material as is the property maker called upon to produce cut-out snow-flakes.

Expanded polystyrene is purchased in blocks (nominal size 8 × 4 ft). It can be worked in a number of ways by cutting or by heating. When it is required to be carved into shape a long narrow-bladed flexible knife is the best tool to use. It is essential to keep this knife razor-sharp by constant honing. A hacksaw blade, ground and provided with a handle, is an excellent tool for this purpose. Carving should be done patiently, a little being removed at a time. The final finish can be achieved with glass paper.

If parts have to be joined or strengthened, pointed hardwood dowels can be driven in at the appropriate places. For glueing parts together an adhesive must be chosen which will not soften the polystyrene. One such adhesive is Bostik 299. Another is Tretobond 375. Large, laminated blocks for sculpture can be built up by using glue or dowels, but the dowels must not interfere with

Expanded polystyrene was used in this scene to give the appearance of rotting wood.

Expanded polystyrene is used extensively for television property making. The fact that it is exceptionally light means that large items and architectural detail can be included in the set without the need for elaborate fixings.

any work to be carried out later on. The adhesive produces a strong skin, which does not take kindly to being sanded.

Carvings in expanded polystyrene can be surfaced with Artex filler before sanding, but again, care must be taken, because the harder plaster sands at a different rate from the soft polystyrene, leading to an uneven finish.

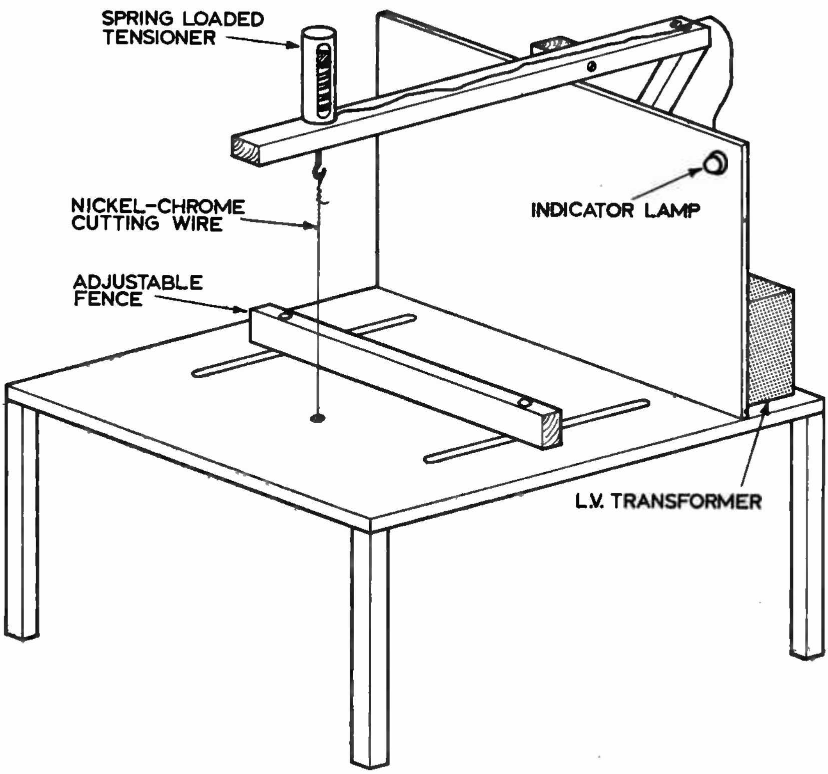
Latex-coated expanded polystyrene used as "stone" blocks.

One method of obtaining a hard, smooth surface is to brush on a mixture of emulsion paint and emulsion glaze. When quite dry this coating can be given a good finish by sanding with wet and dry paper, using plenty of soapy water as a lubricant.

It should be noted that fire regulations govern the use of large amounts of expanded polystyrene in the studio. For rocks and large objects a covering of fireproof muslin or cheese-cloth must be applied under the finishing coat. This does not apply to small objects.

Hot-wire cutting of polystyrene

When it is required to produce shapes or patterns from expanded polystyrene sheet a hot-wire cutter can be used (see below). This operates rather like a bandsaw, but in place of the moving



A hot-wire cutter used for shaping expanded polystyrene. A device of this type can be constructed cheaply and easily and is indispensable where profiled items have to be cut from sheets or blocks.

saw-blade there is a wire which is heated electrically to a temperature just high enough to melt the polystyrene. With such a device it is possible to fret intricate patterns or to cut uniform pieces from blocks.

Hot-wire cutters are often purpose made. To construct a simple one for general use it is desirable to have a horizontal table-top mounted at working height.

Stretching vertically from the centre of this table there should be a length (say 12 in) of nickel–chrome wire. The wire is heated from a low-voltage transformer, and because it sags as it gets hot it must be kept taut by spring loading. This is best arranged by fixing the top end of the wire to an extended overhead arm (rathei like a gallows) which is supported from behind the work-table. At the end of the wire, where it is secured to the arm, there can be a small spring-loaded tube with a single screw fixing, to enable the wire to be replaced easily if it gets broken. Another fixing, similar but not spring-loaded, should be situated below the table to anchor the bottom end of the wire.

It is good policy to have some sort of adjustable guide on the table so that uniform pieces can be sliced off for repetition work.

Hot-wire cutting can also be carried out using a free wire (coupled to the necessary low-voltage leads) with a handle at each end. It is then possible to cut large blocks of expanded polystyrene by pulling the wire through the material by hand. This method produces unusual surface characteristics, because the uneven passage of the wire creates a type of scalloped effect. As it is impossible to control this method of cutting, only rough irregular shapes can be achieved.

Surface finishes on polystyrene

A further method of using heat is to burn away parts of a block with a blowtorch. The texture left after this treatment appears similar to that of natural rock. The surface is also harder than that of the original material, as it becomes glazed with melted polystyrene.

Rocky or uneven surfaces can also be created by painting the polystyrene with acetone or carbon tetrachloride. The material dissolves and runs like snow under a flame-gun.

This rapid dissolution is most useful for some effects purposes. Parts of the human body have been dissolved from within for horror effects, while on other occasions objects have been made from expanded polystyrene to simulate certain materials which have had to "dissolve in acid".

Props made from expanded polystyrene have been sprayed with carbon tetrachloride to produce the illusion of "ray-gun" destruction. This may be done *in vision* if the spray is in the form of fine mist, rendering it invisible to the camera. Such effects should not be carried out in confined areas, because the fumes are harmful if inhaled.

Expanded polystyrene may be given various finishes to make it resemble a variety of other materials. Painted grey, the surface of expanded polystyrene looks remarkably like poured concrete, but it is, of course, fairly fragile, and damages easily. Nevertheless, it has good structural qualities, and in compression will support quite impressive loads.

Certain objects made from expanded polystyrene can be covered with latex and cloth to harden the surface and protect it from damage. The latex cloth treatment can also be used to imitate certain textures. One example is tree bark. Large logs, trunks, and tree stumps have all been made in this way. To obtain a coarse bark texture, strips of cloth or bandage can be twisted and laid on to the expanded polystyrene as the latex is applied.

As a thermal insulator, expanded polystyrene is among the best. Boxes can be lined with it for the storage of dry ice in the studio. It is *not* a satisfactory sound insulator.

Foam plastic

Polyurethane foam plastic can be used in many ways for the manufacture of special props. It is a natural choice for many of the blunt instruments which must be made to resemble practical weapons. Cudgels, mallets, rocks, and any number of other lethal devices can be constructed from this material. It can be finished to resemble many substances, but the porous cellular structure of the surface limits treatment to broad matt finishes.

Foam plastic is also an excellent material for the construction of lifelike dummies. For most purposes it should be applied to a rigid armature of metal rods articulated at knees, elbows, etc. It is easier to apply strips of foam plastic running longways up the arms, legs, and trunk. These can be cemented in position with impact adhesive and trimmed to shape later.

For dummy bodies which have to be placed in predetermined positions (i.e. those dummies which do not have to be flung from cliff tops or windows, etc.) it is possible to apply the foam plastic to an armature of aluminium wire. The inflexible parts of the "skeleton" should be reinforced with rigid rods to prevent the occurrence of bending in improper places. A dummy of this kind may be contorted into various positions to resemble a human body where it would be impractical (or possibly inhuman) to employ a live artist. Dead soldiers impaled on barbed wire, suicides, victims of murder, road accidents—all have been reproduced in resilient foam plastic.

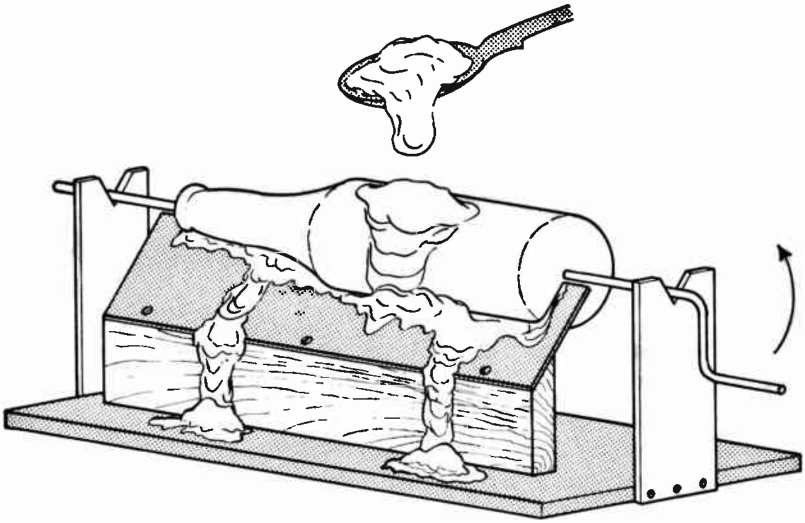
Another method of using foam plastic is in the construction of costumes, where it is laminated over formers which are later removed. Once, for example, it was necessary to make a large prehistoric monster. As it had to appear as a full-size animated animal in a scene with people, it was considered that it should be made up as a costume to be worn by an actor. There were obvious problems, as the "animal" had to be at least twice as tall as a human being. Furthermore, its body and limbs all had to flex in an appropriate fashion.

This is where foam plastic proved to be so useful. It was applied piecemeal to a basic skeleton, consisting of cane and cardboard tubes, most of which was removed once the plastic had become sufficiently self-supporting. The legs and arms formed around the tubes had ample internal space for the limbs of the actor (who entered through a slit in the back) while the long neck and head were supported and controlled by a head-harness worn by the operator.

There were, of course, certain snags. The internal heat rose to unbearable levels (an air-line inserted during non-action times alleviated this). Another snag was that the "blind" actor would occasionally trip over obstacles, falling heavily and requiring the concerted effort of four or five scene men to set him back on his feet! Nevertheless, the foam-plastic construction had a remarkably realistic appearance when all was going well.

Foam plastic can now be obtained in very thin sheets, which makes it possible to cover laminated constructions with a flexible skin. Such covering disguises and softens cruder work underneath.

Plastic foam can prove useful where it is required to camouflage a secret hole or slit. For example, a serving dish shown to be empty was covered in the course of the action. Later when uncovered the dish contained a human head. The bottom of the dish had been made from plastic foam painted to resemble pewter. A hole of suitable size to accommodate the actor's neck had been made in the "dish" and for the earlier scenes the removable centre piece was in



Plaster turning on a revolving mandrel. By using a profiled shape and spooning plaster on to the revolving mass it is possible to produce concentric items such as bottles, columns, bells, etc.

passage of the metal scrapes away all the surplus wet plaster, leaving a uniform shape. In some cases the profile is held stationary while a core of wet plaster is revolved beside it. An example of this might be the method used in making a solid plaster bottle (see above).

A rod which is to become the mandrel is bent at one end to form a crank. This provides a handle which is used to turn the bottle to shape. Next a key is formed somewhere along the length of the rod by soldering to it a piece of twisted wire. The purpose of this key is to secure the plaster which will eventually form around the rod. Next a few turns of bandage lightly wound along the length of the rod act as an anchoring surface, without which the first applications of wet plaster would fall off. The rod is now placed in a horizontal position on a board, where it must be supported by two bearings, one at either end. These are simply pieces of metal bent up at right-angles and fastened to the board. Vee slots cut into the angles suffice to locate the rod while it is being turned. The other item required is the profile, which is cut from a sheet of metal and is fixed to the baseboard at the correct distance from the centre line of the rod.

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Similarly, plastic foam was brought into use to enable a bowl of roses, placed upon a table during the action, to squirt water at a comedian. The water pipe was pushed up through a slot cut in the foam-plastic-covered table. This slot, centred under the open bottom of the bowl, allowed the water tube to be correctly angled for the squirt. Had a fixed tube been used, the trick would have worked only if the bowl of flowers and the actor's face had been precisely aligned.

There are plastic compounds which, when mixed together, foam to several times their original volume before setting. These plastics can be obtained in either rigid or flexible grades. They have their uses, but as yet they have not met with overwhelming popularity in property-making or effects work.

They may be used for packing-out castings which have been made in latex, although care must be taken that in foaming they do not build up such pressure that they distort the rubber casings. The fact that they *do* exert considerable pressure during the foaming action makes these materials difficult to use with plaster piece-moulds. They work well in certain open moulds, and providing a suitable release agent is employed, the moulds may be used several times without damage.

One method of using foaming plastic materials is to pour the mixed chemicals into an ordinary balloon. The balloon is then held firmly in a mould while the action takes place. When the plastic has foamed up and set the balloon may be torn off. This leaves the finished object with a particularly smooth outer surface. The method works only with simple shapes. For example, pressed down into pudding basins, it was once employed successfully to manufacture a number of lightweight Christmas puddings.

Plaster of Paris

In the film industry plaster has always been widely used for the making of props and scenery, but in TV it has never been necessary to use it in the same fashion. Scenery in the TV studio approximates more to that of the stage than the movies. Sets are seldom constructed to the same degree of perfection, and elaborate plaster finishes would not be practical.

Even in the field of property making, plaster is used less and less as other materials are introduced. Expanded polystyrene, foaming plastics, latex—all are now used for many of the things formerly constructed in plaster. However, plaster of Paris is still widely used in the construction of moulds, and methods of making these are explained later in this chapter.

Plaster can be used for breakables such as vases and bottles, cups and saucers, statues and architectural detail. It also features in the manufacture of certain friable materials. For details of these see the chapter on breakables.

Quick-setting plaster is of little use as a filler, but certain plaster-like materials are available which have slower setting times and better working characteristics. Among these are "Alabastine" and "Artex". The latter comes in two forms, both of which are excellent for use in model and prop making. These materials are mixed with water to form a paste which can be applied by brush or palette knife. In a thinner consistency they can be used with strips of hessian or scrim to build up rock or bark textures.

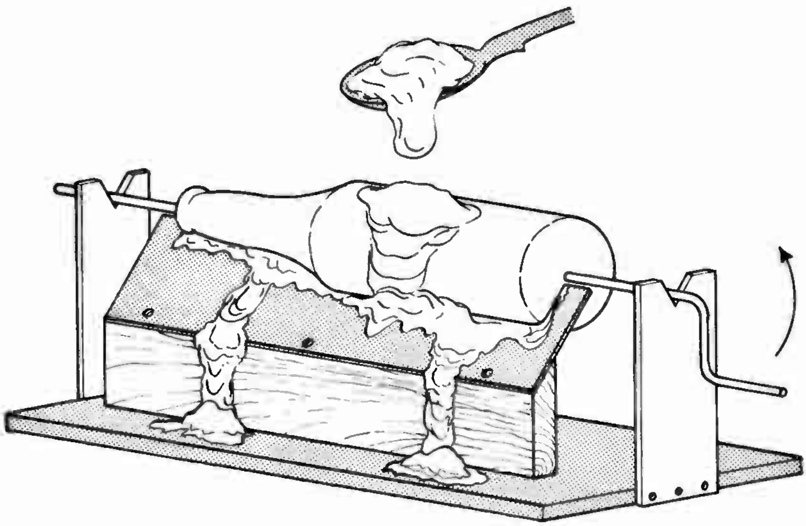
In earlier days studio rocks were invariably made from plaster of Paris smeared on formers constructed from wood covered with wire netting and hessian. These were heavy, fragile, and took a long time to dry out. Nowadays they are usually made from expanded polystyrene surfaced with latex or emulsion paint. Nevertheless, there are still occasions when plaster proves superior, particularly where single rocks must fall to crash heavily.

A disadvantage when using large plaster rocks is that it is impracticable to store them afterwards, and their disposal is both messy and laborious. If expanded polystyrene is used it can be cannibalized when finished with, providing raw material for smaller items.

Plaster turning

A useful method of forming plaster without resorting to moulding or casting is the turning technique. This is employed in the making of such things as plaster columns for models, or in the construction of bells, spheres, or any uniform, circular-based object which might be required.

The method works like this. A profiled shape corresponding to the outline of the object is cut from a metal plate. In one of several ways it is revolved either vertically or horizontally around wet plaster of Paris which meanwhile is being constantly added to. The



Plaster turning on a revolving mandrel. By using a profiled shape and spooning plaster on to the revolving mass it is possible to produce concentric items such as bottles, columns, bells, etc.

passage of the metal scrapes away all the surplus wet plaster, leaving a uniform shape. In some cases the profile is held stationary while a core of wet plaster is revolved beside it. An example of this might be the method used in making a solid plaster bottle (see above).

A rod which is to become the mandrel is bent at one end to form a crank. This provides a handle which is used to turn the bottle to shape. Next a key is formed somewhere along the length of the rod by soldering to it a piece of twisted wire. The purpose of this key is to secure the plaster which will eventually form around the rod. Next a few turns of bandage lightly wound along the length of the rod act as an anchoring surface, without which the first applications of wet plaster would fall off. The rod is now placed in a horizontal position on a board, where it must be supported by two bearings, one at either end. These are simply pieces of metal bent up at right-angles and fastened to the board. Vee slots cut into the angles suffice to locate the rod while it is being turned. The other item required is the profile, which is cut from a sheet of metal and is fixed to the baseboard at the correct distance from the centre line of the rod.

Plaster mix is now poured on to the mandrel, which is slowly revolved. Gradually the plaster builds up until it fouls the profiled metal, which, touching the revolving plaster, acts like the blade of a plane, scraping away the excess material until an article of the desired proportion results.

As the plaster slowly hardens during this process it is necessary to lubricate the material lest the metal profile tears the plaster surface. This lubrication is achieved quite simply by applying water liberally with a brush.

When the finish is satisfactory the rod is removed from its bearers and the plaster is allowed to dry naturally. Later, the protruding ends of the rod are cut away.

For large articles, which would make it impracticable to revolve the plaster, it is possible to adopt a method where the plaster mass remains stationary and the profile is revolved around it. To visualize this, consider the production of a large plaster of Paris bell. Assuming the structure to be formed on a baseboard, an upright tube is fixed to the base longer than the height of the finished bell. Into the tube is placed a rod with enough of it protruding to support the profile (which is welded to the rod).

A similar procedure follows, with wet plaster being heaped around the tube while the profile, revolved by hand, "sculpts" the shape. Again water is applied liberally by brush.

In both the methods described the excess plaster which is scraped off (providing it is still fluid) may be scooped up and repoured over the form.

Plaster moulds

Moulds made from plaster of Paris (or dental plaster) are essential to many of the processes outlined in this book. They are needed for papier mâché work as well as for casting in resin, wax, or latex, and may even be used for the reproduction of articles themselves to be cast in plaster of Paris.

Sometimes the need is for an open mould to reproduce a simple poured article or to lay up papier mâché, while at other times it is necessary to make an enclosed mould of separate sections, known as a piece-mould. This is used for both casting and swilling, and the fact that it is constructed from separate pieces makes it possible for the reproduced article to be removed when set. The number of pieces depends on the shape and complexity of the original. For example, if the reproduction of an ordinary bottle is required a mould comprising two halves is satisfactory. If, however, the bottle has a deep bell in the bottom it is necessary to make a three-piece mould, with one piece on each side and another at the bottom.

The pieces have to be made separately, and must be sufficiently robust to withstand the rigours of casting and handling. They must be neatly made with firm, uniform edges where they butt together, and must have locating toggles to register them when reassembled.

To make a bottle mould the following procedure can be adopted. The bottle is laid on its side, and modelling clay is pressed down all round it until half the bottle is embedded. The top of the block of clay is cleaned up with a knife because it forms one of the butt joints of the mould. The next thing is to prepare the plaster mix.

Plaster of Paris and water, like the materials for a cake, must be mixed with care. To achieve a good mix is absolutely essential. Careless preparation at this stage can easily ruin the mould. Weak points have to be cut out and redone, blow holes have to be filled, and lumps may even break away when the mould is being used. Plaster is best mixed by hand. In this way lumps can be kneaded out and the texture can be better gauged.

Before mixing is carried out it is important to assess the actual amount of material required. Too much wastes time and material. Too little can be disastrous.

Plaster should be mixed in a flexible bowl (polythene will do). This enables any excess material when set to be freed from the mixing vessel without resort to scraping or scouring. The raw plaster must be added to the water—never the other way about! The method most generally accepted as being the best is carried out as follows:

Water is put into the bowl. The amount should approximate to that of the required pour. Next the dry powder is carefully sifted in, using the hands by rubbing them together. This sifting should continue without pause until powder begins to build up above the surface of the water. The moment this happens the mixture has reached the correct proportion, and should then be stirred thoroughly.

As a test to ensure that the ingredients have been adequately mixed and that the plaster is ready to be poured, it is usual to place one finger into the mixture. When withdrawn the finger should be coated with plaster of the consistency of cream. No pink flesh should show through.

It cannot be too strongly emphasized that only the correct consistency will produce a satisfactory mould: too thin and it will run everywhere, too thick and it will not flow into small detail in the master.

To start with, the exposed half of the bottle is given a light

A two-piece plaster mould used for casting a rubber head.

coating of the plaster mix, which should flow nicely over the glass, leaving a firm layer covering the entire surface.

For the purposes of this example it will be assumed that the mould is of two pieces and that the neck of the bottle has been plugged.

The remainder of the mix is now spooned over the plaster already on the bottle until a good, thick, uniform coating not less than 1 in thick is formed. The outer surface of the plaster no longer conforms to the shape of the bottle, but is a rotund lump extending from the bottom to the neck. Plaster correctly mixed sets within a few minutes, and when it is judged finally to have gone off, preparations can be carried out to make the second half of the mould.

When the two halves of the mould are eventually in use there must be some means by which they can be held together in accurate registration; and this need must be taken care of during the making of the mould.

One method is to cut V-shaped grooves (V-shaped from inside to outside as well as V-shaped in depth) in the edge of the first half of the mould. This cutting can be done when the plaster has gone off but is still green. The V grooves form rough, open dovetails that serve as locators. (*Note:* If it is preferred an alternative method of producing locating points can be arranged when the first half of the bottle is covered in clay. In this state it is possible to press into the edge of the clay indentations which will serve to produce lugs on the opposite plaster mould. These in turn will, of course, produce counterpart indentations on the second half of the plaster mould.)

The next step is to invert the bottle and remove the remaining clay. This can be used as a bed which, placed under the plaster half-mould, will cradle the whole thing and prevent it from rolling.

The edge of the plaster should now be given a light wash of thin clay water. This provides a release agent which prevents plaster sticking to plaster.

The second half of the mould is applied in exactly the same way as the first. Fresh plaster is mixed, spooned on to the exposed half of the bottle, and then, when sufficiently thick, allowed to set.

If all has gone well it is a simple matter to tap gently (or prize lightly the two halves of the mould from the master bottle, after which they should be left in a place where they can dry out. Gentle warmth speeds up evaporation, but heat could easily damage the plaster.

During the making of a mould such as the one described care must be taken that the half-mould is not removed from the bottle before the second half has been poured. Once removed it is almost impossible to replace snugly.

Also worth noting is that when glass or china objects are used as masters it is unnecessary to employ a release agent; in fact, to do so can be detrimental. Should any difficulty be experienced in freeing the plaster from the article, the mould should be soaked in water.

The two halves of the mould when dry are ready for use. If the mould is to be used for casting latex or wax the plaster must be left untreated. If, on the other hand, it is to be used for plaster or papier mâché the mould has to be given an internal coating to prevent absorption. Button polish or thin shellac varnish is generally used. For resin reproductions it is advisable to use a release agent recommended by the suppliers of the resin.

When required for use the two halves of the mould have to be held together, and this is done by binding them with a few turns of string or tape, tied in a bow. When stored they are similarly bound with string, but in case they should become separated at any time it is useful to give each an appropriate coding on the outside.

In use the mould has to reproduce bottles in one of the moulding materials already mentioned. Let us assume this material to be wax. It is melted and then poured into the mould, where it is swilled around once or twice and then drained, with the mould standing neck down. It can be seen immediately that the mould has had to be finished with a square end at the neck, in order that it may be stood up without falling over. It will also be appreciated that if molten wax is to be poured into the mould it is advisable to have a large entry hole, preferably funnel-shaped, above the neck. There are two ways of effecting this. One is to cut out the entry hole while the plaster is still green. The other (carried out before moulding) is to make a tapered plug of Plasticine or clay which will not only serve to seal the neck of the bottle but, by extending beyond the neck, form a funnel-shaped entry at the top of the mould.

Flexible moulds

Flexible moulds must be used when rigid-setting materials such as plaster of Paris or polyester resins are to be cast from intricate originals. This applies particularly when the originals have pronounced undercuts. One of the simplest formulas is that used for the well-known "jelly-mould". It is made from Scotch glue or gelatine melted in hot water. When set, this mixture becomes a flexible material rather like a very tough domestic jelly. The degree of toughness is determined by the amount of gelatine added to the water. A high proportion produces a mould almost like rubber. A few drops of carbolic acid or anti-fungicide prevent unwanted mildew forming on the jelly in the event of its being stored in damp conditions; but in fact, since the jelly tends to dehydrate with time, it is scarcely feasible to store such moulds for lengthy periods.

Jelly moulds are used chiefly for reproductions of articles in plaster of Paris, but as jelly moulds dissolve in water, they are attacked by the action of the wet plaster. They will usually produce between six and twelve copies before becoming useless—though this figure naturally depends upon the sort of detail in the original subject. Jelly moulds will reproduce very fine detail, but this coarsens with each pull (reproduction). They should be given a light coating of oil before each pour.

To make a jelly mould, the gelatine or glue should first be soaked in cold water to soften. Hot water should then be added to the mixture and the resulting solution heated and stirred until all the gelatine has dissolved. It should be allowed to cool before pouring.

If the original master is a simple Plasticine device (for example, a medallion) it should be fixed (preferably during the modelling stage) to a sheet of glass or metal. The next step is to place a retaining wall around the master. Plasticine will suffice and should be erected about an inch away from the master. This wall should be high enough to allow a suitably thick mould to be poured. It should also be robust enough to support the weight of the liquid jelly; and to prevent the possibility of the wall's collapsing it should be buttressed with lumps of Plasticine placed at intervals along its length.

It is most important to ensure that the Plasticine is pressed down firmly on to the glass or metal base, because it is possible for the liquid material to seep between the wall and the base as the depth of liquid increases. Usually jelly sets in a matter of hours, and it is then merely necessary to strip the mould from the master.

A material which has been specially developed for the making of flexible moulds is Vinamold. This is a thermoplastic material which needs to be melted in a special container (although small quantities can be handled by gently heating in a thick saucepan over minimal heat). Vinamold, being a bad conductor of heat, needs to be melted very slowly, and the professional equipment which is marketed for use with this material is thermostatically controlled to regulate the rate of melting. If attempts are made to melt Vinamold quickly the outside burns but the centre remains solid.

Vinamold, once it is molten, is poured in the same fashion as for the jelly mould. It is advisable, however, to complete the pour in one operation. Vinamold should be poured not over the master but to one side, in order that the material may flow upwards, filling all detail without trapping air pockets.

The pouring temperature for Vinamold (even when it has been left to cool slightly) is still much greater than that of the jelly, and certain materials are therefore unsuitable for the making of the master object. Where large moulds are involved, Plasticine sometimes bubbles or even fuses with the Vinamold. Nevertheless, where small items are involved and the Vinamold is likely to cool quickly, Plasticine can be used successfully. Clay is a better proposition, provided it is practical to use it.

If a plaster of Paris master is to be used with Vinamold it must be thoroughly impregnated with successive thin coats of a mixture of methylated spirit and shellac. Without this procedure the air which is normally present in plaster expands under the heat of the Vinamold and escapes into the mould, where it mars the surface.

A one-gallon electric heater for melting Vinamold. This is a useful size for an effects workshop where it would be employed chiefly for the moulding of small props.

Vinatex sealer SP99 is a preparation specially developed for impregnation purposes.

Vinamold may be used to reproduce dozens of copies without any noticeable effect on the mould. Furthermore, it will store for long periods without dehydration or shrinkage. It is eminently suitable for use where glass-fibre or cold-cast resin articles have to be moulded.

To limit the flexibility of a mould it is usual to back it with plaster, which both reinforces the overall shape and prevents distortion of the cast when the mould is being used. This combination of rigid and flexible components is referred to as a case mould. It is a simple matter to make the plaster shell for a single-piece open mould. The master (and for the purposes of example we will again assume this to be something like a large medallion) is surrounded by a retaining wall of clay. Vinamold is then poured around the master until it is completely covered. When the Vinamold has cooled the wall is stripped away and replaced by another—deeper, and positioned about an inch outside the Vinamold. Plaster is then poured into this retaining wall until it has covered the Vinamold to the depth of at least an inch. When this has set and become reasonably firm the second wall is stripped away. The assembly is then inverted, the master removed, and the mould is ready for use.

For small open-mould work it is not always necessary to reinforce the mould with plaster, but where it *is* considered advisable a key must be provided between the flexible mould and the rigid plaster. A good method is to drop small pieces of unmelted Vinamold into the molten cast when it is judged to be suitably cool. These knobs will lock into the plaster case as it is poured over the Vinamold.

When the mould is to be a piece-mould of the enclosed variety (for example, one used for the reproduction of bottles or vases), the method of constructing the outer plaster casing is entirely different. This time the plaster is applied beforehand. The bottle is surrounded by a suitable coating of clay (this determines the size, shape, and volume of the final flexible component of the mould and should be about $\frac{3}{4}$ in thick all over). Small rough knobs of clay should be applied to the surface of this casing; they produce cavities in the final plaster case which, when filled with Vinamold, act as keys locking the flexible mould into its plaster shell. The next step is to fix a clay strip all round the clay lump, as when making an ordinary two-piece mould. The strip should run around the bottle lengthwise. Plaster is then spooned over half the lump. Again, a nominal thickness of an inch should be applied.

When this has set, the clay strip is removed and the edge of the first plaster shell has to be notched and given a coating of clay water to prevent adhesion of the second half.

When the second application of plaster has set we are left with the following assembly: a bottle or vase embedded in a lump of clay about $\frac{1}{2}$ or $\frac{3}{4}$ in thick overall, which in turn is surrounded by plaster of Paris about 1 in thick or more. This plaster case is in two halves.

The next step is to remove one half of the plaster case and cut away the clay which surrounds the bottle on that side. With a sharp knife the clay should be trimmed smoothly down to the level of the plaster case which remains.

Next the half plaster case is returned to the bottle to match up once again with the half which is still fixed to the bottle by the remaining clay. The two halves are now bound with string. Before this, however, a hole should have been made in the top of the empty plaster case to receive the Vinamold.

At this point the assembly must be supported in some fashion

A typical case mould. This shows one half of the mould with its flexible Vinamold lining embedded in the firm plaster of Paris case. The moulded head is made from glass fibre and resin.

while the hot Vinamold is poured in at the top. Pouring should continue until the Vinamold flows down the outside of the case.

When the Vinamold has cooled sufficiently the other half of the plaster case and the remaining clay can be removed. The process is repeated in exactly the same way for the other half, and in order to prevent the fresh Vinamold from sticking to the first half it is necessary to dust the edge of the mould with french chalk.

A mould of this type would be used for the production of solid plaster objects or those having to be swilled in plaster or resin. The two halves may also be used separately to produce glass-fibre laminates which will later be joined together by hand.

As well as being a useful moulding material, Vinamold may also be used to simulate other materials. It has a heavy, floppy quality which approximates to that of animal tissue. Consequently, it is possible to cast it in shapes resembling anatomical specimens. As well as having this educational potential, it can be used for such props as comedy pieces of meat. It is, however, a difficult material to colour.

Vinamold has also been used for such props as snakes and fish, and has simulated iron girders which had to bend (for the latter it was cast around copper wire).

When finished with, Vinamold casts can be cut into small pieces and remelted.

Glass fibre and resins

The technique of combining filaments of drawn glass with polyester resin is a well-known one and is used extensivelv in industry.

It produces a tough hard material with an excellent strength-to-weight ratio. This makes it an ideal substance for many TV purposes. The resin, usually supplied as two components, has to be carefully measured, and mixed to manufacturer's directions, after which it is applied straight to the mould by brushing.

This first application is known as the "gel-coat". It must be allowed to "gel" or harden to such an extent that the next application, which consists of resin and glass cloth, does not penetrate the surface, where it would mar the finish.

The glass fibre can be obtained either in the form of woven cloth or as a material known as "chopped mat". This is a sort of pressed cloth which is composed entirely of short lengths of filaments laid in random direction and lightly secured with a bonding material. In its original state it can easily be pulled apart, but once embedded in solid resin it forms an excellent reinforcement.

The glass mat is cut into conveniently sized pieces and applied one at a time to the gel coat while fresh resin is brushed firmly into the material. This should penetrate the air spaces between the fibres and form a suitable coating on the back. If the moulded article must be thick, second and third layers of glass fibre and resin may be applied, but it is wise to allow each layer to gel before the next is added.

Flexible moulds are preferable when using glass fibre, because the resin should harden fully before removal. Laminated glass fibre can be used for a host of special props, particularly those that are required to be durable or strong. It can be cut with a hacksaw, and it can be filed and drilled, but it is a tough material and quickly blunts tools.

Polyester resin can be, and often is, used without glass reinforcement. For small props it is a useful casting material and, if suitable fillers are included, can be made to resemble other materials such as stone or metal. Imitation metal made in this fashion can be polished, after first sanding with wet and dry paper. Polishing is carried out as it would be for real metal.

It is often easier to mould "metal" objects than to fabricate them from the real stuff. An example might be a knife in which the handle and blade would be cast in one operation, the blade being eventually polished and the handle painted. This metal-powder–filler method is extremely versatile, and innumerable simulated metal props have been made in this way. It is quite usual to discover in the property store such items as bronze busts and silver coins made of polyester resin.

Latex moulding and casting

Latex casting liquids can be used for making many of the props formerly cast in plaster of Paris or fabricated from papier mâché. For most purposes it is poured into a dry plaster piece-mould (which should be free of all release agents or surface treatments).

A plaster piece-mould with a suitably large entry hole is filled to the brim with the liquid latex solution. After being allowed to stand for about fifteen to twenty minutes (during which time the liquid should be topped up as the level falls), the latex is emptied back into the can. (This latex may be re-used.) The mould is inverted and allowed to drain for a few minutes, after which it is warmed to a temperature of between 50° and 70° C. This dries the mould and sets the latex. The drying time varies with the size of the object and the thickness of the mould, but will seldom be less than 20 minutes.

The cast rubber article should then be removed from the mould and given a further curing period (at about 70° C) until the article is finally hardened.

Some latex solutions differ from others, and the manufacturers' instructions should always be studied.

Rubber items produced in this fashion have a final colour which is best described as "off-white". They may be coloured with any number of different paints or finishes, both shiny and matt.

The material itself is tough and flexible and is an ideal substance for the manufacture of many types of prop, both large and small.

Besides the semi-rigid white rubber, there is another variety which can be used to cast soft flexible items needing to be thinner and have more elasticity. This other material looks rather like the natural rubber used in the manufacture of such items as baby feeding-bottle teats or rubber gloves. The eventual thickness is governed by the number of pours (just as with the former material), but for the eventual curing it is essential to use an oven. As the heating must be uniform, a large oven is better than a small one.

Rubber items cast in piece-moulds invariably have an obvious "flashing" where the liquid enters the crack between the pieces of the mould. This can usually be removed by a sharp knife which is kept heated. A motorized flexible drive with a small grinding wheel may also be used for cleaning up.

For other purposes latex solution can be brushed on to the

Often required in TV drama are disembodied limbs and heads. The collection of gruesomes shown here are but a few of those used in the course of a year. Made from latex they are frequently re-used in different guises.

surface of such materials as expanded polystyrene, foam plastic, hessian, etc. When dry, such applications will give a tough outer skin to the more fragile materials.

Another use for liquid latex is in the preparation of simulated pools of paint, tar, oil, food, etc. For these it is necessary only to pour the latex on to a non-porous surface such as that of glass or metal. Allowed to run freely, it eventually sets into "pools", which may afterwards be peeled from the glass or metal backing. Given a finish of colour and high-gloss lacquer, such pools can resemble "wet" or messy liquids with such fidelity that they may be freely shown in close-up. The fact that they may be laid down anywhere on floors, furniture, or equipment makes them ideal props for many of the pre-arranged messy scenes. With the right amount of artistry it is quite possible to show such things as burnt milk on electric cookers and spilled paint on expensive furniture. For the former effect the material can be poured directly on to the metalwork, because it can be peeled off when finished with; but for porous surfaces the "spill" should be prepared elsewhere.

Papier mâché

Papier mâché, in common with plaster of Paris, is no longer employed to the same extent as in earlier years. Other materials have proved to be stronger and quicker to work with. There are still uses for this material, however, and the technique is consequently outlined here. Papier mâché is built up in the form of laminations, bonded with a simple paste. It can be moulded into shapes while still wet, and is usually formed in plaster moulds.

The paper (known as sugar paper) is supplied in two colours (blue and grey). These colours are applied alternately, making it easy to see if a whole area has been covered before the next layer is begun.

The paste is made in the conventional fashion from flour and water. Flour is first mixed with cold water into a lump-free thick paste. This is then thinned with warm water and brought gently to the boil until it thickens. Proprietary wallpaper pastes may also be used.

The paper must be torn into small pieces, the size depending upon the intricacy of the mould. Large flat surfaces allow bigger pieces to be laid-up than do small heavily detailed surfaces. The paper should be wetted with paste in the following fashion. The first piece is pasted on both sides using a brush. This piece is then laid on a board, and the next piece, treated in the same fashion, is laid on top of the first. When enough pieces have been dealt with the pile is turned over so that the first one wetted is now at the top. This is peeled off and pushed down by hand into parts of the mould. Further pieces (slightly overlapping) are applied until the first layer is completed. The process is repeated with the alternate colour. Three or four layers are sufficient for most work.

Papier mâché dries to a hard, board-like substance, but it must be removed from the mould before it reaches that state. It will retain its shape when removed from the mould, after which it should be allowed to dry naturally.

Many types of mould or former may be used, but all must be inflexible. Plaster moulds are best, and they should be well coated with shellac on the operational surfaces, which in turn should be smeared with Vaseline before each lay-up.

When dry, papier mâché can be trimmed with a knife or a pair of scissors to remove the surplus material around the edges. Items can be joined by applying pasted paper to the seams. This increases thickness in that area, so the join should be feathered—i.e. built up with strips of decreasing width. Papier mâché can be painted in the same way as any hard paper material can be finished, but thick, slow-drying water-paints will soften it.

Papier mâché was often used for "brick walls" and "stonework" when bullet effects were wanted. It is easy to remove parts by cutting with a sharp knife. These pieces can be replaced over bullet effects if the tiniest pieces of pasted tissue paper are used to hold them in place.

Vacuum forming

Vacuum forming is the process by which sheets of plastic polyvinyl chloride are first heated and then, when softened, drawn down on to a mould by evacuation of the air between the mould and the sheet.

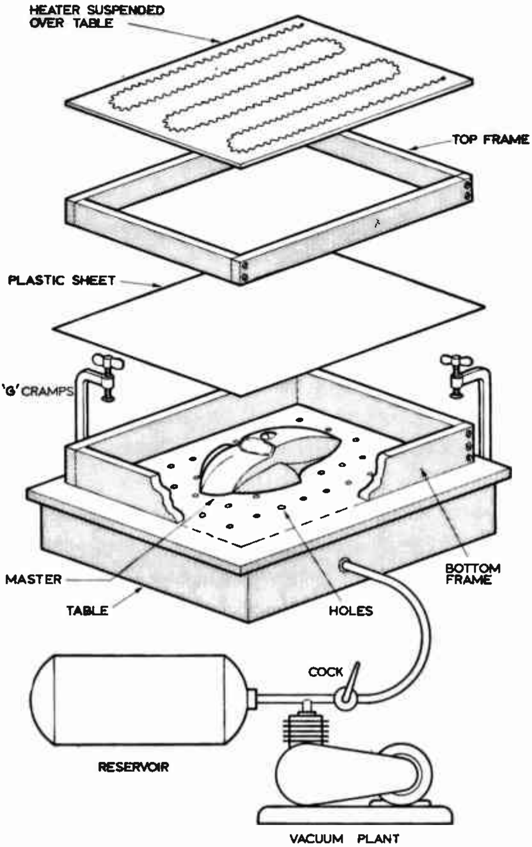
Although many practical and efficient vacuum-forming machines are available, they are usually too expensive to install unless they are to be fully productive. In the effects workshop machinery must be less specialized than this. Therefore a crude plant which will work reasonably well and which can be tucked under a bench when not in use is likely to be more suitable than a sophisticated commercial machine.

A simple plant should consist of three parts—the table on which the mould and the plastic sheets are fixed, a heater placed above the table, and a vacuum plant to exhaust the air from the table (page 377).

For a table, an enclosed wooden box with alternative tops can be built. Sealed all round, it must be air-tight and heavily built. The alternative tops must be screwed to the box with some sort of gasket between the underside of the table and the walls of the box. These alternative tops have holes in different places and are used in different ways. Some support solid male moulds, while others are in themselves female moulds. They should also vary in size; small work demands a small table-top with a small clamping frame for the plastic sheet, while larger work demands correspondingly larger tops and frames.

From somewhere in the box a flexible high-pressure hose must run to the vacuum plant. This plant may be specially built, although as an alternative it is possible to use the air intake of an air compressor. If a piston-type compressor already exists for paint spraying it is a comparatively simple matter to fit it with an adaptor to connect it to the vacuum-forming machine when wanted.

A diagrammatic view of a simple vacuum forming plant. Constructed from timber, this sort of equipment is useful when several small, identical items have to be reproduced in sheet plastic.



If the vacuum plant is to be specially built it should have a motor-driven vacuum-pump arranged to exhaust the air from a suitable pressure vessel. This in turn should be connected to the box via the flexible hose and a gas tap.

When the pump has evacuated the reservoir the tap is turned to the open position and the heated sheet is instantly pulled firmly on to the mould. For medium-sized work the vacuum reservoir is not absolutely necessary. It is possible to connect the air intake of the air compressor directly to the table. The process takes a little longer, but is still quite practicable.

An air-tight seal between the table and the plastic sheet is essential, and for this purpose it is necessary to make some wooden frames which can be clamped to the surface with G cramps.

The top of the box (the work table) should be slightly larger than the box itself. The resulting lip provides purchase for the fixing of the G cramps. Small holes are drilled in the top at intervals to allow the suction to take place. Assuming the mould to be a simple block (wood, metal, or plaster may be used), a rectangular wooden frame slightly deeper than the mould has to be made. The block is positioned in the centre of the table and the frame placed around it. The sheet of PVC plastic is placed on top of this and held in position by a second frame of the same overall size. The assembly is held down firmly by G cramps.

To heat the PVC an electric heater must be fixed (or even held) over the top. It should be of conventional electric-grill design, with the heat being spread uniformly over the entire area.

The sheet softens quickly, and as it sags on to the mould the air must be exhausted, causing the plastic to wrap itself tightly to the mould and to suck itself into any detail that is present. In places where the air might be trapped the mould itself must be drilled to allow its escape.

The plastic may be cooled quickly by blowing compressed air on to it after removal of the heater. In some cases compressed air may also be used to separate the plastic from the mould.

This type of equipment is very useful when rigid half-spheres are wanted. They can be drawn without the use of a mould. The top of the box is fitted with a table in which there is a circular hole. Plastic is put over this in the same way as before, and is again sealed by a frame and cramps. For a free pull of this nature the heating must be uniform. Too little or too much in any one place, and the shape pulls to one side.

For a half-sphere it is sometimes difficult to judge when the material has been sucked in far enough. One method of establishing this is to fix the exhaust tube inside the box in a position under the centre of the table at a depth corresponding to half the diameter of the hole. When the plastic is drawn down it seals the air outlet on touching the pipe. (This, of course, marks the plastic, which is still hot at this stage, and if a mark of this kind cannot be tolerated guesswork must suffice.)

Rigid and semi-rigid plastic sheet

There are many types of plastic material which have become so commonplace that they are known to almost everyone. It can be taken for granted therefore that there is no purpose in making a detailed examination of their merits. Nevertheless, in the field of property-making some are indispensable, while others are seldom used. Polythene is in the latter category. Designed principally as a material to be formed by injection moulding, it offers little in the capacity of a raw material. It is not easy to form or to glue. In thin flexible film, however, it is in everyday use. Also, of course, it is widely used as "dressing". Commercially produced moulded items appear in a thousand disguises, and science fiction would surely wither were it not for the polythene domestic utensils incorporated into sets, props, models, and costumes.

Perspex (and Oroglas) acrylic sheet is a material which falls into the indispensable category. Apart from its obvious use as a substitute for glass, it can be used to fabricate items which need to be lightweight, of clean finish, strong, and rigid. Items made from Perspex and finished with sprayed paint can resemble metal or moulded plastic objects. When working models of technical equipment are required for demonstration purposes Perspex is often chosen as the basic material, because it is easier to work than metal and parts can be assembled by glueing instead of by welding or soldering. "Tensol" cements are specially prepared for use with Perspex, although for certain purposes where very clean joints are required some craftsmen prefer to use pure chloroform.

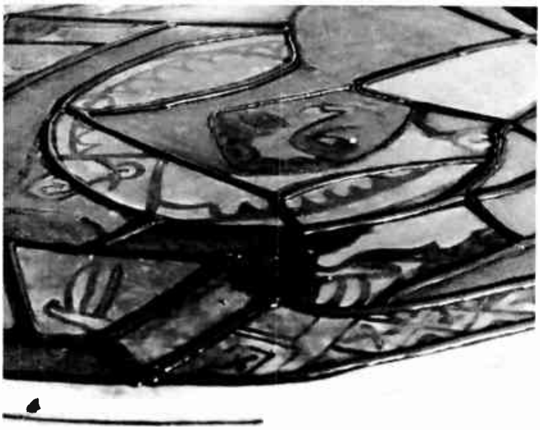
There are two types of pre-formed acrylic tube, cast and extruded. Use of the latter can sometimes lead to trouble. When bonded with chloroform or cements containing highly volatile substances the tubes tend to craze around the joint. In severe cases this crazing can extend the entire length of the tube. There are, of course, many glues or even paints which provide adhesion without crazing, but these are rarely transparent. When the finished article is to be painted the problem of crazing may not be significant. Cast tubes (more expensive than the extruded article) are not prone to crazing.

Clear Perspex (and Oroglas) can be obtained in quite large sheets (10×6 ft are usually available from stockists) and in a variety of thicknesses.

Cobex is a transparent plastic which is more flexible than Perspex. It has a slightly yellow tinge and can be obtained in thicknesses of $\frac{1}{16}$ and $\frac{1}{8}$ in, and a common stock size is 6×4 ft.

Balsa wood

Apart from its obvious use in the manufacture of breakaway furniture, balsa wood is employed extensively in the effects department. It is the material chiefly used in the making of model



A material with potential possibly greater than even its manufacturers realize. Bostik 771 sealing compound is extremely versatile and in constant use in effects work. It can be used to "weld" parts together. It will seal metal tubes into tin cans and as shown here can be used to simulate leading on a stained glass window. Although not marketed as an adhesive it has exceptional qualities in that direction.

buildings. Cut into strips of $\frac{1}{4}$ in sq, $\frac{1}{16} \times \frac{1}{8}$ in, etc., as well as into sheets, it is used to form the skeletal work on which the card and plaster models are built. It is a useful wood because it does not warp, and being light and strong, it allows large structures to be assembled from slender units. It is easy to fix, because its absorbent texture makes a good key for glue. Parts may be held together with pins while the glue dries. The fact that it can be cut easily with a knife means that construction is quicker with this wood than with any comparable material.

Sawdust

Sawdust has been mentioned several times in preceding chapters. It is used in many ways in effects work. Dyed in various colours, it is used to appear as "vegetation texture" for model landscapes. It can be applied to surfaces which must appear mildewed or decayed. Laid on the floor, it can look like snow or sand. Mixed with paint, it can simulate rusty iron. Used with explosives, it flies harmlessly around without producing too much fine dust, and packed into bullet holes it can enhance the shattering effect. It can be used in sacks to represent sandbags, and it can be laid around to soak up water during messy tank or pond scenes. It is invaluable as packing material when transporting wax or plaster breakables.

Fireproofing

In other chapters emphasis has been placed upon safety precautions. Unless the rules are observed, the effects man may find himself in conflict with other personnel in the TV studio. Firemen are naturally concerned with regulations, particularly those relating to fire prevention, and they are generally empowered to test any device or material in the studio for its fireproof qualities. Sometimes, for special purposes, highly inflammable substances are allowed into the studios; these are mostly supervised by the fireman (or if being used in effects, by the effects man). Nevertheless, it is a rule that no material used for normal purposes in the studio should be classified as a fire hazard. This is usually interpreted as applying to any substance capable of sustaining fire. Materials used in effects sequences are not necessarily exempt from the rules, unless of course the intention is to burn them in vision. Some plastics are particularly inflammable. Expanded polystyrene, for example, will support combustion, and large snowstorm effects using this material are considered to be potentially dangerous; there are special fire-retardant grades and these are usually specified when expanded polystyrene is to be used in TV studios.

Models made of balsa wood and card burn quite well, but are seldom considered to be dangerous. More likely to attract the fireman's attention are the log fires for which transparent plastic, electric lights, and smoke-makers are assembled in one unit. Perspex and Oroglas can be obtained in fireproof quality, although they are more expensive than the ordinary grades. Cobex is fireproof in its standard quality.

For the fireproofing of cloth, equal quantities of boric acid and borax should be dissolved in water. (For small quantities a teaspoonful of each to four ounces of water will suffice.) Soaked in this solution and dried, the materials become relatively fireproof or fire retardant. Tests should be carried out before use.

20

CONTROLLING THE COST

It must be conceded that special effects are sometimes difficult to cost. There are usually unknown factors involved. Experimentation may be more costly than the final effect, or it may be necessary to hire or buy special equipment or materials. The effects designer trained to work in this field is able to assess these problems and the implications involved. It is for writers, directors, and scenic designers that this chapter is intended.

Economical use of pyrotechnics

Battle sequences or big dramatic fire scenes may be easier to cost than simpler or more prosaic effects. They are relatively uncomplicated, and the explosives and pyrotechnics employed have known prices. It is merely a matter of determining the extent of the scene to arrive at an estimated budget. It must be appreciated, however, that the total number of pyrotechnics ordered must be at least three times the number required for actual use. Some will be required for rehearsals or experimentation, while others will have to be available for possible retakes.

Pyrotechnics are not excessively expensive items, although some are more costly than might be expected. A single bullet-hit, for example, is at the present time as expensive as a medium-sized maroon or flash-pot. This makes runs of machine-gun bullets an expensive proposition. Furthermore, the cost of wiring adds to the budget, as each bullet effect must be individually connected to a separate length of twin flex, which in turn must be buried or hidden in some fashion, thereby increasing the time involved in the operation. It can be assumed, as always, that time means money!

Although the materials are not prohibitively expensive, scenes of this kind can often become expensive because of hidden costs. For the simplest pyrotechnic set-up it is usually obligatory for two effects men to be present. On location it is necessary for separate transport to be provided to carry the pyrotechnics, and it is also possible that special equipment may be involved. Nevertheless, in terms of screen time battle scenes and fire sequences are relatively economic.

Importance of hidden costs

Hidden costs can often mislead all those concerned (including the effects designer). As an example we can consider the castle wall which must be destroyed. Whether blown up or knocked down, expanded polystyrene would be a natural choice for the simulated stone blocks. However, in order that they should be tough enough to withstand the effect they would have to be treated in some fashion. A coating of latex would be suitable, but as each block has six sides, the time taken to treat each surface might well exceed the cost of the original material. The estimated cost could be quadrupled.

There are many ways in which costs can be adjusted without deviating too much from the original conception. If a vehicle has to be blown up the method described on page 91 would be a reasonably economic proposition. If, on the other hand, it has to be destroyed by actually setting it on fire additional costs would arise from the fact that it would have to be towed to the site (assuming it to be unroadworthy) and also that the burnt-out wreckage would have to be disposed of.

Justifying the elaborate effect

It is equally important to apply this reasoning to those effects carried out in the studio. Assume that a writer wanted to include a comic scene where a cooker had to explode, demolishing part of the kitchen. He would have to decide whether this particular gag was of primary or secondary importance. If it came at the end of a sketch, where all the preceding matter built up to this climax, there would be ample reasons for making the explosion a big and expensive one. The cooker could fly apart, the walls could crash down, and dust and smoke could cover the scene. If, on the other hand, the explosion was just one of a similar series of mishaps it might be more reasonable to confine it to a minimal area and economize on the total cost of the sketch.

It is easy to see the implications in these examples. A big explosion scene demands that the scenery must be specially prepared. It also calls for resetting time. The alternative would be to economize on money and effort and use (to stay with the exploding cooker example) a ceiling drop.

It is worth examining this subject even further. All too often elaborate effects do not justify the money and time involved. The important thing is to examine the results that are wanted thoroughly. To take yet another hypothetical example, we can imagine a scene in which a director requires a man to sink while rowing a boat. Is the eventual product going to be worth a major effort or a minor one?

If the effect required is of paramount importance the director could request a prop that would sink on cue. This in turn would involve the effects designer in the following procedure: He locates a suitable boat which he buys and arranges for it to be transported to his workshop. He devises and fits a suitable scuttling device and tries it out. With so many imponderables a trial is absolutely necessary. This means transport to and from the nearest available pond or river and the cost of the experimental time. Eventually he and the boat are transported to the scene of the location.

By now the costs have begun to rise, but if the eventual scene shows the boat slowly sinking all the effort will have been worth while. Nevertheless, there is always an alternative. If the boat is to appear only briefly and the effect is meant to be comic, the boat can be filled progressively with buckets of water and the time lapse covered by cut-away shots to the actor's face.

It is too trite to say that what is worth doing is worth doing well, but it is as undeniably true in the field of special effects as in most things. Nevertheless, costs and results do not always equate as they do in other activities. The important ingredients are the designer's skill and invention and the director's ability to make full and imaginative use of the facilities at his disposal.

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INDEX