PRACTICAL MECHANICS AND SCIENCE

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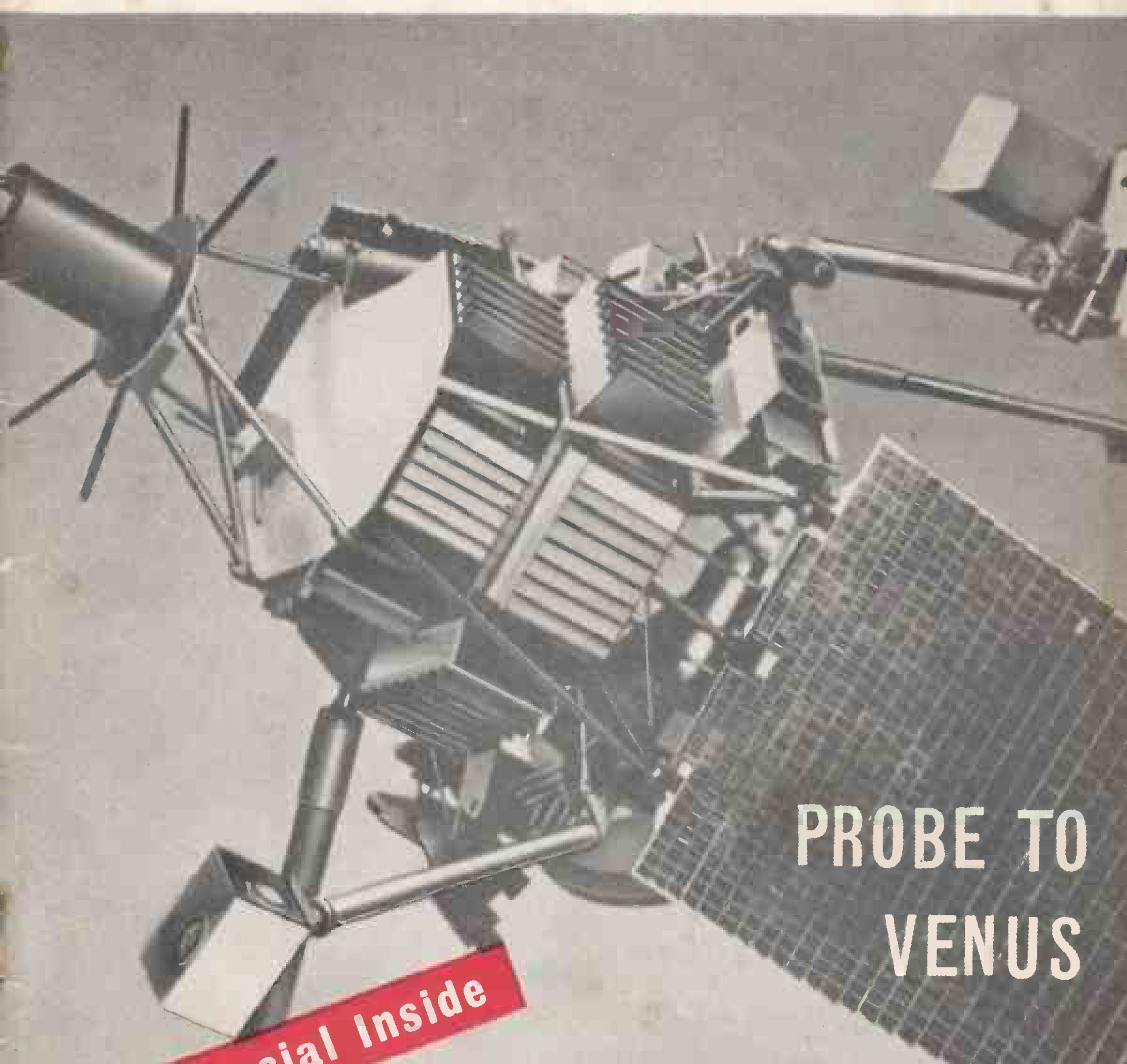

A CAMERA KITE ★ AUTOMATION AND ELECTRONICS ★ MAKING A WET DIVING SUIT

PRACTICAL MECHANICS AND SCIENCE

Vol. XXX October, 1962 No. 342

Editorial and Advertisement Offices
"PRACTICAL MECHANICS"
George Newnes Ltd., Tower House, Southampton Street, Strand, W.C.2.

Phone: Temple Bar 4363
Telegrams:
Newnes, Rand, London

SUBSCRIPTION RATES
including postage for one year

Inland - - - £1 8s. per annum
Abroad - - £1 6s. 6d. per annum
Canada - - - £1 5s. per annum

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CONTRIBUTIONS
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TALKING POINT

Test Tube of History

A PREHISTORIC hundred feet deep shaft at Wilsford, Wiltshire, only a few miles from Stonehenge, which has been excavated by the Ministry of Public Building and Works over two years, has proved to be a veritable giant test tube of history.

The shaft was discovered by accident when excavations were begun on what was thought to be a rare pond barrow. Below the central part of the pond the opening of the shaft was found and digging went on last year down to about 80 feet. This year the work has been completed. The shaft was found to be six feet wide at the top and only four feet wide at the bottom of its 100 feet.

The excavation showed that the shaft had been dug by prehistoric "engineers" in short sections. They used a plumb line and a circular template, Antler picks were used for digging and their marks can clearly be seen today on the sides of the shaft.

The lower half of the shaft, especially near the bottom, was finished by these early workmen by swinging broad-bladed bronze axes. The record of the tools used in the making of the shaft is thought to be the most elaborate and detailed yet discovered and it is far superior to the traces in flint mines such as Grimes Graves in Norfolk.

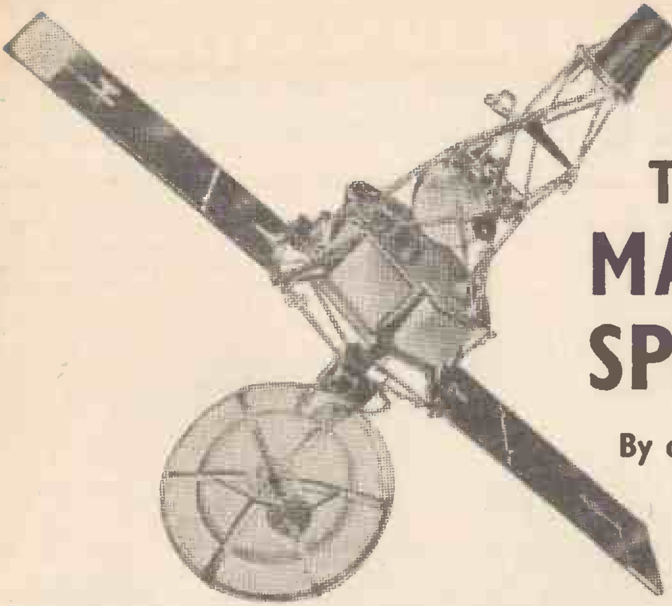
The excavation was carried out by Mr. Paul Ashbee, of Chelsfield, near Orpington, Kent. He was assisted by his wife, Mrs. Richmal Ashbee. Among the most important finds they made were pieces of plaited bass thong and well twisted rope of sophisticated finish. It is believed that this is the only rope known from the 2nd Millenium B.C. to have been discovered in England.

These finds were made in the rubble with which the shaft was filled, in which Mr. Ashbee also discovered Bronze Age urns. At the bottom of the shaft where the infill was waterlogged, Mr. Ashbee found quantities of broken wooden tubs, bowls, scoops and other objects. There was also plenty of rotted wood, twigs, branches, grass, seeds, leaves, berries, insects and fungi.

The excavation revealed that the shaft was filled by natural siltings and a record of the environment of the later Bronze Age —within two centuries of the completion of Stonehenge—has been preserved, a condition that is mainly due to the waterlogging which is unique on the southern chalk downlands.

Excavation of this shaft was only possible with a scaffolding rig, lighting, air pumps and telephones, all installed by the Ministry of Public Building and Works. All-round control was achieved by closed-circuit television supplemented by telephones and tubes. The engineering aids to the conclusion of this outstanding excavation proved to be, in their operation, a complex problem comparable to that faced at Stonehenge. Indeed, many aspects of the work could only be achieved by close co-operation between archæologists and engineers.

The closed-circuit television, without which the work could not have been brought to the present satisfactory conclusion, was loaned to the undertaking by E.M.I. Electronics Ltd. There are considerable potentialities for the application of this technique to archaeological problems. Closed-circuit television will undoubtedly take its place among the modern scientific aids to the study of the prehistoric past.



THE MARINER II SPACECRAFT

By our Science Correspondent

MARINER II, the second of a series of U.S. spacecraft designed for planetary exploration, has been launched successfully. Providing the spacecraft can be maintained on its proper course, it will pass within 10,000 miles of Venus in early December. The Russians, too, it is understood, may be sending a vehicle towards Venus during this same period. In view of this exciting occasion, a description of the Mariner II will be of interest.

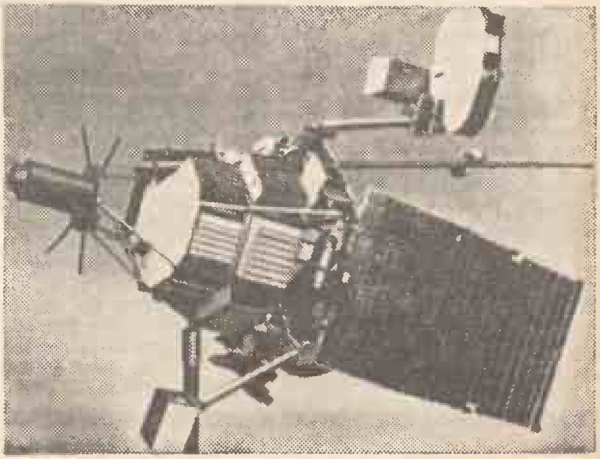
The Mariner weighs 447lb and, in the launch position, was five feet in diameter at the base and 9 feet, 11 inches in height. In the cruise position, with solar panels and high-gain antenna extended, it is 16·5 feet across in span and 11 feet, 11 inches in height.

The design is a variation of the hexagonal concept used for the Ranger series. The hexagonal framework base houses a liquid-fuel rocket motor, for trajectory correction, and six modules containing the attitude control system, electronic circuitry for the scientific experiments, power supply, battery and charger, data encoder and command subsystem, digital computer and sequencer, and radio transmitter and receiver. Sun sensors and attitude control jets are mounted on the exterior of the base hexagon.

A tubular superstructure extends upward from the base hexagon. Scientific experiments are attached to the framework. An omnidirectional antenna is mounted at the peak of the superstructure. A parabolic, high-gain antenna is hinge-mounted below the base hexagon. Two solar panels are also hinged to the base hexagon. They fold up alongside the spacecraft during launch, parking orbit and injection and are folded down, like butterfly wings, when the craft is in space. A command antenna for receiving transmissions from earth is mounted on one of the panels.

The solar panels contain 9,800 solar cells in 27 square feet of area. They will collect energy from the sun and convert it into electrical power at a

Another version of the Mariner spacecraft but showing the same basic layout. Spacecraft are continually being modified in the light of experience with others.



minimum of 148 watts and a maximum of 222 watts. The amount of power available from the panels is expected to increase slightly during the mission due to the increased intensity of the sun. Each solar cell has a protective glass filter that reduces the amount of heat absorbed from the sun, but does not interfere with the energy conversion process. The glass covers filter out the sun's ultra-violet and infra-red radiation that would produce heat but not electrical energy.

Prior to deployment of the solar cells, power will be supplied by a 33·3-pound, silver-zinc, rechargeable battery with a capacity of 1,000 watt-hours. The recharge capability is used to meet the long-term power requirements of the Venus mission. The battery will supply power directly for switching and sharing peak loads with the solar panels, and also supply power during trajectory correction when the panels will not be directed at the sun.

The power subsystem will convert electricity from the solar panels and battery to 50 volt, 2,400 cps ac, and 25·8 to 33·3 volt dc.

Two-way communication aboard the Mariner is provided by the receiver/transmitter with its antennas; the omnidirectional and high-gain antenna; and the command antenna for receiving instructions from earth. Transmitting power will be 3 watts.

The high-gain antenna is hinged and equipped with a drive mechanism allowing it to be pointed at the earth on command. An earth sensor is mounted on the antenna yoke, near the high-gain dish-shaped antenna, to search for and keep the antenna pointed at the earth.

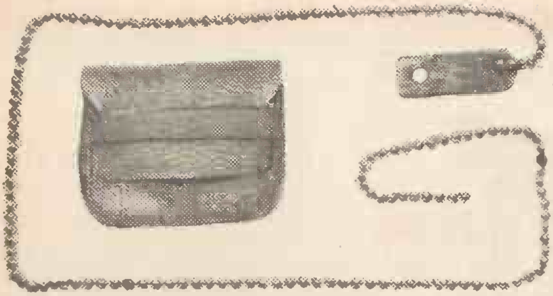
Stabilisation of the spacecraft for yaw, pitch and roll, is provided by ten cold gas jets, mounted in four locations (3,3,2,2), fed by two titanium bottles containing 4·3lb of nitrogen gas, pressurised to 3,500 PSI. The jets are linked by logic circuitry to three gyros in the attitude control subsystem, to the earth sensor on the parabolic antenna and to six sun sensors mounted on the spacecraft frame and on the back of the two solar panels.

The four primary sun sensors are mounted on four of the six legs of the hexagon, and the two secondary sensors on the backs of the solar panels. These are light-sensitive diodes which inform the attitude control system—gas jets and gyros—when they see the sun. The attitude control system responds to these signals by turning the spacecraft and pointing the longitudinal or roll axis, towards the sun. Torquing of the spacecraft for these manoeuvres is provided by the cold gas jets fed by the nitrogen gas regulated to 15 pounds per square inch pressure. That is calculated to be enough nitrogen to operate the gas jets and maintain attitude control for a minimum of 200 days.

Computation for the subsystems, and the issuing of commands, is a function of the digital Central

(Continued on page 46)

Technicians complete a checkout of a Mariner spacecraft prior to installing it on an Atlas - Agena B rocket. The 447lb package contains instruments to measure the temperatures on Venus and study magnetic fields and charged particles in interplanetary space.



CLOSE-UP PHOTO MEASURING DEVICE

A. E. BENSUSAN

PARTICULARLY since the public interest in colour photography has increased so much over the past two or three years, the ability to take close-up photographs in colour of, say, single large flower heads, or relatively small groups of more diminutive ones, has become correspondingly important. Three separate strengths of close-up-lens attachments are available from all photographic dealers at less than 5s. each. Between them they cover the entire range of distances which most cameras cannot accommodate unaided. The coverage is, in fact, from 40 to 9⅝in. when the camera focusing scale is engraved from infinity to 3ft. The No. 1 lens permits a distance of 40in. from the close-up-lens attachment to the subject when the camera is set to infinity and 18½in. when set to 3ft. The No. 2 lens is for use at 20in. when the camera scale reads infinity and 12¾in. when at 3ft. Finally, the No. 3 lens attachment works at 13 and 9⅝in. when the camera is adjusted to infinity and 3ft respectively.

It is important to realise that all distances are measured from the attachment to the subject, the type of camera, aperture and focal length of its basic lens having no bearing whatever on the matter. The size of the negative and the focal length of the camera lens do, however, affect the area covered by the combination. This coverage is best found in individual cases by photographing a ruled chart, graph paper or other easily measured flat subject at the required ranges and then comparing the number of divisions shown on the resulting negatives with the original subject.

The principal difficulty in using close-up lenses is that of making certain that the camera is at the correct distance from the subject when fitted with a close-up attachment. To carry a rule or tape measure is seldom convenient and the use of the device shown is a far better proposition for consistent accuracy, particularly since the depth of field obtained, even at small apertures, is extremely limited at short ranges. Errors in judging distances are all too obvious on the negatives.

The writer has found that he generally needs to use only the nearest and furthest focusing distances attainable with the lens attachment since intermediate settings have little effect on the image size obtained on the negative. Furthermore, I use my No. 2 lens attachment far more than the others in the series. The device shown here therefore accommodates only these requirements, but modifications to suit other needs is simple and will be described later.

A connecting plate (Fig. 2) is made up from aluminium alloy or brass of approximately 16s.w.g. To this plate, at the end furthest from the hole, is attached the last two links of a length of bead chain. Araldite or a similar epoxy resin adhesive is the simplest means of attachment. The bead chain can be bought by the foot from larger builders' merchants. Smaller shops usually stock it only in short, cut lengths with plug and sink fittings at the ends. The beads are about ⅛in. diameter, nickel or chromium plated, so they require no rustproofing treatment. It is advisable to have the chain a little longer than is actually needed as this makes it easier to use.

The chain can be fitted to the camera as shown in Fig. 1 or with the connecting plate trapped between the camera and a tripod head. The screw passes through the hole in the plate and provides positive location. At the appropriate distances, which must be measured from the close-ups lens itself, the two beads which represent those distances with the chain fully extended are painted a bright colour. It is only necessary to extend the

(Continued on page 9)

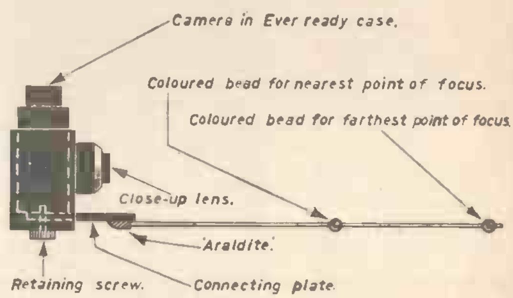


Fig. 1.—The device attached to the camera.

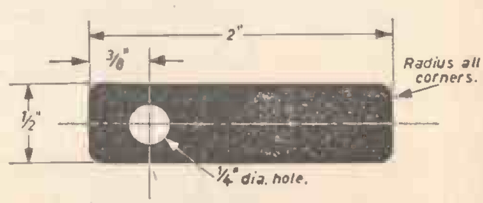


Fig. 2.—The connecting plate.

LATHE GADGETS

Part 10

INDEXING GEAR 2

By L. C. MASON

THE mandrel indexing gear already described (September issue) provides for locating round a job most of the normal number of points likely to be required.

However, the author recently encountered a dividing job where two sets of points were required, one a ring of 16 holes and the other of 24, both in the same job. Reference to the table given before shows that neither of these is possible using a change wheel from the standard set. These and many other more awkward numbers are available by bringing into use an additional pair of wheels. In this way factors of the required number can be utilised as gear ratios. Some examples will serve to illustrate the idea.

The number 24 was quoted above, which is not forthcoming from a single wheel. However we can get 12 from the 60 wheel. If therefore, we set up a wheel which will produce 12 divisions and then gear down 2: 1 to halve each of those 12 divisions, we shall obtain the required 24. Retaining the 60 wheel to index round, if we mount a 40 wheel say, on the mandrel and gear a 20 with it, we get a 2:1 ratio down. Now, if the 60 wheel is keyed to the 20 on the same stud and we index round the 60 every fifth tooth as before, we shall get only half the 60 wheels circular movement on the mandrel, as it is geared down 2:1. One revolution of the 60 wheel gives the 12 points, but the mandrel will have turned only half a rev. for those 12, requiring a second rev. of the 60 wheel to complete one turn of the mandrel. That is, it needs 24 indexings round the 60 wheel in two revs. to complete one turn of the mandrel, which is thus indexed at 24 points.

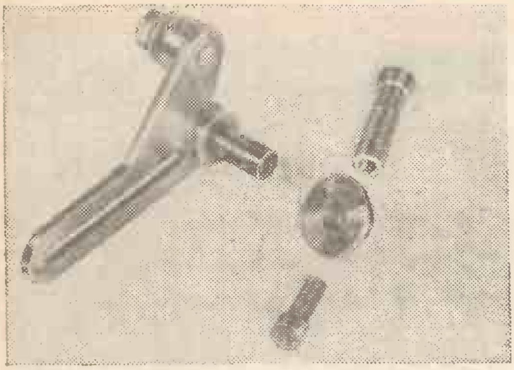
For another example, suppose 28 divisions are required. While that is unobtainable direct, we can get 14 from one wheel, indexing round every 5 on the 70 wheel. Therefore we need only gear down 2:1 with the 40:20 pair (or 50:25) as above, and we get the doubled 14 to produce 28. The same principle applies to a number like 39. One factor of 39 is 13, which we can get from indexing every 5 round the 65. A 3:1 pair down from the mandrel in the shape of the 60 and 20 wheels, indexing 3 times round the 65 gives $3 \times 13 = 39$.

There are in fact hundreds of combinations possible by gearing in this way to provide the most unlikely numbers. Should 72 be wanted—72 is amongst other things 12×6. We can get 12 from the 60, so indexing *every* space round the 60 we need to gear down 6:5 for 72. A 30:25 pair does it, giving 1 1/5 revs. of the 60 to provide the 72 in one mandrel rev. The following table shows some of the more obvious numbers using an additional pair of gears in this way:

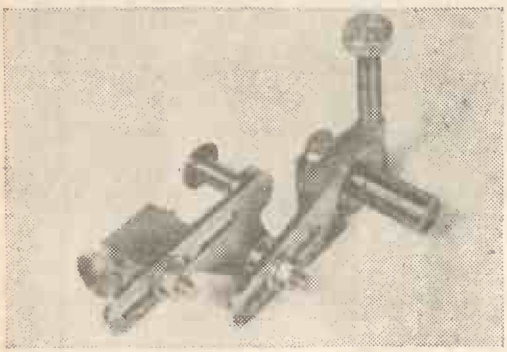
No. Divsns.	Mandrel Wheel	Second Wheel	Index Wheel	Index Every
16	50	25	40	5
18	40	20	45	5
21	60	20	35	5
22	40	20	55	5
24	40	20	60	5
26	40	20	65	5
27	60	20	45	5
28	40	20	70	5
32	40	25	60	3
33	60	20	55	5
36	45	25	60	3
39	60	20	65	5
42	60	20	70	5
44	40	50	55	1
48	40	50	60	1
49	35	50	70	1
52	40	50	65	1
54	30	25	45	1
56	40	25	35	1
57	60	20	38	2
63	35	25	45	1
* 64	40	25	40	1
66	30	25	55	1
72	30	25	60	1
76	40	20	38	1
77	35	25	55	1
78	30	25	65	1
80	50	25	40	1
84	35	25	60	1
88	40	25	55	1
90	40	20	45	1
96	40	25	60	1
98	35	25	70	1
99	45	25	55	1
100	40	20	50	1
180	75	25	60	1

* A possibly useful number, requiring a second 40.

The easiest way to obtain some numbers is to gear *up* to the mandrel, indexing round only part of the index wheel. In that case the gear ratio required is in the same proportion as the number wanted to the indexing wheel. Forty-four divs. provides a case in point, as will be seen from the table above.



Dividing attachment bracket for compound dividing, with modified drawbolt.

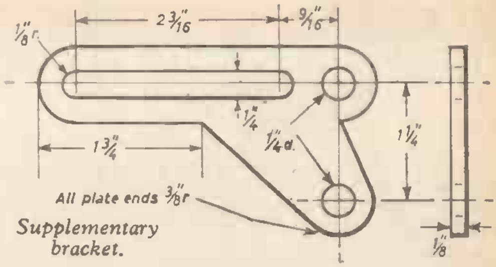


Mandrel dividing attachment with bracket added for compound dividing.

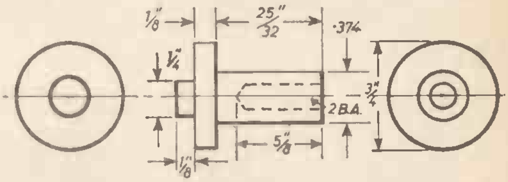
The easiest way to provide for the second pair of wheels as an addition to the simple attachment is to have a bracket to take the place of the original detent block, which can provide for the additional wheels and a slot for the detent block—now transferred to the bracket to index round the outer wheel of the extra pair.

The bracket needs a stud for fixing it in the slot of the main piece and also a collar to space the bracket out so that the inner wheel of its pair will mesh with the one on the mandrel extension. This stud and collar can very well be combined in the one piece, a simple turning job, which can be either brazed, silver-soldered or riveted to the bracket. The nut on the stud holds the upper end of the stay in exactly the same way as did the nut on the detent block formerly in that position. The bracket stud for the new pair of gears duplicates the ML7 change wheel stud so far as wheel mounting is concerned and like the other fixed stud can be riveted or brazed in place. The sleeve on which the wheels are keyed together can either be borrowed from the lathe or a duplicate made up especially for the indexing gear. The latter would probably save time in the long run.

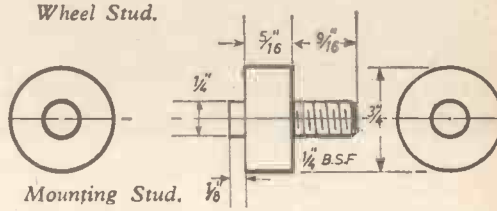
The proportions of the bracket and its slot are designed to allow for mounting any combination of pairs of gears to be found in the standard Myford change wheel set. If it should be desired to make



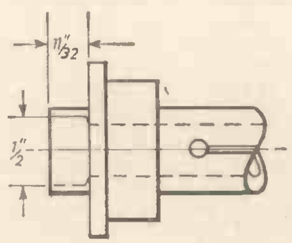
Supplementary bracket.



Wheel Stud.

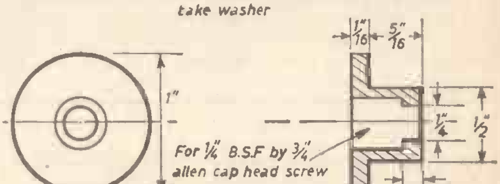


Mounting Stud.

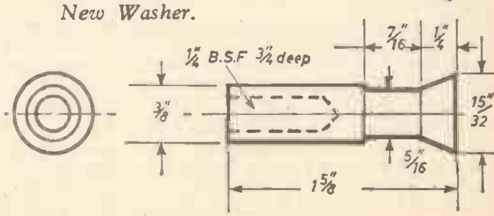


Modification to Mandrel extension.

Open out 3/8 bore at wheel end to 1/2" dia. X 11/32" or 3/8" deep to take washer



New Washer.



Modified Drawbolt.

Compound dividing attachment set up for 24 divisions; 40t wheel on mandrel, meshing with 20t wheel keyed to 60t indexing wheel.

use of non-standard wheels larger than any of these, the bracket dimensions can be enlarged accordingly. The detent in its block is moved to the slot in the extra bracket and used in exactly the same way as on the simple fitting. In those set-ups featuring a 2:1 gear down with either a 40:20 or 50:25 pair, it will be found that the largest index wheel that can be accommodated on the bracket stud is a 45, as larger sizes foul the nut holding the mandrel wheel. This restriction can be overcome by a modified type of drawbolt, in which the nut is replaced by a $\frac{5}{16}$in. B.S.F. Allen cap screw, tapped into the end of a shorter bolt. The screw head is accommodated in a recessed washer which holds the mandrel wheel, leaving only the washer thickness outside the wheel over which any size indexing wheel is then free to swing.

With this arrangement the plain $\frac{3}{8}$in. bore at the wheel end of the extension piece requires opening out to $\frac{1}{2}$in. diameter by $\frac{3}{8}$in. deep to accept the projection on the washer. The photo and drawing show this modification carried out.

Setting up for using the combined fitting for compound dividing follows the same procedure as for the single stage version, except that as the stay is now held at the top by the bracket attachment stud, the whole fitting can be mounted up for use with the stay nuts both tight before adjusting the position of the detent block. Adjust the mesh of the mandrel and second wheels by positioning the bracket before tightening the bracket nut.

When used in this way for compound dividing employing three wheels, it is advisable to adopt a regular sequence of operations when moving round to the next station. A slight amount of backlash between the gears is unavoidable if they are to run smoothly, but this can be cancelled out by a systematic routine. Some such way of working as the following is therefore advised: on completion of the work at each location, slack off the mandrel clamp nut sufficiently to allow the mandrel to turn. Screw the detent back to clear the indexing wheel and turn the *Indexing Wheel Only* to the next station, allowing the mandrel to be turned through the gearing, which will take out the backlash always in the same direction and to the same degree of loading. Turn the indexing wheel slowly and when the chosen tooth space is almost opposite the point of the detent, start to run the detent into the space. In this way, when the detent is properly home between the teeth, the indexing wheel will have turned no more than is absolutely necessary to arrive at that location and there will be no slack anywhere in the train through the indexing wheel having over-run its true position.

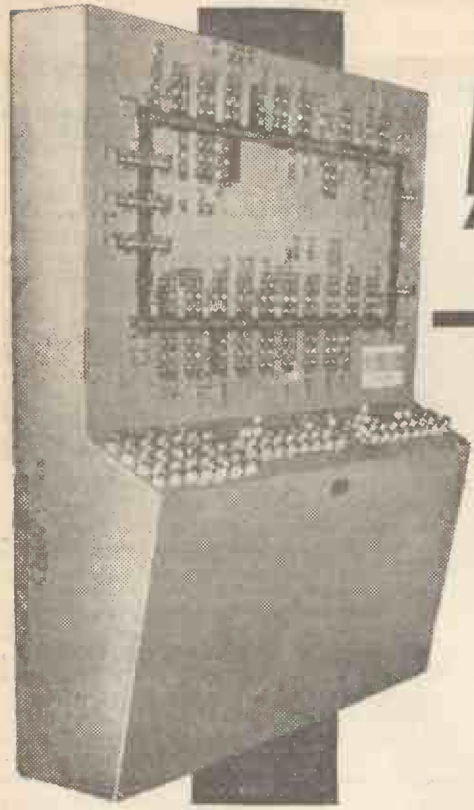
If you do over-run a position in moving round, turn the indexing wheel back towards the previous station till the mandrel is seen to move, then re-select the new position, taking care not to repeat the over-run.

CLOSE-UP PHOTO MEASURING DEVICE

(Continued from page 6)

chain and move the camera until the required bead reaches the plane of the subject for the range to be automatically correct. If marked beads are needed to cater for all three close-up lenses the pairs defining the near and far distances for each lens may be painted different colours and matching colour spots put on the mounting of the lenses. This type of colour coding makes quick working a matter of routine.

A tuck-flap case to hold the device when not in use can be made up from scraps of leather or P.V.C. coated cloth. Alternatively a large-size filter case of similar design may be bought from a photographic dealer.



AUTOMATION AND ELECTRONICS

by D.S.C. Fraser

Control console of the 76-station transfer machine described in the article.

ENGINEERING design, in the form of automation and electronics, has made the working man's job in America today, easier, more satisfying and interesting. But wait—look what is happening to the tools he works with!

To machine a 6 lb power-steering pump-housing for motor cars, for instance, one of the larger motor car manufacturers uses a 620,000 lb machine.

If all the wires in this machine were spliced together, the wire would cover a distance of over 90 miles. More than 3,600 individual wires have a total of 20,973 connections. To perform the 220 machining and inspection operations required, the 6 lb housings travel through the machine a distance of 250ft supported by 72 1,000 lb "holders".

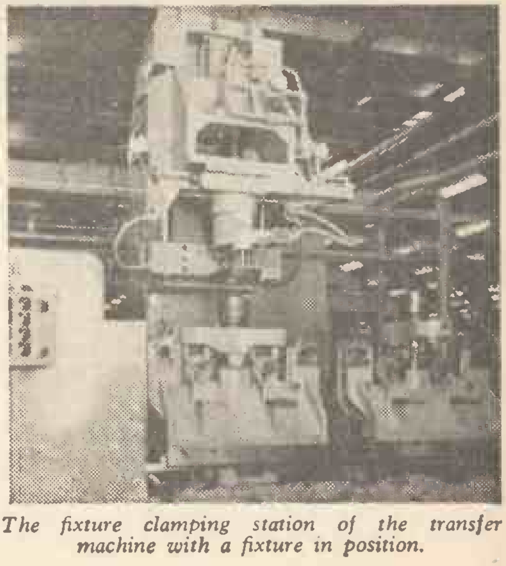
The machine has 115 electric motors, adding up to more than 500 h.p. Fifty-one of these motors run hydraulic pumps that operate 229 hydraulic cylinders that power the machine movements.

Transfer machines are commonly thought of as performing only related operations. This 76-station, closed-loop, palletised transfer machine, however, includes drilling, reaming, tapping, recessing, face milling, wire brushing, surface generation, precision boring and assembly among its 220 operations. In addition, each power-steering pump-housing is automatically gauged and marked so it can be assembled with mating components.

Another type of American machine tool to favour the working man — the offspring of the marriage of the automatic machine and the computer's electronic "brain"—may increase output per man-hour at a startling rate in some operations in the years ahead.

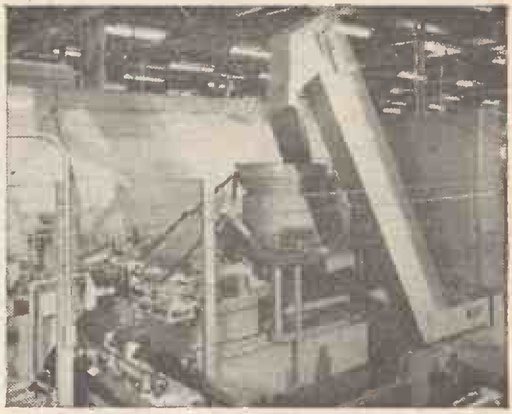
The unique feature of this type of machine tool is "numerical control", a term that means control of the automatic machines by magnetic tape, punched tape, punch cards, or electronic plates (a variation of the punch card method). The numerical control system, its inventors say, can be applied not only to metal working tools, but to machinery in textiles and practically all industries.

The numerical-control machine tool needs an operator to show it only once how to do an intricate job. In the process, its computer brain jots down symbolic numerical notes, and therefore the machine can work automatically from "memory", or learn a new task just as quickly. Where it takes a day to "set up" an ordinary lathe, or other machine tool, before it can begin turning out parts, the controlled machine tools can be ready to work in minutes, switch easily from one job to another.



The fixture clamping station of the transfer machine with a fixture in position.

General view of the entire transfer machine.



The bushing assembly station and feed mechanism.

The numerical-control devices, which are akin to those used in guided missiles, are more accurate than previous control systems. Some can correct tolerance to one ten-millionth of an inch.

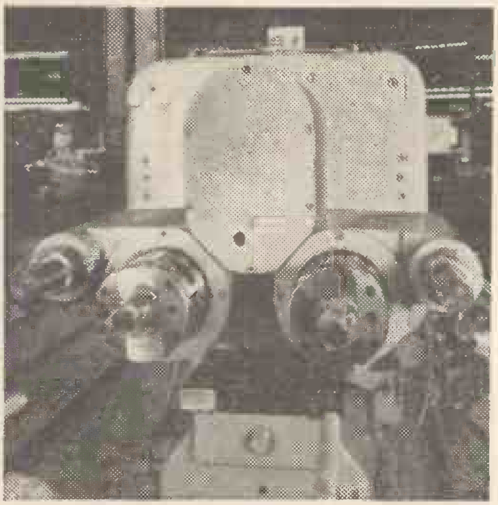
The controls are usually operated by "directions" or a "programme" punched into a paper tape. The directions cause the machine's cutter, or its positioning table, to move in the paths necessary to cut away the required metal. These paths are laid out with numbers plotted directly from blueprints. The direct translation from blueprints saves slow and costly making of patterns, jigs and fixtures which guide tools.

In contrast with what is called automatic control, the new type of numerical electronic control tells the machine exactly what to do.

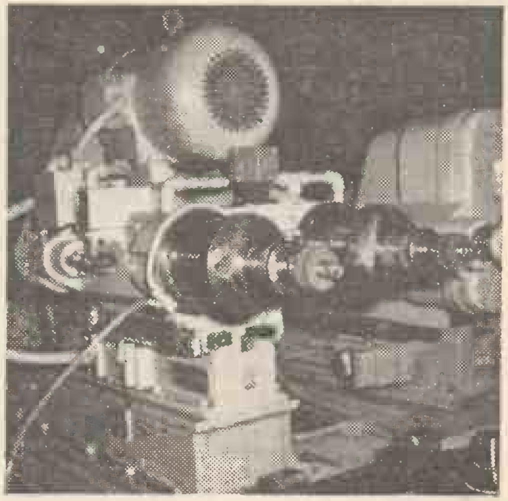
The head of one machine tool company said that some "numerical control" machines speeded production fifty-fold. Another of the new machines—one designed to produce dies for presses and forges—can turn out the complex cavity of a forging die for an automotive steering knuckle in 40% less time than the conventional method.

The new machines are still expensive, with about one-third of the total cost represented by the control. One American firm recently installed a large numerical-control machine to bore holes and machine surfaces on big tractor main frames. It cost $150,000. Their production engineer estimated that a standard machine to do the job would have cost $55,000 plus $36,000 for two fixtures to guide the tool. But additional machines would have been needed for the other machining operations, along with more floor space and more machining time. Because of these factors his firm decided to buy the more expensive numerical-controlled machine.

No wonder that the American working man's job has become easier, satisfying and interesting.



The recessing station showing the rotary recessing cutters end on.



The wire brushing station showing multiple wire brushes on two shafts.

PART 2

Direction Finding Receiver

by E. V. King

Getting Better Sensitivity of Radio Beacons

To get better sensitivity all round the dial the padder TC5 is used. If a station is received with the vanes closed, "peak" it up by rocking the condenser vanes very slightly while adjusting TC5 for loudest signals. When a station is received with the vanes open do not rock the condenser but adjust TC3 and TC2 for best results. Repeat two or three times.

Finally, when left the receiver should have been peaked up with the vanes in, using TC5, and the shorter side with the vanes out, using TC1 and TC2. These adjustments are critical, require care and patience, and it is useless to proceed unless they are done correctly.

Alignment Data

The above explanation is for non-technical readers. For those with the necessary knowledge or those who can obtain the help of a friend with a signal generator the following service instructions will suffice:

Medium Wave Band (Adjustment).
- Tracking points at approximately 600kc/s and 1,400kc/s.
- Trimming with TC1, TC4 and core of L5 for coverage.
- Padding by coil position on ferrite rod.

Radio Beacon Band (Adjustment).
- Tracking points 286 and 312kc/s.
- Trimming with TC3 and TC2.
- Padding with TC5.

I.F. Frequency.
- 470kc/s.

Making the B.F.O. Unit

The wiring is seen BELOW the "chassis" line in Fig. 10 and in Figs. 3b, 8b and 14b.

A small piece of tag strip forms the base and another oscillator coil (X028) is used. This has one or two black spots on its side. The unit is made up as in Figs. 8b and 14b. Note that there are only two connections to the main tag

Fig. 11.

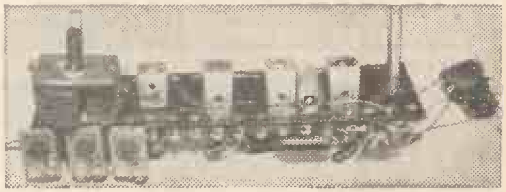


Fig. 12.

Fig. 13.

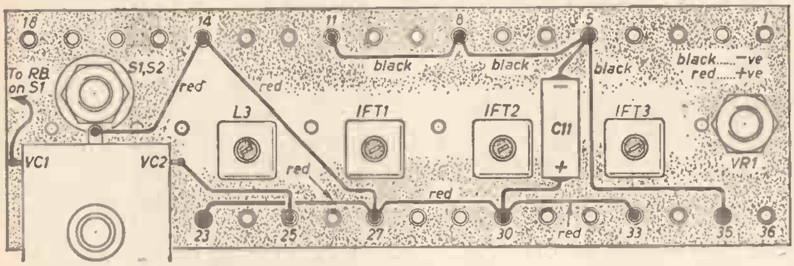


Fig. 14a.

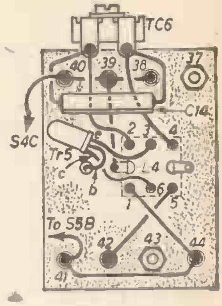


Fig. 14b.

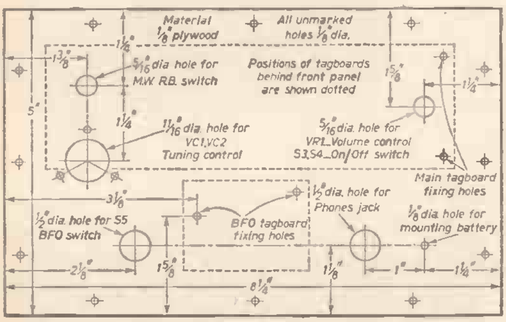


Fig. 15a.

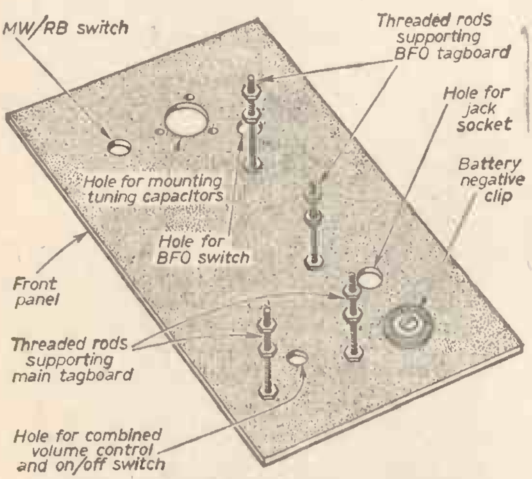


Fig. 15b.

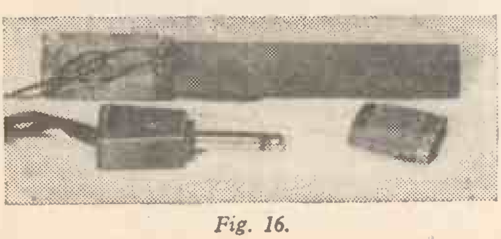


Fig. 16.

board, one via the switch S5, the other the switch on the volume control.

Adjusting the B.F.O.

Switch the receiver on to medium waves and by adjustment of trimmer TC6 (and possibly the core of the X028 on the B.F.O. unit) find a setting which causes a continuous whistle at each and every station tuned in. The B.F.O. is now set and may be left alone.

Using the B.F.O.

For medium wave entertainment reception no B.F.O. is required. For strong signals on the Beacon band it is not usually required for station identification but will be for weak ones. At all times better direction finding is possible (even on medium waves) with the B.F.O. on.

Mounting the B.F.O. Receiver and Controls

A panel of plywood or hardboard is made up to the pattern of Fig. 15a (top view) and four ⅛in. or similar bolts are mounted as shown. In addition the negative battery clip is drilled and fixed as in Fig. 15b. The main tag-board complete will now fit under this panel and is secured as in Figs. 6, 11 and 13 by two bolts at one end (Fig. 15b) and three countersunk screws which fit the upper part of the tuning condenser (Fig. 7). Small washers may be required under these screws.

The B.F.O. tag-board is fixed as in Fig. 13, using two of the bolts in Fig. 15b. The battery clips directly on to the clip of Fig. 15b, the positive lead being flexible clips on as in Fig. 13.

The switch S5 (B.F.O. switch) is mounted as in Figs. 13 and 15 and similarly the phone jack is fitted between the battery and the B.F.O. panel (Fig. 13). At this stage test the receiver and rectify any broken connections, etc., which may have been made by the rearrangement.

Making a Suitable Cabinet

As far as possible large magnetic objects should be eliminated and the cabinet should thus be of plastic or wood. A suitable design is shown in Fig. 18.

Final Alignment

The receiver is now aligned once more on the Beacon band only. The trimmers TC2, TC3 and TC5 are used as described, the lid of the cabinet being lifted very slightly to allow a screwdriver to enter. Very slight adjustment only will be required.

The prototype, used in Southampton, was aligned to cover 321kc/s to 290kc/s since an aircraft beacon (of local use) uses 320kc/s and St. Catherine's Point could still be obtained, together with Pte. de Barfleur, Roches Douvres, Casquets, etc., on 291·9kc/s.

The design will just cover the whole shipping beacon band, but readers who wish to use one or more aircraft beacons can slightly alter the band by suitable adjustment of TC2, TC3 and TC5.

Reception (December 30th, 1961) of coastal beacons was good at 50 miles range and very useful at over 100 miles on some beacons such as Roches Douvres. This is reasonable since the Admiralty Handbook lists this lighthouse as having a 50-mile range.

The Compass

Any good small compass may be used. That shown on the prototype is a popular, easy-to-obtain surplus R.A.F. Mark 1 made of plastic material and with a slotted mirror allowing sightings to be made simultaneously with the reading. It is

Fig. 17.

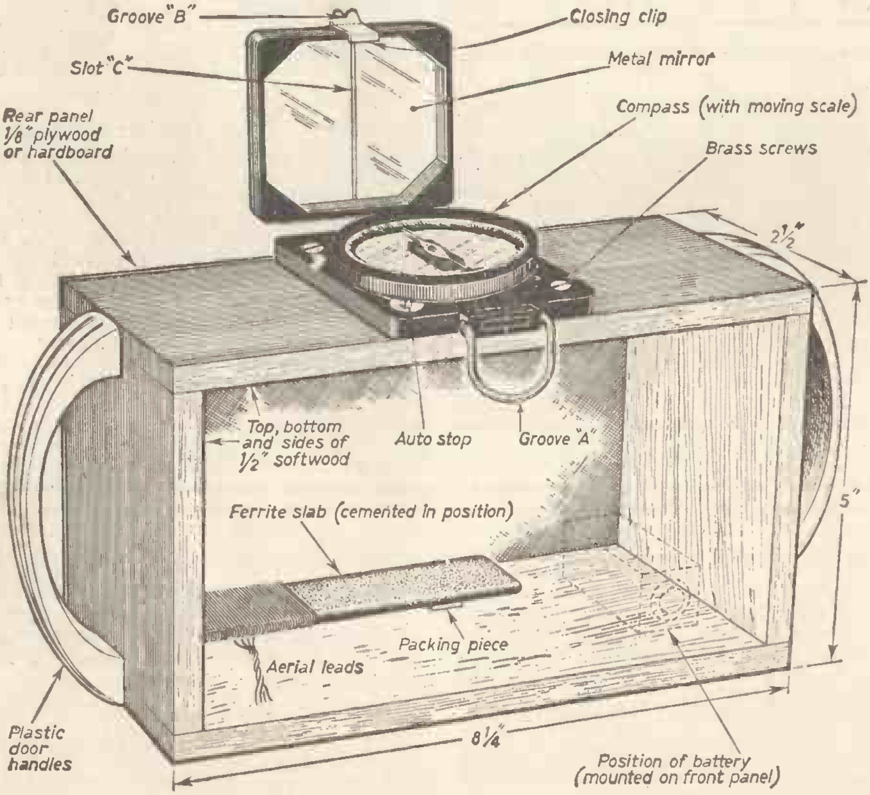


Fig. 18.

Fig. 19.

Fig. 20.

obtainable from surplus dealers, including Messrs. Charles Franks, 67-75 Saltmarket, Glasgow. Cost is 15s.

The dial is marked 0 to 99deg four times and may be left as it is. However, it is a good idea to make a new scale going from 0 to 360deg anti-clockwise. The reason will be apparent when using the instrument for plotting on a chart.

The dial can be turned through any angle. Once set up, however, the N/S line of the scale is set exactly along the ferrite rod. Put the receiver with the carrying handles pointing W and E. The magnetic needle should now point to 90deg and 270deg.

With an anti-clockwise 360deg scale the null point on any radio beacon as seen on the compass by direct vision (Fig. 19) will be the actual bearing East of North from your position to the Beacon—i.e., for simplicity, say a station is N-E of you. A null is obtained and the compass reading is 45deg—i.e., the station is 45deg East of North, which is, in fact, N-E.

Using the Direction Finder

The instrument must be used away from all metal objects and as far off the ground as possible. The receiver is put on and the volume turned up as required; the B.F.O. switch is left "out". Any beacon or station is then received. If too loud turn down the volume, if weak use the B.F.O. and off-tune slightly. Now hold the receiver as in Fig. 19 and turn round until the signal fades out or goes as low as possible. The beacon or station is now in line with the aerial (Fig. 1) and the compass sight will give the actual direction of the station (there may be 180deg error here) and the compass reading will give the actual bearing (180deg ambiguity again).

Generally on radio beacons the B.F.O. should be used and the tuning indicator off-tuned to give a good audible note in the phones.

The 180deg ambiguity cannot be resolved with this simple instrument, but it is rare that anyone does not know their position to such an extent! Sensing is not normally required in coastal navigation or "inland hiking".

Charts and Information

Radio Beacons.

A full list of all beacons in the world is published, together with charts of all maritime countries in the Admiralty List of Radio Signals, Volume II. Published by H.M.S.O. at 23s. and obtainable from their chart agents, Messrs. Potters, The Minories, London.

Two charts are available for a few shillings. These will give all the beacons situated in or near this country. 1, British Isles and North Sea Radio Beacons; 2, English Channel and Approaches Radio Beacons. Charts of other countries are also available. Obtainable from Admiralty chart agents as above.

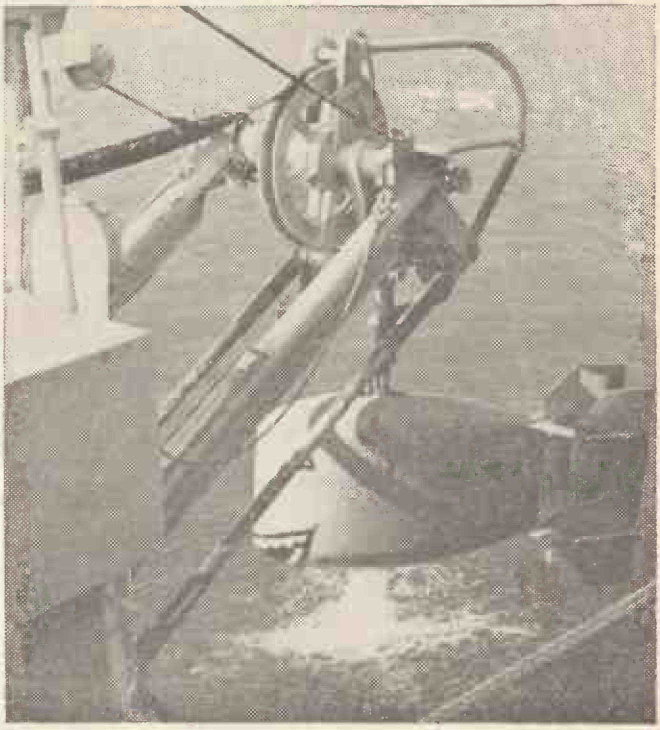
Information.

Aircraft beacons are often useful and the frequency of the D.F. set may often be set to use them. Two charts which would be useful to readers are British Isles Chart EUR/1 and the London Area Chart. These are available from Messrs. International Aeradio Ltd., Hayes Road, Southall, Middlesex. The station at Epsom, for instance, proved useful in trials over Bagshot Heath in Surrey.

Other useful information is contained in The Admiralty List of Radio Signals, Volume 5; The Principles and Practice of Radio Direction Finding, by Charles Cotter, published by Pitmans; The Complete Air Navigator, by Bennett, published also by Pitmans, and the General Post Office Handbook for Radio Operators, obtainable from Her Majesty's Stationery Office, Kingsway, London, W.C.2.

PICTURE NEWS

FROM THE WORLD OF SCIENCE



NEW SUBMARINE DETECTOR

H.M.C.S. *Crescent*, which has recently been visiting U.K. waters, is fitted with a new anti-submarine detection device known as Variable Depth Sonar, by means of which it is possible to detect submarines at considerable depths.

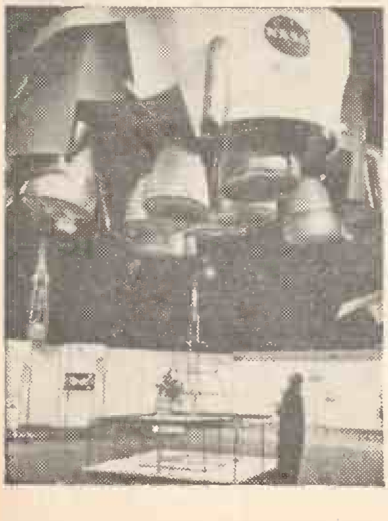
This Canadian equipment, which is one of the first to be produced in the world, is made by EMI-Cossor Electronics Ltd.

The device consists of an asdic transducer which is towed behind the ship and, by varying the length of tow, the depth of the transducer can be controlled.

Until the advent of this device, submarines were able to lie below certain layers of water which, because of their temperature variation, reflected the beam from the surface vessel's asdic set back towards the surface. The submarine could not, therefore, be detected.

SATURN MODEL

At the glittering and compact World's Fair under way at Seattle, Washington, visitors get a realistic glimpse into the space age at the (NASA) display. This full scale model of the Saturn space booster engine section flashes lights and projects the deafening roar of a blastoff at regular intervals.

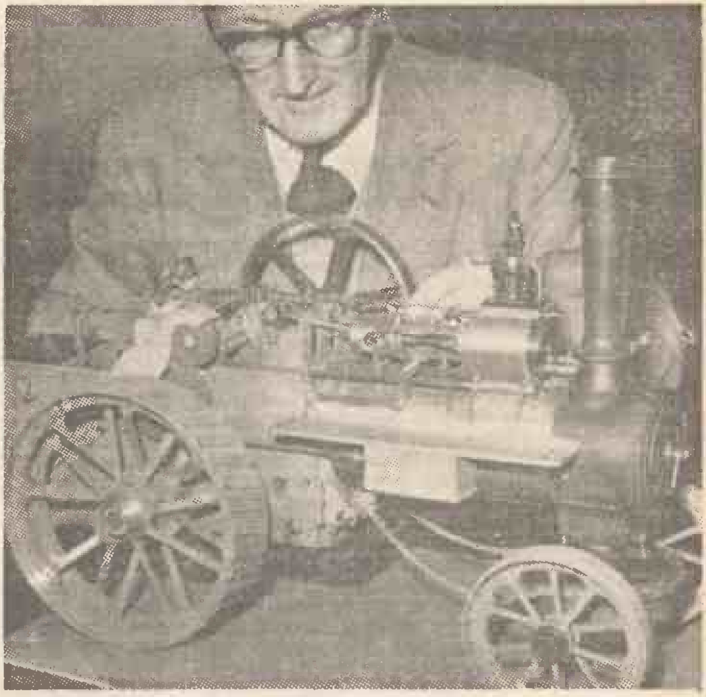


WATER JETS CHECK AIRCRAFT

Water forced through tubes forms the basis of a new spray-type aircraft arresting gear developed at the Royal Aircraft Establishment at Bedford. There have already been over 70 test runs and the performance of the new device has been reported as outstanding. The new gear may be used on future aircraft carriers for stopping aircraft as they land and could be developed for civil aviation.

A MIGHTY MIDGET—TRACTION ENGINE

A model traction engine built by Mr. S. C. Crouch, of Sevenoaks, Kent, over a period of ten years is a masterpiece of fine engineering. This model a faithful reproduction of the famous Allchin Steam Engine, formerly used for work on the roads and in fair grounds, is capable of towing twenty people or uprooting a small tree and every part has been hand turned by Mr. Crouch, who is a production inspector with an electrical firm.

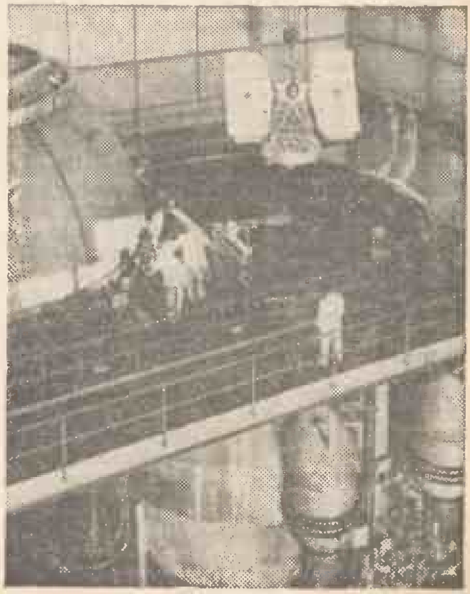


FOREMAN GETS PROTECTION

Safety Foreman W. L. Jones wears protective clothing and breathes compressed air as he works in a radio-active section of The Fast Breeder Reactor for Industrial Nuclear Power which is under construction at Dounreay in the North of Scotland. The reactor, an experimental one, will produce more fissile material than it consumes.

SATELLITES BECOMING VITAL TOOLS FOR WEATHERMEN

A white Nimbus meteorological satellite (at top) is lowered carefully into a large laboratory called a space similator. There the satellite is tested under the extreme conditions of outer space—alternating intense heat and deep cold in a vacuum. The General Electric Company conducts this testing for the National Aeronautics and Space Administration and the Weather Bureau.



Amateur Climatological Station

Part 2

MAKING THE ANEMOMETER and EVAPORIMETER

By A. Crawfoot

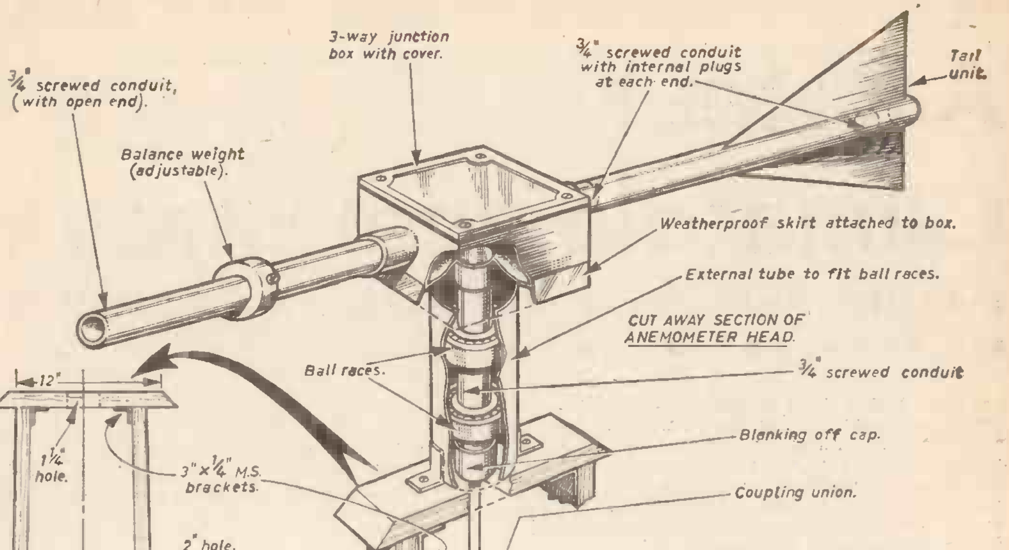
AN anemometer is an instrument for measuring wind velocity. The type which has revolving cups is limited to this. It measures the distance travelled by the cups (which is the same as the air passing the cups) and the daily figure is then read off. It is very difficult to assess the true wind speed, as only an average can be taken. The Dynes Anemometer operates by means of a pressure tube and a suction tube, acting on a bell floating in water. This instrument also records the wind direction. The instrument that I describe is operated by the wind pressure only, and because of that does not have enough energy to make continuous recordings of velocity readings. It will however record the wind direction. The velocity scale is easy to read, and the direction can be observed visually as well as being recorded.

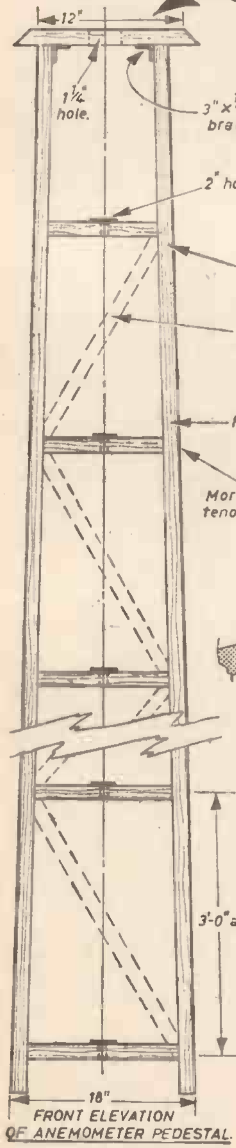
The vane is built up from two pieces of ¾in. screwed electrical conduit, both 12in. long. These are screwed into a three-way junction box, having two inlets opposite each other and a third from the centre of the bottom. The top is screwed to the rim of the box, and should be fitted with either a cork or rubber washer. The box forms a pressure chamber which helps to smooth out slight variations in pressure that are of no account. The two pieces of tube are threaded on one end only. The inlet end is left as it is, whilst the other is blocked tight both ends with wooden plugs. This tube also carries the tail fins. The shape of these can be made to suit yourself, but a simple arrow tail is as effective as any. This is made by cutting two pieces of galvanised sheet iron in the form of a triangle, with one edge turned over about ⅜in. This is then brazed onto the tube, making certain that the two pieces are turned opposite ways, as extra weight on one side will make the vane tend to yaw. The overall size of the vanes should not exceed 6in. If you are surrounded by trees or houses, make it even smaller, otherwise you will record all sorts of eddy currents that have no meaning at all. Use a little jointing compound to seal the threads when fitting the tubes and the top of the box.

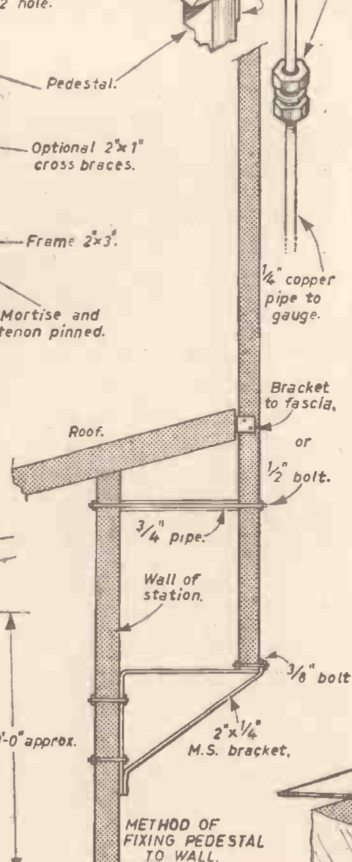
The outlet tube is of the same material as the inlet and tail tubes but is only 6in. long, screwed both ends. Obtain two ball races which are a tight fit over the tube, or maybe slightly smaller so that the tube can be turned down slightly to fit. The upper side of the top bearing should be fitted so that when the tube is screwed into the box, it will seat hard against the female union of the box. The bottom bearing is treated in the same way, but instead of a union a blanking-off cap is used. When screwed up tight this holds the bearing in position. The outer casing of the mounting is made from an 8in. length of malleable water pipe, of a diameter to suit the outside size of the bearings. If you have to turn the inside of the pipe to suit, make sure that the top of it clears the underside of the pressure box by about ⅛in. Before mounting the bearings, solder or braze a strip of brass 1in. wide round the bottom of the pressure box to form a weather shield. Screw a flange on the bottom of the pipe to enable it to be fixed to the pedestal. Press the top bearing onto the ¾in. tube and screw the tube up into the pressure box, using a little jointing compound as with the other joints. Smear the bearing both sides with thick grease then press the outer tube over the bearing. Next press the bottom bearing into position, greasing both sides first. Drill a ¼in. clearance in the end of the blanking cap and braze a 6in. length of ¼in. copper pipe into the hole. Screw the blanking-off cap into position and make sure that the vane turns very easily in all directions.

Next make a temporary frame on which to mount the vane. This will be used only for calibration, and can be made from any material that you may have at hand. The height will be determined by the method of calibration that you will have to use. Mount the vane on the frame, and make a brass balance weight to slide over the inlet end of the vane. The weight of this must be a little more than the weight of the tail unit. A grub screw in the weight will fix it in position. Support the vane unit on its side and adjust the weight until the vane balances in any position. It is now ready for calibration.

Before this can be done a U-tube must be obtained or made. This is a glass tube, $\frac{1}{16}$in. internal diameter and 12in. long, bent into an equal U with a bottom curve of about ¾in. radius. Mount this by means of small clips to a suitable back board. Fix this gauge to the temporary pedestal and you are ready to calibrate. If you can get this done in the wind tunnel do so, as this is by far the best way. If not, the only other way is with a car. That is why I said that the temporary frame should be made to suit the method of calibration. It must be high enough for the vane to be well up above the car so that a minimum of air disturbance from the car will affect the vane. Mix a little water and blue-black ink, with a few drops of liquid detergent. Pour some into the glass tube so that when upright the levels are in the straight arms of the U-tube.

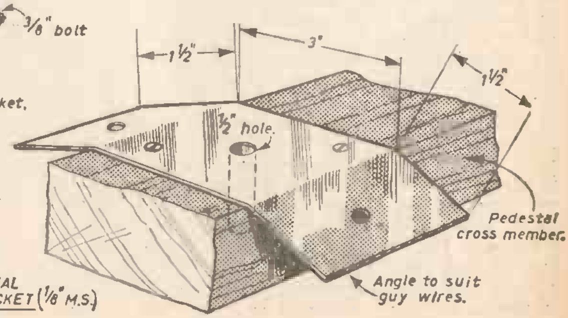






Connect the ¼in. copper pipe from the vane to the gauge by means of a long piece of plastic tubing. A piece of paper should be fixed behind the U-tube to mark the readings on. Mark the zero levels. Now comes the difficulty of finding an open car that the vane can be mounted in. This is where the old type of sliding sunshine roof is useful. Wait for a dead calm day then take the car out and carefully drive at speeds of 5, 10, 15, 20, 25, 30 m.p.h. up to 70 m.p.h. Most speedometers are somewhat inaccurate in the higher speed range, but this error can be spotted on the resulting scale, and the marks adjusted to suit. Mark the liquid levels on the paper scale so that it can be read easily. The calibration finished, the next job is to make the pedestal to mount the vane on. It should be noted that no N.S.E.W. letters are fitted to the vane. This is done inside your station, and would only be a useless appendage outside.

The pedestal is of the ladder type. This makes it easy to mount the vane, and the cross members form steadies for the revolving pressure tube. The height is something you must determine for yourself. The main thing to consider is the height of the surrounding buildings and trees. Try to take it up as far as possible above the top of these.



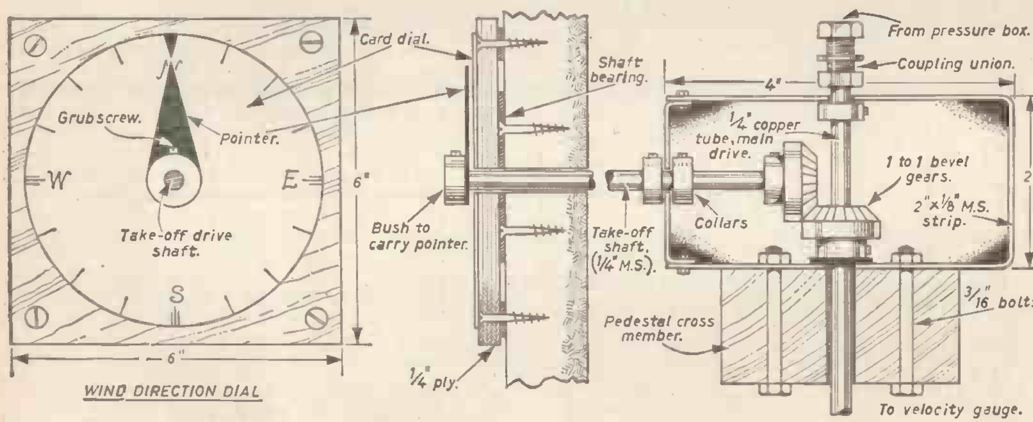
This is not a " must " but it is certainly advisable. The frame is built up from 2in. x 3in. planed timber; hardwood if possible. The top should be 12in. wide overall, and the bottom 18in. The cross members should be about 3ft apart. Drill a 1¼in. hole through the centre of the top member, and a ½in. hole through the centre of each of the others. Fix a pair of metal brackets to the side of the station to carry the pedestal. These should be arranged so that the bottom cross member is level with the position in which you want your direction recorder. This member carries the take-off gear for the wind direction dial and recorder.

The take-off unit is constructed from a length of 2in. x ⅛in. mild steel strip, bent in the form of an equal U, the arms being 2in. apart. A separate end piece, in the form of a shallow U, to fit in between the main body carries the take-off shaft (see drawing). Drill a ¼in. clearance hole through the centre of the top and bottom of the unit and one through the end piece. Drill two holes for 3/16in. bolts in the bottom of the unit, to take the holding-down bolts. Two one-to-one bevel gears, drilled to take the ¼in. copper tube and the ¼in. mild steel take-off shaft together with three collars, are needed for the assembly. A 6in. piece of ¼in. copper tube is used for the main drive, which of course also forms part of the pressure tube. A collar and one gear is slid on to the tube, 1in. of which is left projecting from the top of the unit, and the remainder from the bottom. The take-off shaft should be long enough to go right through the wall of the station. Two collars, one inside and one outside, hold the take-off shaft in position. The gear on the vertical shaft may have to be packed up with washers to make it mesh correctly with the take-off gear. I used " Meccano " gears and found them very satisfactory. The only modification was to increase the bore to ¼in. The unit is bolted to the cross member of the pedestal with 3/16in. bolts.

Before erecting the pedestal, remove the take-off shaft, leaving the rest of the gear in position. Re-check the balance of the vane, then connect the vane and the take-off gear with a length of ¼in. copper pipe, and two ¼in. coupling unions. Make sure that the couplings are tight. If the height above the upper fixing bracket or bolt is over 20ft you should guy the pedestal. A ⅛in. mild steel plate drilled ¼in. in the centre with two holes to take 1½in. x No. 10 wood screws is fixed to the cross member below the vane. The overhang each side of the cross member is turned down at a suitable angle, and galvanised wires are threaded through the ¼in. holes. Anchor to suitable foundations. The pedestal can also be cross braced if desired. Use 2in. x 1in. battens screwed to the surface of the uprights. Fix them from corner to corner of each section between the cross members, alternately on each side. For the actual erection you will need plenty of help to keep the pedestal steady until the bolts are home. Make sure that the whole thing is in plumb both ways. Fix the guys if you are using them, and stand back and watch the vane working into the wind.

A length of ¼in. plastic tube should be taken from the bottom of the pressure tube (below the take-off gear), letting it hang down at least 1ft below the end of the tube, and then bringing it up about 1ft 6in. above the take-off gear and through the wall into your station. From that point it can be taken to wherever your U-tube and indicator is situated.

When the velocity indicator is set up and working satisfactorily make a hole through the wall of the station, level with the direction take-off shaft. Mount 2in. x 2in. bearing plates on both the inside and the outside of the wall, with ¼in. clearance holes for the shaft. The length of the shaft inside will depend on the thickness of the board you use to mount the direction indicator on. The board should be 6in. square with a 5in. diameter card indicator dial glued to it. A ½in. hole is drilled through the middle to take the shaft. When marking the board with the compass points keep the figures as simple as possible. Only the four cardinal points are needed, the rest can be read without any other letters. Just mark the points (NNE, NE, ENE, etc.) with short lines. Remember that the cardinal points as marked in the sketch will apply only if the take-off shaft is mounted above the gear on the main drive tube. If, for any reason you have to reverse the position of the gears, the E and W points will have to be reversed as well. The pointer is a piece of flat tin 2in. long. Turn up a ¾in. diameter bush, with a ¼in. hole to fit the shaft, and a hole for a ⅛in. grub screw. This will be the drive for the recorder. Solder the pointer on to the bush, making certain that the grub screw is on



the same radius as the pointer. The screw not only drives, but also locates the drum in relation to the vane. To assemble the indicator, screw the ply board and dial over the shaft bearing plate. To line the pointer up with the vane, you will need help. Choose a day that is either calm or with only a little wind. Having determined the direction of north, one person should hold the vane in position by the pressure tube whilst the other sets the pointer and locks it with the grub screw.

The Evaporimeter

Rather than commencing to construct the direction recorder, I think that it would now be better to start on the Evaporimeter. The wind direction indicator can meanwhile be used by visual observation.

This instrument is perhaps best described as the reverse of the rain gauge. The construction was illustrated in last month's article. It measures, in points, the evaporation of water from an open surface. The tank is made from a concrete or iron container let into the ground. A standard diameter is 3ft but experiments with different size tanks show that there is little or no difference in evaporation. My own tank was 2ft 6in. in diameter and 2ft 6in. deep, made from a concrete pipe. The actual size is not critical so you can use anything suitable that you have. Whatever is used, paint the inside white. If metal, give the outside several coats of bitumastic paint before letting the tank into the ground. The rim of the tank should be about 3in. above the ground, or sufficient to avoid the possibility of flooding. The water is filled to a little below ground level. When the water has evaporated to about 3in. below the "full" mark, refill. One trouble that constantly occurs is the growth of algae in the water. Various chemicals can be obtained to stop this, but I find ordinary household carbolic quite satisfactory. About three tablespoonfuls each time the water is topped up is enough.

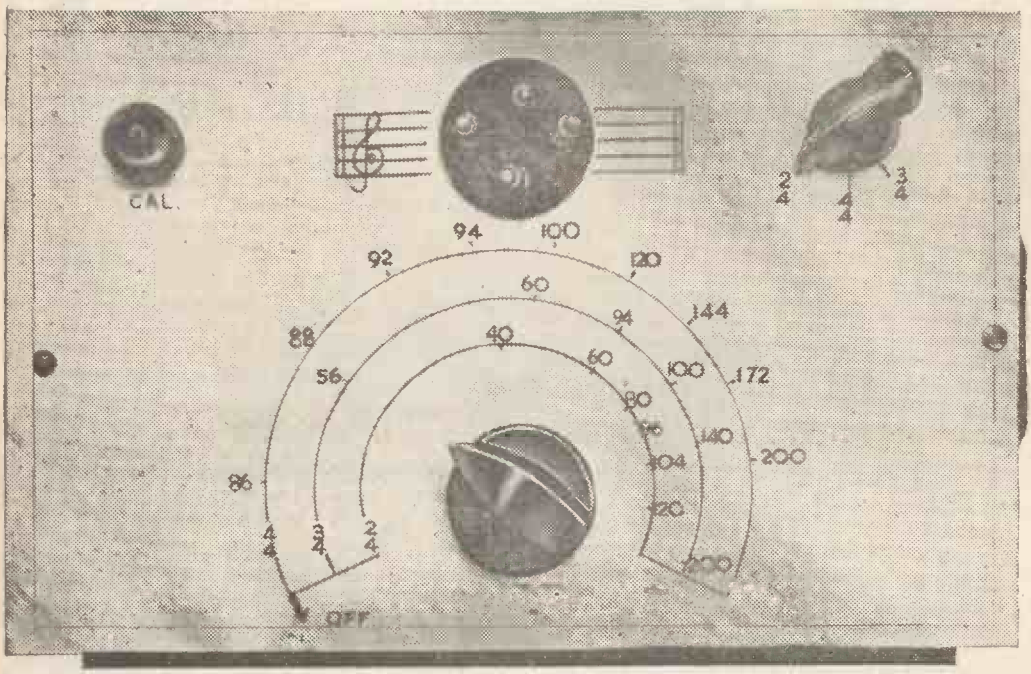
The water level is measured by means of a pointed hook, point upwards. The point is brought up to the surface, and the instant of breaking through can be very easily seen. Measurements are taken on a scale. When the tank is placed in the ground, cement a 3ft high, 3in. x 3in. post in the ground, close to the side of the tank. In the Northern hemisphere it should be placed on the north side of the tank, and in the Southern hemisphere on the south side. This is to avoid the shadow of the post falling across the water and so lessening the evaporation. The hook mentioned above is brought up to the surface of the water by means of a ¼in. Whitworth threaded brass rod. This has ten threads to the inch. The 2in. diameter threaded collar which moves the rod up and down is marked with ten equal divisions. Thus each tenth of a turn is an upward movement of 1/100in. The ¼in. rod has a pointer which reads against an ordinary inch rule which has tenths marked on it. The pointer on the rule might read 2·4in. and the collar 7. This would be 247 points. The next day the reading could be 1·5 and 3 on the collar. That would be 153 points. Subtracting one from the other leaves 94 points. It is very doubtful that you will ever record such a high evaporation rate unless you live in a very dry, almost desert, country, but the example shows the simplicity of the reading.

A rather interesting anomaly that can occur should be explained. The first reading may be, say, 121 points. The average evaporation over the past few weeks may be, say, 12 points per day. The reading should be 109 points. During the day there has been 25 points of rain, which should bring the figure up to 134 (109 plus 25). The reading might well be 128 however, showing a deficiency of 6 points. This is due to the fact that the air during rainfall is actually drier than when it is not raining. Evaporation goes on during the rain, and the raindrops absorb some of the moisture from the air, leaving the air more able to absorb water from your tank. One point when taking measurements. Always sink the point well below surface level, and bring it up with a slow but continuous movement. This takes out any back lash from the screw. By watching closely, you will observe the point actually pushing the surface of the water up. It is simple to take the reading as the point breaks through, although this is a fraction above the actual level. As long as each reading is taken the same way, it will make no difference. Make sure that you cover the tank with a piece of wire netting. This may make a slight difference to the evaporation, but not as much as a dog drinking or, as I once had, a child falling into the tank!

Your station now consists of a rain gauge, barometer, wet and dry bulb thermometers, anemometer and evaporimeter, with the Stevenson Box to house the outside instruments. If you have also got a barograph and thermograph and a Stokes sunshine recorder you will have a station that would rank as first-class. The records must be very carefully kept, and all readings should be taken at the same times every day. The official times are 2359, 0300, 0600 and so on, every three hours, Greenwich Mean Time. Readings from amateur climatological stations can be very useful to the Meteorological Office. If you wish to supply yours, you should first write to the Director General, Meteorological Office, London Road, Bracknell, giving details of your instruments.

(To be continued)

the 'METRONEONOME'



By Roy Bebbington, Grad. Brit. I.R.E.

WHETHER you are a musician or not this simple but fascinating neon timing device is well worth constructing. Simple in that the basic circuit requirements read as follows: Take four capacitors and wire up in the form of a square; take four resistors and wire up in the form of a cross. Likewise wire up four small neon indicators in the form of a cross. Connect the assembly to a battery as shown in Fig. 1 and the neons will flash in a definite sequence at a speed determined by the battery voltage and the component values. Fascinating because the flashing neons could make a most entertaining toy, especially if the number of components is increased; the writer constructed a ring of eight with most effective results, the extreme simplicity of the circuit lending itself to considerable experiment. As the number of neons is increased so the overall time-constant decreases, resulting in faster flashing. This can be slowed down, however, by increasing the value of the capacitors in the circuit.

The device has further useful applications in the electronic switching field that have not yet been fully exploited, but its use as a metronome will be considered in detail here. The "Metroneonome" has several features not found in the more conventional types of metronome. Visual indication of the tempo overcomes one of the limitations of the audible types, which tend to become inaudible during loud passages of music. True, these usually have some visual indication besides their incessant death-watch-beetle tick but are not so easily observed as the flashing neons. If an audible signal is thought to be necessary this can easily be added to the "Metroneonome" as an extra refinement. The difficulty of getting across to pupils the relationship between time signatures and accent is, in the writer's experience, a very real one. The metroneonome has therefore been designed to give a visual indication of the position of each beat in the bar. In 2-4 time, for example, only two of the four neons are in circuit and thus the first strong accent of the bar can easily be discerned. Three of the neons are operative when the time signature switch is in the 3-4 position and again no difficulty should be found in picking out the familiar triangular waltz-time beat. All four neons are employed to display 4-4 time and the first and third beats of the bar, which demand a strong and a medium accent respectively, occur in the same positions of the bar pattern for every repetition. Compound times have not been catered for as these can readily be broken down into simple time. Slow 6-8 measure can be split into 3-4 without much confusion arising and faster 6-8, where normally two beats to the bar would be given, can be accommodated on the 2-4 switch position.

Operation

Whilst the mathematical approach to the theory of operation is rather lengthy a more practical explanation is shorter and easier to understand. When a battery is connected the neon with the lowest striking voltage will glow. This will create a potential difference across the associated feed resistor due to the current flowing through the neon. This p.d. will charge up the adjacent capacitors as the neon conducts until the extinguishing voltage of the latter is reached, whereupon it ceases to conduct. The sequence then repeats itself with the neon striking that has the next lowest breakdown voltage. Similarly its two adjacent capacitors will charge to oppose its striking voltage until it ceases to conduct. By virtue of the fact that once the sequence has begun, some of the capacitors have acquired a charge, the flashing mode becomes fully sequencial, employing all the neons in turn. In a three-neon circuit a clockwise or anti-clockwise mode must inevitably result, but with a four-neon circuit the bulbs may have to be rearranged to obtain the required mode of operation. To obtain a regular beat sequence it is important that the components should be closely matched.

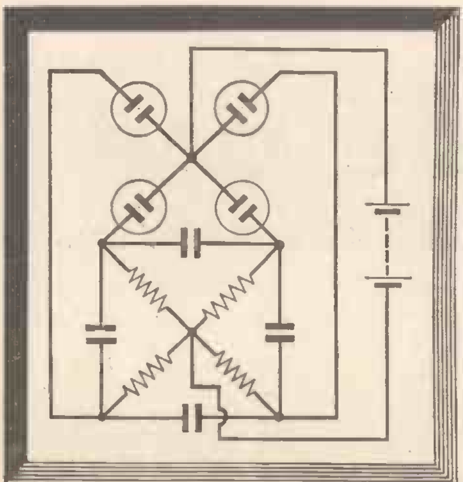
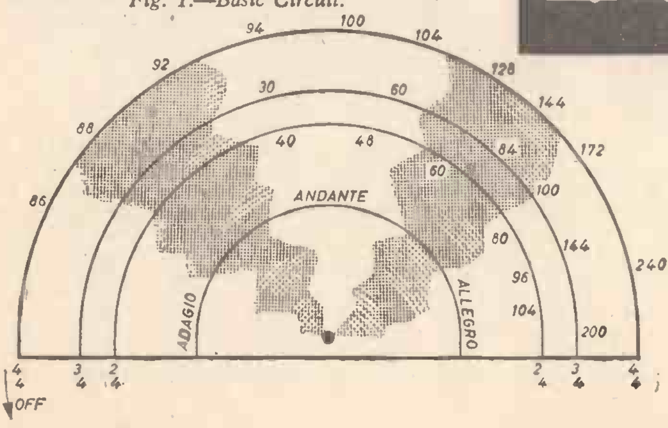


Fig. 1.—Basic Circuit.



Practical Circuit

The practical requirements for a metronome follow from the basic circuit of Fig. 1. Obviously some form of speed regulation is necessary and this takes the form of a 1 megohm potentiometer. A control with a single pole switch should be employed and can then serve as a battery on-off switch. Being voltage dependent, some means of compensating for battery changes is necessary, although the current drain is exceedingly small. A 100k preset potentiometer serves this purpose and should be set to maximum resistance when calibrating the scale with a new battery.

The time signature is indicated by switching the appropriate number of neons into circuit. The 4-4 signature is achieved by leaving all components in circuit as the circuit is symmetrical. This is not possible in the 3-4 position and the switch is arranged to short out one capacitor and disconnect one resistor. The layout of components is in no way critical and for the sake of simplicity the device can be built up as shown in the theoretical diagram (Fig. 2), the four large capacitors providing excel-

(Continued on page 30)

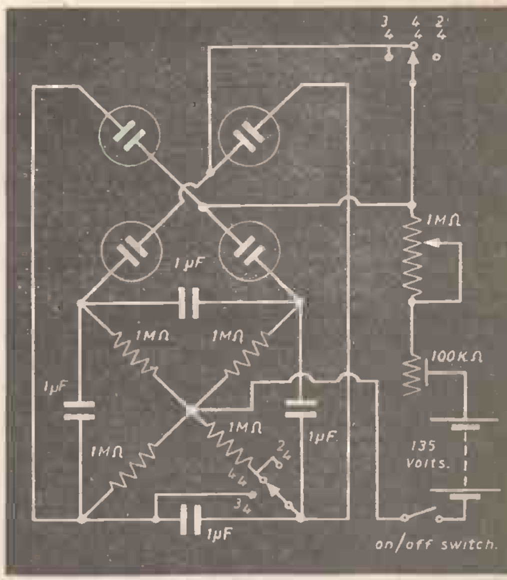


Fig. 2.—Practical Circuit.

The first step in the preparation of a city under the ice. A snowmiller cutting one of the many trenches of New Byrd.

The second step . . . Installing archways in the excavated trenches.

ON THE ICE CAP

BY PETER STEWART

McMurdo Sound Base. "Our Lady of the Snow" chapel nestled at the foot of Observation Hill. The chaplain has to rise early on Sundays to clear the snow from the entrance for his congregation.

DOES anyone want fizz water? Then put a drop of ice from an Antarctic iceberg in your drink. The entrapped air, in most instances many centuries old, makes a popping sound when it is released on melting.

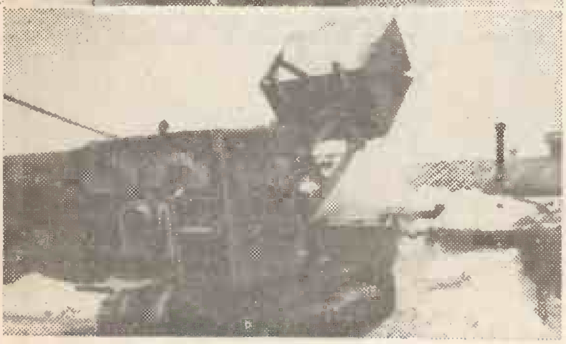
The igloo is out. Latest fashion in the Antarctic is to live in the best of tunnels burrowed well under the ice.

Do you want a trip to the South Pole? No need to take weeks on a bumping sled dragged by a team of huskies. Just take one of the transport planes leaving from an Antarctic base and be there and back in the same day.

These are but a few of the sidelights of life on the great southern ice cap, where things are very different to Scott's day of 50 years ago, most of the changes being due to the tremendous scientific and technical achievements of recent times. A new "Science City" under the ice, atomic reactors generating electricity, automatic weather stations, mechanised aids by the score—these have changed the whole character of life and work in the Antarctic. The activities of the 12 nations with research teams there have increased every year since the International Geophysical Year of 1957-58 and more and more has science been brought in.

The site of the nuclear reactor which was installed at McMurdo Sound, at the beginning of 1962.

Building the 40ft " Wonder Arch " over the garage trench at New Byrd station.



D-4 Traxcavator filling the snow melter at McMurdo Sound base.

Setting up a " Grasshopper " automatic weather recorder station at the foot of Beardmore Glacier in Antarctica, during Operation Deepfreeze 1961.

The new " Science City " has almost been completed beneath the Antarctic ice and snow, 5,000ft up on the ice cap and 600 miles from the South Pole. In winter the snow on the surface is beautiful in eerie, bone-hard shapes, and in summer it is soft and smooth, etched by winds that rarely cease. But underneath is a revolutionary settlement, New Byrd base, named after the late Admiral Byrd, famous American explorer. Old Byrd station is six miles away, slowly being crushed under five years' accumulation of ice and snow. There, roofs have had to be shored up, even steel girders have twisted and bent, while erosion from waste water has also contributed to the dangerous condition of the old base.

New ideas, developed in Greenland on similar schemes, are being put into the new construction, and many of the men working on the replacement project at the South Pole also had experience in Greenland. Tunnelled six miles away from the old base in order to secure uncontaminated snow, the new base consists of one main tunnel beneath the snow from which branch out seven others, all up to 33ft deep and up to 36ft wide. They are roofed with sections of curved corrugated steel covered with snow and, where necessary, are lined and partitioned to become living quarters, offices, workshops, laboratories and recreational rooms. Above the snow there will eventually be an aurora-dome building, a balloon release building and a radar tracking station. By 1965 it is hoped to have a nuclear power plant in operation generating electricity.

Key equipment in the tunnelling operations have been the two " snowmillers ", trench cutting machines made in Switzerland. Two revolving drums dig out a swathe of up to 4ft deep and 9ft wide and eject the removed snow outwards and upwards through two chutes so that from a distance the whole procedure looks like an erupting geyser. These snowmillers have enabled the modern base to be completed a year ahead of schedule.

A top priority in America's Antarctic work, New Byrd will be the centre of scientific research yielding significant aid to the United States space programme; to weather forecasting for the Southern Hemisphere; and to studies aimed at the better understanding of earthquakes. Another recent development by the United States (whose Antarctic activities, incidentally, are financed each year by a budget of well over 3,000,000 dollars) has been the installation of an atomic reactor at McMurdo Sound, the main American station in the Antarctic, containing more than 140 personnel. The atomic reactor overcomes one of the major problems of the Antarctic—fuel supply. Bringing in oil fuel from the outside world for heaters and generators is a huge task. It is not until well into November that the first supply ships can smash their way through the vast fields of pack ice that surround the great southern land mass and, by March, it is freezing again. It is not expected that the reactor will require refuelling for ten years and, though costing millions of dollars, it should pay for itself in five years through the saving it makes on the cost and transport of other types of fuel.

But this is just another of the many new aids that would make the old Antarctic explorers shake their heads or open their eyes in wonderment.

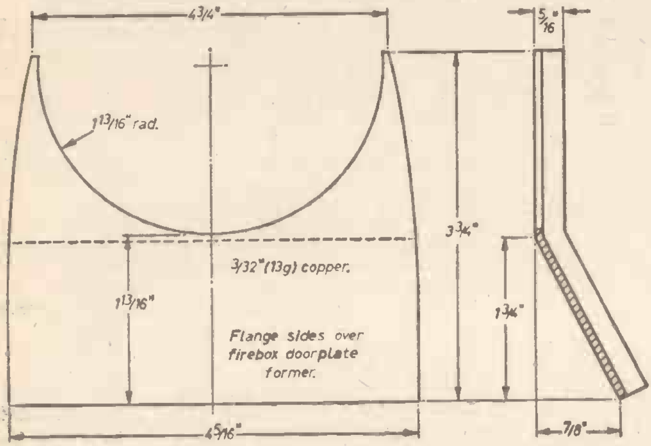
(Continued on page 46)

L.B.S.C's $3\frac{1}{2}$in. Gauge

EVENING STAR

PART 20

FIREBOX AND COMBUSTION CHAMBER CONCLUDED



FIREBOX THROATPLATE *Fig. 123.*

CLEAN the flange all round with a coarse file so that the brazed joint will be sound. At $1\frac{1}{2}$in. from the top, on the centre line, mark out the oval shown for the firehole ring, but don't cut the hole until the ring is made.

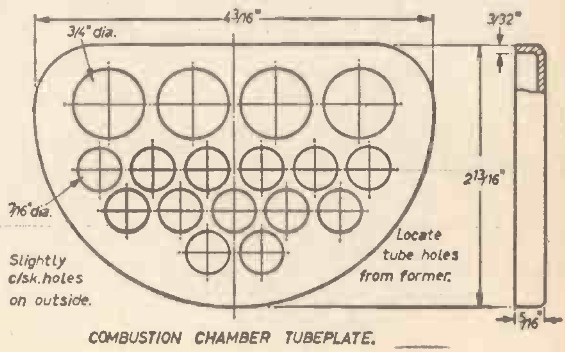
The type of firehole ring shown (see general arrangement drawing for a section of it) was originally designed by a Brighton works friend now deceased and is the best type of ring for small boilers that I ever tried. It needs no riveting, no plate flanging, and forms a substantial stay between the firebox doorplate and backhead. It is made from a piece of copper tube $1\frac{3}{8}$in. diameter and $\frac{1}{8}$in. thick. Chuck in three jaw, face the end and turn down $\frac{1}{4}$in. length to $1\frac{1}{4}$in. diameter. Part off at a bare $\frac{3}{4}$in. from the end, reverse in chuck and turn down a full $\frac{7}{32}$in. length to $1\frac{1}{4}$in. diameter, leaving $\frac{1}{4}$in. full diameter between the shoulders. Anneal by heating to medium red and plunging into clean cold water, then squeeze the ring into an oval shape in the bench vice until the hole measures $1\frac{3}{8}$in. x $\frac{7}{8}$in. The exact radius of the ends doesn't matter.

Lay the oval ring on the firebox doorplate at the marked place and scribe a line around it. Cut out the piece, then push the $\frac{7}{32}$in. end of the ring through, from the outside of the doorplate, and beat the projecting lip of the flange outward and downward until the metal of the doorplate is firmly gripped between the shoulder of the ring and the beaten-down flange. The rear end of the firebox can then be cleaned on the inner side with coarse emerycloth or similar abrasive (the more scratches made in the copper the better the joint after brazing), the doorplate inserted so that it is flush with the end and a few $\frac{3}{32}$in. copper rivets put through flange and plate to keep the parts in position for brazing.

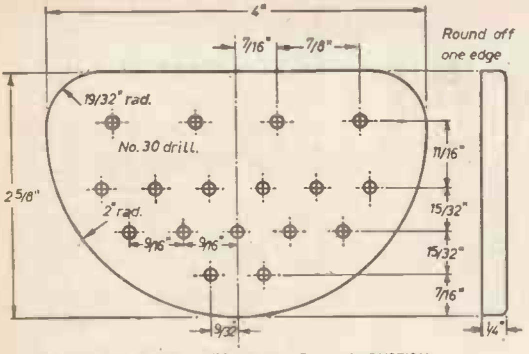
Combustion Chamber Tubeplate

The end of the combustion chamber is closed by a flanged plate which fits over the end like the lid of a coffee tin. The former, over which this is flanged, must therefore be the same size as the end of the chamber. It also serves as a jig to drill the tube holes in both the combustion chamber and smokebox tubeplates, as both should be alike. Either use the iron casting supplied by our advertisers or saw the former from $\frac{1}{4}$in. steel plate as before, rounding off one edge. Set out very carefully the location of the tube holes, as shown in Fig. 125. The horizontal spacing of the tube holes, the lower rows, is $\frac{9}{16}$in. and the vertical spacing is $\frac{15}{32}$in. The centres of the holes for the super-heater flues are $\frac{11}{16}$in. above the upper row of small tubes and the horizontal spacing is $\frac{7}{8}$in. Make deep centrepops so that the drill won't wander when starting to penetrate, then drill the lot No. 30.

The piece of 13-gauge copper required will be $4\frac{5}{8}$in. x $3\frac{1}{4}$in. Lay the drilled former on it, scribe a line all round $\frac{5}{16}$in. away from the former, cut away the surplus, soften the copper and flange it over the former as before. This time, before removing the flanged copper plate from the former, run the No. 30 drill through all the holes, carrying on right through the copper. Clean the flange with a coarse file, remove the former and open up all the holes in the copper with a $\frac{27}{64}$in. drill. Tip for beginners: if you haven't a machine vice big enough to hold the tubeplate while drilling *don't attempt to hold it with your fingers.* Soft copper

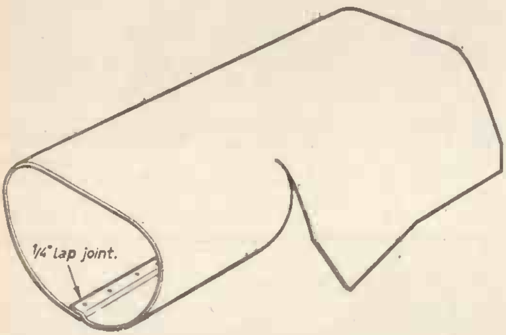


COMBUSTION CHAMBER TUBEPLATE.
Fig. 124.



FORMER AND TUBE-DRILLING JIG FOR COMBUSTION CHAMBER TUBEPLATE.

Fig. 125.



FIREBOX AND COMBUSTION CHAMBER AFTER BENDING.

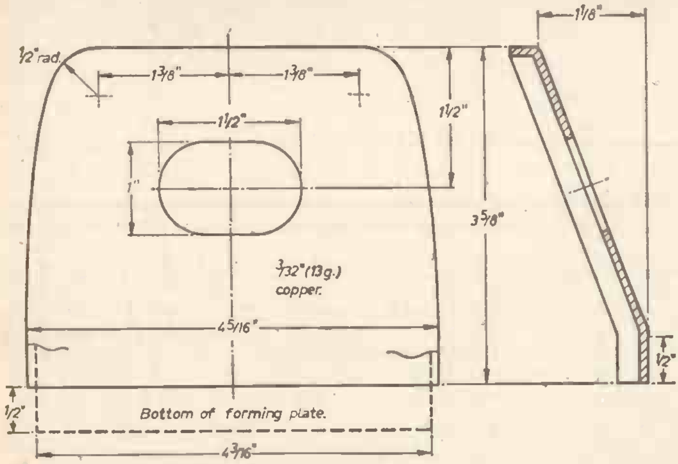
Fig. 126.

is finicky stuff to drill and the chances are a million dollars to a pinch of snuff that the drill will catch up just as it breaks through, the tubeplate will spin and in a split second your fingers will be in a bluepencil mess where the sharp edge of the copper has caught them. The way to avoid this is to put a piece of *hard* wood on the drilling machine table, lay the tubeplate on it flange upward, and either grip the flange with a "Footprint" wrench or something similar, or else grip it with a thick piece of cloth or rag. Press the plate down to the wood as tightly as possible, run the drill at slow speed and apply plenty of cutting oil. The hardwood backing will prevent the drill from catching up and the cutting oil will ease it through.

Open up the top row of holes with a $\frac{47}{64}$in. drill and true them up with a $\frac{3}{4}$in. parallel reamer. Don't put it right through, only insert the "lead" end far enough to bring the hole to a true circle. Ditto repeat the smaller holes using a $\frac{7}{16}$in. parallel reamer. Slightly countersink the lot on the side opposite to the flange, then clean the inside of the flange and the end of the combustion chamber and "put the lid on". It should fit very tightly.

Crown Stays

Rod stays are often used in full-size practice between firebox crown sheet and the outside shell, but as Nature refuses to be "scaled" this type isn't suitable for a boiler of the size we are building. Erosion takes place at the same speed whatever the size of the boiler and, while a loss of, say, $\frac{1}{16}$in. would make little appreciable difference to a full-size rod stay, it would weaken a little one to breaking point in a short time. I once saw the crown sheet of a rod-stayed firebox collapse at a local club exhibition and afterwards held a post-mortem on the remains. The rod stays, $1\frac{1}{2}$in. long and $\frac{1}{8}$in. diameter, had wasted away to the thickness of a domestic pin at the middle. They were made of the alloy used for making commercial brass screws.



FIREBOX DOORPLATE

Fig. 127.

Girder stays are the best to use for small locomotive boilers for supporting the crown sheet. They are easy to make and fit, there is freedom from leakage, and they convert the back end of the boiler into what is virtually a box girder, one of the strongest forms of construction. My pet version is shown in the longitudinal and cross-sections of the boiler. The side stays are each made up of two-channel sections riveted back to back and the middle one is formed by two angles. To make the side stays cut four pieces of 16-gauge sheet copper to the dimensions shown, bend the flanges in the bench vice and rivet each pair back to back with nine $\frac{3}{32}$in. copper rivets. The middle stay is formed from two pieces of $\frac{1}{16}$in. sheet copper, cut and bent as shown and riveted together with the flanges outwards.

(Continued on page 32)

A CAMERA KITE

by C. Morgan

THE popularity of "kite flying", made it a very ancient as well as a modern pastime. The fascination of getting something into the air has a direct appeal to almost every boy, and the fact that there exist kite clubs, with many adults as members, is proof enough that the popularity is on the increase.

With this in mind, plus the added fascination of photography, the idea of a combination of the two activities was conceived. The purpose of this was to be able to take aerial photographs without hiring an aircraft, or purchasing balloons, bearing in mind that the gas cylinder plus fittings can run to a tidy sum. No attempt has been made to use the idea on a commercial basis, neither has the writer approached the local Town Clerk for a possible survey commission to photograph the town, etc., but this is the germ of an idea.

Most old hands will probably know how a high flying kite is constructed, and in case the "dim days" have dulled the memory a little, reference to the diagrams will soon recall the once forgotten facts.

Construction of the Kite

The size of the kite is 5ft high, and 3ft wide, almost diamond in shape. The two main spars, or struts, are of bamboo or lightweight wood. The sheet is of cotton, and for the construction of such a large kite, was obtained from the lady of the house. On the presentation of a bunch of her favourite flowers, she also agreed to cut the desired shape out, double hem the edges, sew in the tabs and pockets, and look very satisfied afterwards.

In purchasing the bamboo spars, select those which are even throughout their entire length. The width should be about half an inch, with no splits at the ends. Smooth the ends of the spars after cutting to size, then bind the ends with insulating tape to stop them wearing a hole in the pockets when the kite is in flight. The spars are then ready to be assembled. With thin stout twine such as is used for sewing leather together, bind them together as in the diagram. The longer spar will be underneath when the whole kite is assembled.

The next step is the sheet. Reference to the diagram will explain the size and shape you ought to have if you make it yourself. Remember to measure an inch larger all round, to allow for double hemming the seams—best done under a woman's supervision and guidance perhaps. The pockets can be made from the off-cuts from the sheet. They are simple to make, the purpose of them on the kite being to hold the spars in position, and keep the sheet spread on the frame.

Referring to the diagram, it will be seen that on the spars are black dots. These indicate that the sheet has to be secured to the spars at these points. Small loops of not more than 2in. in length should be sewn into place and the canes passed through them. The centre of the kite has to "billow" in order to get lifting power, whilst at the same time the porosity of the material will allow the kite to remain steady in the air. If this were not so, the air under the sheet would spill out at the sides and in so doing cause the kite to weave about in the sky. This is very undesirable as the movement, although not very obvious from the ground, could cause the aerial photograph to be blurred.

The semi-circular dotted line "C" in the illustration, is the loop line. On this line depends the angle at which the kite will fly. Using very strong cord, having a breaking strain of at least 25lb, secure one end to the long spar at a distance of 12in. from the nose of the kite. Measure off 5ft of cord and secure the other end to the long spar at a distance of 3ft from the first knot. To this loop line is attached the flying line that will determine the height to which the kite is allowed to rise. The flying line needs to be of good quality, and a breaking strain of at least 25lb is required.

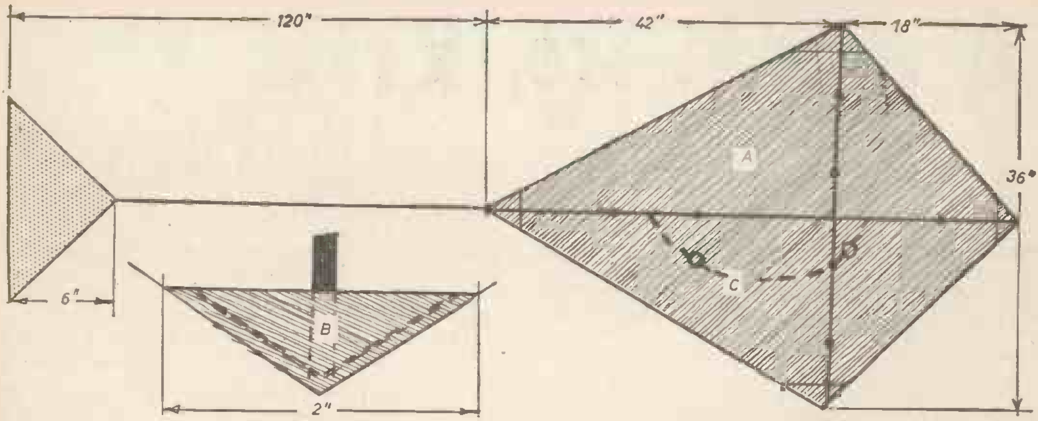
If reference is made to the diagram of the tail unit, it will be seen that this also is a simple affair. The constructor can use balsa wood to manufacture it, with the cord holding the tail to the main frame glued on. In flight it will then rotate and if the tail has been painted two different colours the effect will be very noticeable. The length of the cord used on the writer's model was 10ft between tail and frame. This will not be the same for all models, as no two kites are the same. A little experimenting with the length will soon bring satisfactory results. If the kite leaps into the air, with the tail drooping, then shorten the distance between tail unit and the frame. If the kite takes to the sky but in flight weaves about, then the distance between the tail and kite should be increased.

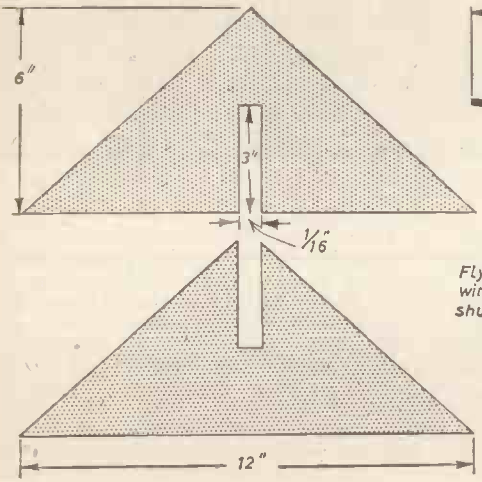
Fixing the Camera

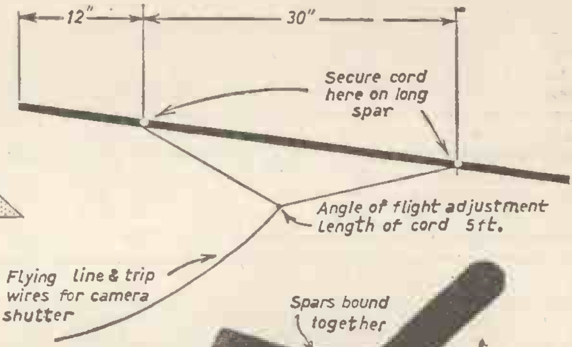
If reference is made to the illustration of the spars, it will be seen that glued to them are pads of soft or foam rubber. This is to prevent the vibration that the wind blowing on the kite and flying cord causes, from being transmitted to the camera. The best way of fixing the rubber, is first to decide on the camera to be used, and then mark the position where the camera will be secured in flight. Use an adhesive such as that used for sticking on rubber soles to shoes, for the job, and when dry, secure the camera in position with strong rubber bands.

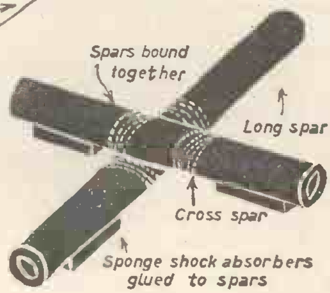
Construction of the "Tripping Gear"

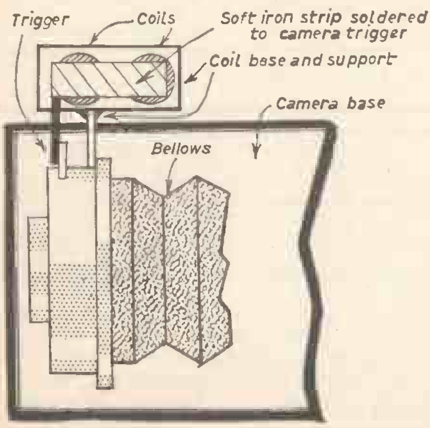
In order to take the aerial photo, some means of tripping the shutter of the camera is required. To do this, an old battery door bell was pressed into use. All that is required of it is the two coils with

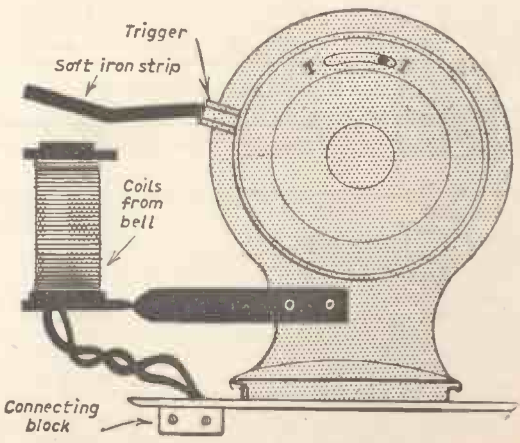

120"
42"
18"
36"
A
C
B
6"
2"


6"
3"
1/16"
12"


12"
30"
Secure cord here on long spar
Angle of flight adjustment
Length of cord 5ft.
Flying line & trip wires for camera shutter


Spars bound together
Long spar
Cross spar
Sponge shock absorbers glued to spars


Trigger
Coils
Soft iron strip soldered to camera trigger
Coil base and support
Camera base
Bellows


Trigger
Soft iron strip
Coils from bell
Connecting block

the small piece of metal that holds them together on the metal frame, and the armature. The camera to be used for the aerial photograph governs the position in which the tripping unit should be mounted. In the writer's prototype, the camera used was an old "Coronet" that had seen many good sights at ground level, and was considered by modern standards as being "out of date".

The two coils from the electric bell, were positioned on the side of the camera about 2in. away and 1in. below the trigger lever of the camera. This was arranged by mounting the coils on a piece of aluminium sheet, and fixing the coil platform to the front of the camera with two 6B.A. nuts and bolts. All surplus metal should be filed or drilled away from the coil platform and associated parts to help to lighten the assembly. When the coils have been fitted into position, it is then possible to see where the armature will have to be positioned in order to trip the camera.

If a box camera is used (and they are very suitable for aerial photography), make sure that no light will creep in where any fixing holes have been drilled. To be doubly sure, stick a piece of black material over them. In most of the cheaper cameras, the camera shutter lever has sufficient projection to allow a small brass lever to be soldered to it. This needs to be of such a length that when the shutter lever is pressed down it will reach the coils. When this requirement has been met, the original armature of the bell, minus the hammer, can be lightly soldered into such a position, that, when the coils are energised by the application of a 4V battery, the armature is attracted towards the magnets of the coil and operates the camera shutter. When the correct position has been found, solder it into position more firmly. Operate the shutter several times with the battery, and observe that the shutter does open and close each time.

The ends of the magnet coils should be connected to a small insulated terminal block, so that the long leads which operate the camera when it is in the air, will not cause the wire leads on to the coils to be broken. The length of twin wire necessary will depend on the height at which the kite is to be flown. It should be as light as possible, as it does not have to take any strain. The flying line does this, not the wire. If the intending constructor has a search in one of the larger and cheaper national multiple stores, he will find there a highly suitable wire.

Do not fly the kite at more than 100 to 200ft, as detail will tend to be lost. When the writer first constructed the prototype, he was puzzled by many double exposures. This was not due to any mechanical or electrical fault, but due to over-interested spectators who operated the trip switch while his attention was distracted elsewhere! Seeing that a kite capable of lifting several pounds, and having the ability to be able to take photo's also, is bound to attract a considerable amount of attention, it is best if the battery is kept in the pocket. When the time has come to take the photograph, plug into a 12V battery one end of the trip wire only. The other end is then dabbed smartly on and off the battery so that the shutter will be tripped once only. The reason for the 12V battery is that the wire used has a certain resistance, and requires extra voltage to overcome this. Another point is that the extra voltage will ensure the armature being pulled in with a reasonable force.

How to Get Best Results

The kite will gain height and stay steady in flight if the angle of the sheet to the ground is about 30deg. This can be obtained by adjustment of the loop line and the flying line. Get an assistant to hold the kite at the desired angle and then secure the two cords together. Try the kite first with a dummy load equal to the weight of the camera, with the wires attached. This will find out the defects, if any, before the camera is mounted into position, and perhaps save the camera from damage. Remember to print your name and addresss on the kite in case of a breakaway. It is worth while to promise a reward to the finder.

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the 'METRONEONOME'

(Continued from page 23)

lent anchoring points for the rest of the components. The construction is extremely simple and the circuit can be put together in a matter of minutes. Miniature wire-ended or screw-in type neons may be used having a striking potential of about 60 volts. The writer tried several different types with equal success. The 135v supply was obtained from two 67½v batteries connected in series, but any battery of 90 volts or more can be used providing the time-constant components are reduced in value to suit. The circuit lends itself to many variations on the original theme, as has already been stated, and one does not require electronic experience to achieve interesting results.

Calibration

A stop-watch was used to calibrate the original device but any watch with a second hand would serve equally well. A rough cardboard dial affixed behind the 1MΩ control pointer was used for the initial calibration, the markings being then transferred to a more respectable looking dial. This had a radius of 2½in., thus providing a greater scale length and increasing the degree of accuracy.

PARTS LIST

4	60v miniature neon lamps
4	1μF, 250v wkg. capacitors
4	1 MΩ resistors
1	100 kΩ preset potentiometer
1	1 MΩ potentiometer with switch
1	2-pole, 3-way rotary switch

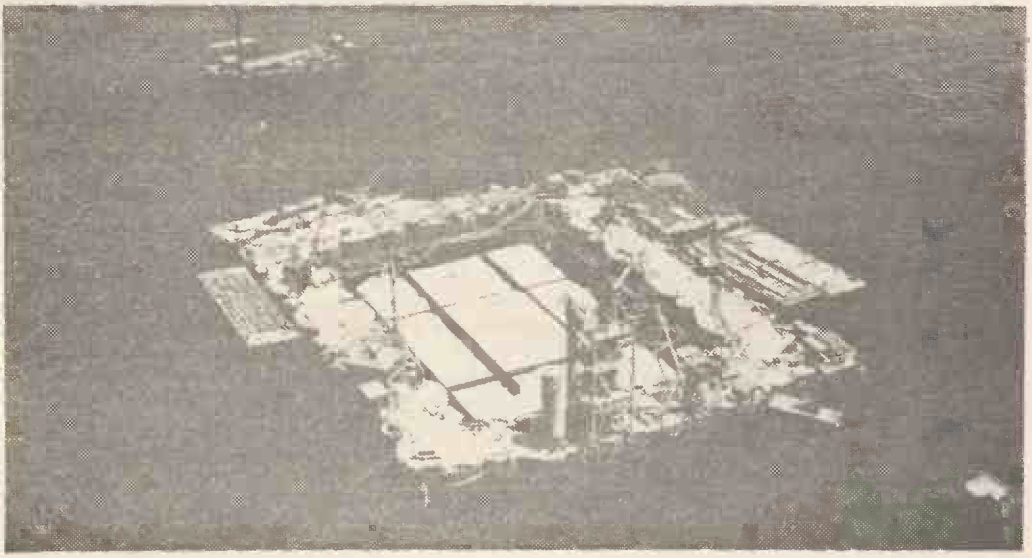
HOW BRIDGES ARE SUPPORTED THROUGH MUD AND WATER

By R. J. SALTER, Lecturer in Civil Engineering, Bradford Institute of Technology.

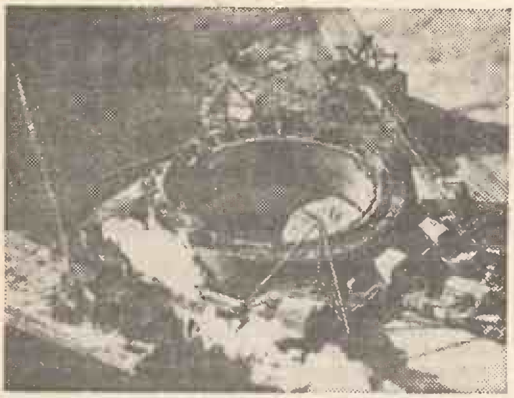
ONE of the most difficult and dangerous jobs in building a great bridge is not the erection of the towering steel and concrete spans which stretch far up into the air, but building down through mud and water to reach a solid foundation. Few people give a thought to the drama which took place to build this part of the bridge, which lies hidden for all time beneath the water. Sometimes the bridge builder is fortunate in finding a firm layer of rock on the river bottom upon which the bridge can be quite safely supported. At other times it is found that the water is deep and that there is a great depth of mud before solid ground is reached. It is then that the bridge builder pits his skill against the forces of nature and on occasions loses both his reputation and his life in the battle.

One of the greatest weapons of the bridge builder in this struggle is the caisson. In its simplest form it is a large steel cylinder open at both ends. It is placed upright in the water at the site of the bridge and held truly vertical by timber supports driven into the soft river bottom. At first the great weight of the steel cylinder is enough to start it sinking slowly down into the mud. There soon comes a time however when the friction between the mud and the cylinder walls is too great and the caisson slowly comes to rest. Then is the time for cranes fitted with clamshell bucket grabs to go into action. They lower the grabs down inside the caissons and bring out the mud from within. When the mud is dug out from beneath the bottom of the caisson it starts to sink downwards once again. Day and night the digging and sinking goes on until at last the caisson reaches solid rock. All the mud and dirt is then cleaned out from within the steel cylinder and concrete poured in making a strong column to carry the weight of the bridge down to the solid rock. One caisson is not strong enough to take the weight of a large bridge and so sometimes a great many are joined together in the form of a large box. Often a dozen or more are arranged side by side and the spaces between them filled with concrete. The whole box is then sunk down into the river bottom, digging out the mud from inside the cylinders as before. Where the water is deep at the site of the bridge the steel caisson can be built at a nearby shipyard and then floated into place. At the exact site of the bridge pier the caisson is slowly sunk down through the water and then through the mud and slime. As the caisson sinks its sides are built up so that they are always above the surface of the water.

Often men have to go down inside these caissons and this means that the water has to be



A temporary wall has been built around the site of this bridge foundation, the water pumped out and the cutting edge of the rectangular box caisson assembled on the dry floor. Slowly it will sink down through the mud, the sides being added to all the time, to keep them above the surface.



This is a circular steel caisson sinking down into the mud beneath the waters of the Straits of Mackinac in the United States. Barge mounted cranes dig out the mud from inside the caisson whilst the sides are slowly built up.

pumped out. The trouble is that as fast as the pumps suck the water up from the inside of the caisson more rushes in through the mud to take its place. It was many years before engineers learnt how to overcome this difficulty by using the pneumatic caisson. Like very many famous discoveries the idea behind the invention is quite simple. An airtight cover is placed over the open top of the caisson and air is then pumped in so that the air pressure within is considerably greater than normal atmospheric pressure. Providing that the pressure is great enough it prevents water running into the bottom of the caisson, thus making it possible for work to go ahead in the dry. The farther down below the water surface that the bottom of the caisson is, the greater is the water pressure, and so the greater is the air pressure necessary to prevent water flowing into the caisson bottom. One of the most famous early bridges which was built in this way was the Royal Albert Bridge at Saltash. Many years ago caisson workers spending too long in the caisson often suffered attacks of "the bends" which could easily prove fatal. Today men work for only a short time under high pressure, sometimes spending as long as two hours in special chambers where the air pressure is lowered very gradually until it reaches that of the outside air. This allows the nitrogen absorbed in their blood, like gas in ginger beer, to escape gradually and harmlessly.

Caissons have been used in the construction of the first really long-span suspension bridge to be built outside the United States. This is the new Forth Road Bridge now being erected near the famous railway bridge. When the new bridge is finished the two bridges standing side by side will present an inspiring sight with their tremendously long spans reaching out across the waters of the Firth of Forth. The north suspension tower for the bridge was founded upon the Mackintosh Rock but at the site of the south tower the rock was about 111ft below the high water level, and between the rock and the water was a considerable depth of clay and silt. Two caissons, side by side, were chosen by the engineers for the bridge to carry the heavy loads on the suspension towers down to the solid rock. First step in the job was to drive heavy sheets of steel down into the clay bed of the Firth of Forth. They were driven down so that they formed two circles which just touched each other. When seen from the air they formed a wall with the shape of a large figure eight. The soft mud inside the two circular walls was then dredged out with clamshell grabs until the firmer clay was reached. Next the water was pumped out and all was ready to start sinking the two caissons down through the clay to reach the solid rock beneath.

To start the caisson sinking, two 60ft diameter steel cutting edges were assembled on the dry clay floor within the figure eight. Above the cutting edges were built up the hollow steel-walled caissons. On the outside these were tall steel cylinders, whilst on the inside each had a dome-shaped steel roof a short way above the cutting edge. Between the domed roof and the clay floor was the working chamber where men and small excavating machines dug out the clay, so allowing the caisson to sink deeper towards the bedrock. In the top of the dome-shaped roof was a circular opening which men and machines, and also the clay they dug out, could pass through. If a great deal of water had poured into the working chamber through the clay an air-lock could have been fitted above this opening and the work carried out under air pressure.

As the steel shell of the caisson sank down into the clay the caisson was strengthened by filling the hollow walls with concrete. When at last the cutting edge of the caisson rested on rock the working chamber was completely filled with concrete. The space inside the caisson above the working chamber was then filled with large boulders and concrete. Finally a 20ft thick slab of concrete and steel was built over the top of the caisson, giving a base upon which the tall graceful suspension tower could be built. A large and difficult feat of engineering had been accomplished which will remain hidden for all time beneath the waters of the Firth of Forth.

L.B.S.C's Evening Star

(Continued from page 27)

As the cross-stays supporting the upper part of the firebox wrapper have to pass through the girders, drill five $\frac{1}{16}$in. holes in each in the position shown in the longitudinal section of the boiler (Fig. 122 last instalment), then rivet the middle one to the top of the firebox, on the centre line, and the other two with their vertical centre lines at $\frac{7}{8}$in. on either side of it, bringing the distance between the inner sides of the plates to $1\frac{5}{8}$in. Use $\frac{3}{32}$in. copper rivets at approximately $\frac{1}{4}$in. centres with the heads inside the firebox. Make sure that the crown stay flanges bed tightly down to the firebox top for their full length.

EASY TO MAKE

ANTI-DAZZLE LENS

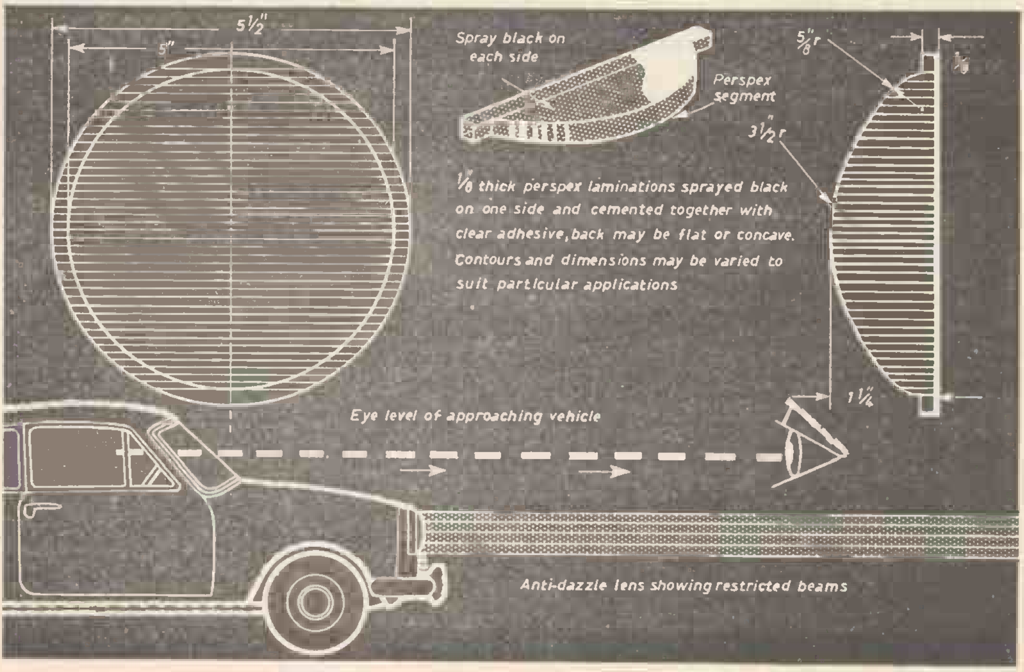
BY B.G. COOK

As seen from the drawing, Perspex strips are cut to shape, 40 strips in all for a 5½ inch diameter lens. They are then laid flat on a bench and sprayed with a black paint, then when dry, a suitable adhesive is used to assemble the strips side by side to make up the lens shape. Heavy pressure is applied and when dry the lens is highlv polished.

The lens described above was used on a motor cycle for experimental purposes only. Sitting behind the headlamp it was noted that the beam of light was sufficient for fast driving. If the lens is viewed in a central position by eye the masking cannot be seen, but if viewed from the seat of an oncoming car the beam rapidly disappears.

Each section of the lens was cut to shape by fretsaw, then filed to shape. A rim was formed by leaving a tag on the end of each segment, this rim is required so that the lens fitted the existing headlamp rim. All kinds of shapes can be made, and any colour can be used for masking.

If you have access to a lathe, it would simplify the shaping considerably if, having cut the segments, they are painted and glued together. The whole assembly can then be glued to a faceplate on the lathe and turned to the desired shape. This method should also facilitate polishing.



By A.P. Kitchin

ADAPTING AN OLD TYPE OF TRIPOD

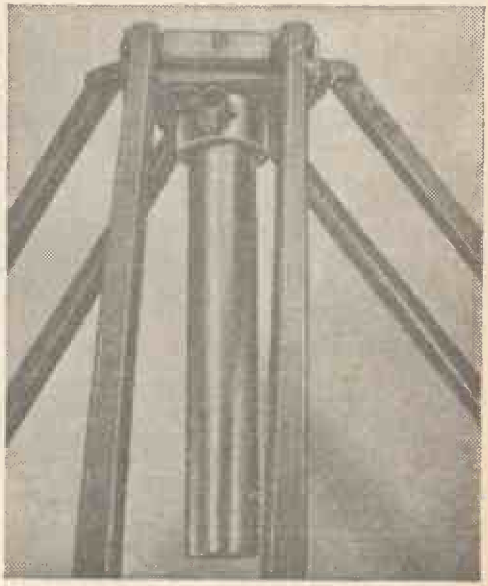
THE older type of folding wooden tripod, although rather cumbersome by modern standards, does give a very firm support. The fitting of a centre pillar much increases its usefulness, especially for indoor and close-up work. I have been using one originally made some 50 years ago for a half-plate camera, fitting it with a centre pillar carrying a pan and tilt head derived from a war-surplus astro compass.

The head of the tripod, a brass triangle to which the legs were hinged, was replaced with a wooden one made from three pieces of ½in. oak, glued and screwed together, with the grains crossing to prevent warping. The centre was bored out to be a tight fit for an 18in. length of 1¼in. diameter aluminium tube. The pillar was turned down from a 2ft length of 1½ x 1½in. oak, to be a smooth sliding fit in the tube. A 2in. square was left at one end to take the tripod head. A ⅜in. bolt with the head cut off was driven into the top of the pillar, leaving ½in. protruding to secure the pan and tilt head. This bolt was fixed in the pillar by drilling through both and driving in a cross pin.

A collar from the astro compass was fitted round the tube and screwed to the underside of the head. It carries a bolt which can be screwed in to lock the centre pillar in position. Two longitudinal slits were cut in the centre tube opposite the end of the bolt, the aluminium being sufficiently springy to grip the pillar but release it again when the bolt is slackened off.

When assembling the tripod the tube was simply driven into place through the collar and head, needing no further fixing. The hinge pins for the legs were made from short lengths of brass rod soldered to brass curtain rod strip. A wooden turnbuckle on each side prevents the legs accidentally springing inwards and coming off the pins.

The pillar can be reversed in the tube to use the camera close to the ground between the tripod legs, the total height range being 5ft. I use the tripod chiefly for a twin-lens reflex camera and grooves cut in the pillar at distances equal to the between-lens distance make adjustments for parallax very simple.

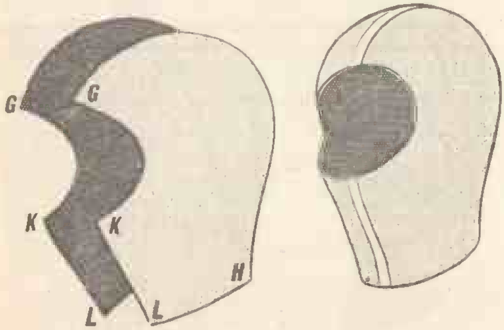


a Wet Diving Suit

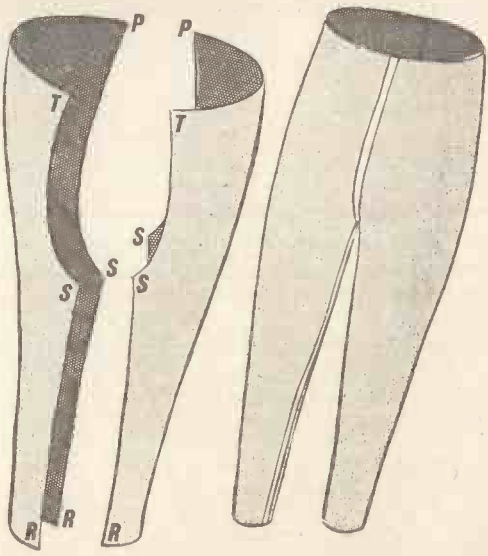
By B. R. Pearce

THE wet diving suit described is made from foam neoprene sheet, assembled using a readily available adhesive. The suit will support the weight of a person in the water and requires no effort by the individual to keep afloat. It is thus ideal also as a water ski-ing suit. For diving a weight belt is required and about 18lb of weight will be needed . This varies from person to person however, and should be determined by trial. In the event of an emergency the weight belt can be released and the diver is then supported by his suit until help arrives. The suit is tight fitting but allows a certain amount of "seepage". This water is soon warmed to body temperature and retained by the suit, thus protecting the diver from cold waters and prolonging endurance.

A $\frac{3}{16}$in. skin/skin foam neoprene sheet is recommended as being the most serviceable. All the materials were obtained by the author from:

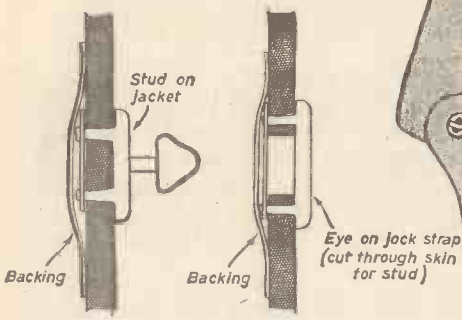


Figs. 1 and 2.



Figs. 3 and 4.

Fig. 5.



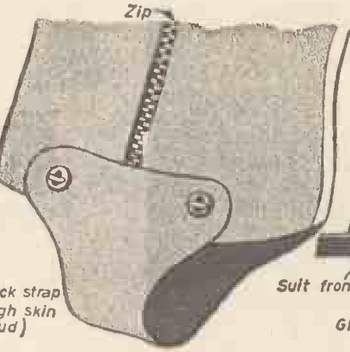
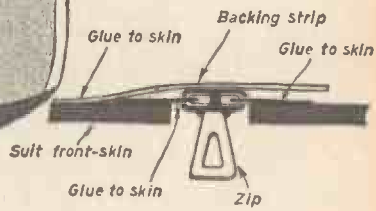


Fig. 6.



Sub-Aqua Products, 63 Twyford Road, Eastleigh, Hants. The cost of these items was about £8 5s.

Neoprene sheet skin/skin: 9in. x 34in. x $\frac{3}{16}$in.
22½in. x 34in. x $\frac{3}{16}$in.

Yellow neoprene tape ½in. wide x 36ft

Two stud fasteners

One zip fastener (length as required)

Half-pint 'Evostik' 528 adhesive

Cutting Out

A paper pattern should be cut out and each piece laid on the neoprene sheet and marked out with a ballpoint pen. The items should then be cut out.

The pattern is shown drawn on a 3in. square grid and was designed to suit a man 5ft 11in. tall, 38in. chest, 31in. inside leg, 20in. armpit to wrist, 31in. waist. Adjustments may be made according to individual requirements, always remembering that the suit should fit skin tight. The important factor is to maintain the correct limb lengths—e.g., inside leg. Due to material stretch, girth measurements (e.g., chest) are not too critical.

Hood

Apply adhesive to edges GH and KL in Fig. 1. Leave 10 minutes then press edges together carefully to achieve the finished hood (Fig. 2). With a ½in. brush apply adhesive to the hood seams and to two lengths of yellow tape (cut to length). After 10 minutes apply tape to hood seams.

Trousers

Apply adhesive to edges RS (Fig. 3). Join edges to produce legs as shown in Fig. 4. Apply adhesive to edges ST and PS and join trouser halves together (Fig. 4). Apply yellow tape to all seams as for hood.

Jacket

Apply jock strap to jacket back at seam FF (Fig. 7). Join edges EF ond HG, thus joining jacket front halves to the back. Join edges AB and CD on both sides.

Taking both halves of one sleeve, apply adhesive around armhole AC-EH and to each sleeve half

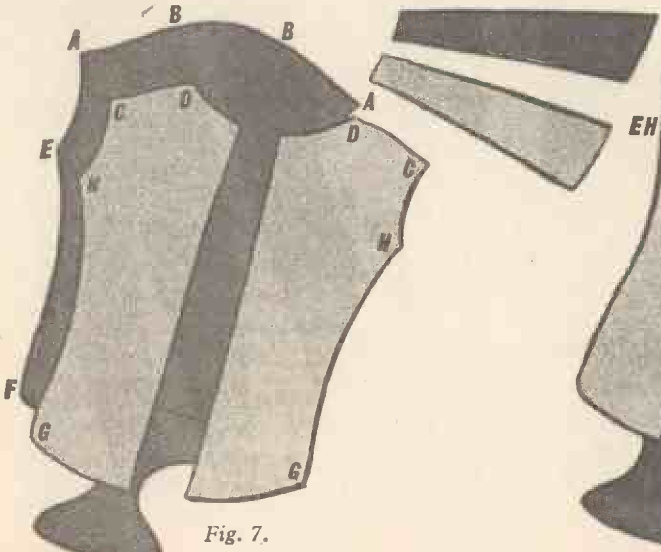


Fig. 7.

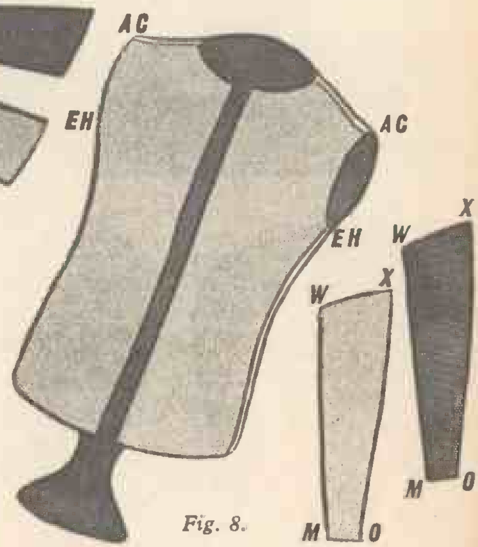
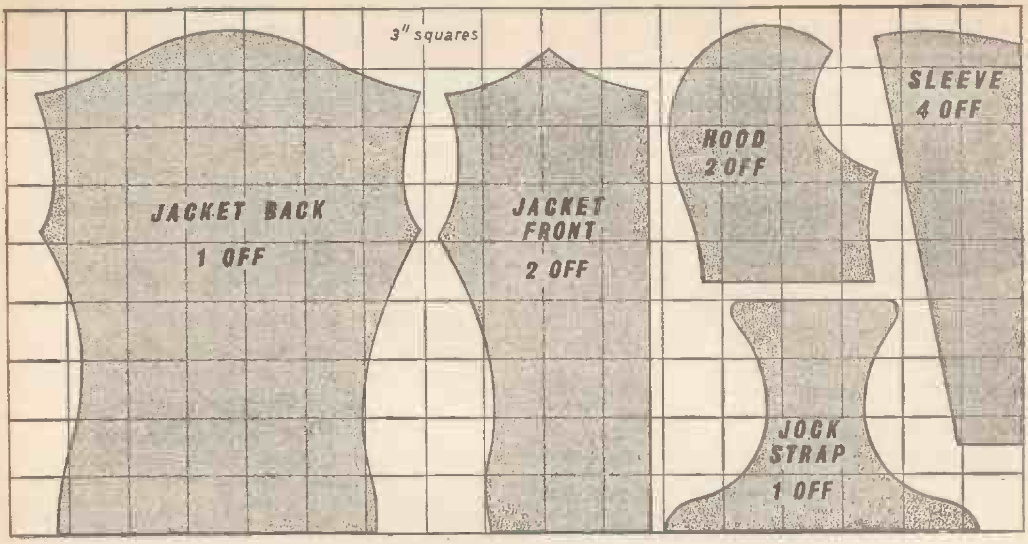


Fig. 8.



XW (Fig. 8). Join sleeve halves to armhole. Repeat on other side of jacket. Apply adhesive to seams OX and MW on all four sleeve halves. Join seams to form finished sleeves.

Apply $\frac{3}{8}$in. wide strip of adhesive to the inside edge of jacket front and to one side of zip backing. Join as in Fig. 6. Repeat with other side, thus assembling zip to jacket. It is advisable to back the zip with a 3in. x $\frac{1}{8}$in. strip of neoprene as shown. The length of the zip will vary according to the jacket length.

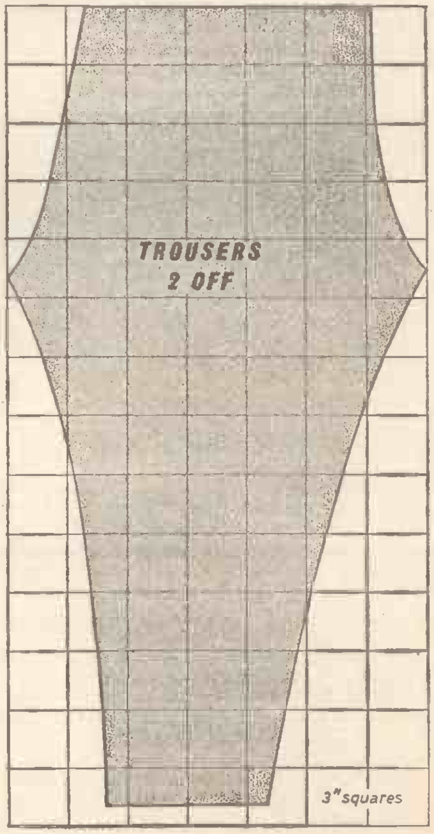
To complete the jacket, fix studs on jacket front and eyelets on jock straps as detailed in Fig. 5. If the strap is found to be too tight, cut and insert a piece of scrap neoprene to give the required length. Finally, tape all seams as for hood and trousers but first check the suit for fitting as below.

Final Adjustments

Apply talcum powder or french chalk to the inside of the suit and put it on. If the trouser waist is too large a long wedge-shaped cut can be made from the waist. Adhesive is applied to cut edges and they are rejoined. The reverse process (i.e., adding a wedge strip) will increase the waist. The suit will feel somewhat tight out of water but frees when water has seeped in. So do not make drastic modifications until after water trials! Jacket alterations can be made similarly by cutting out or inserting strips of neoprene. If the hood face opening has to be enlarged this should be done carefully, a little at a time between fittings in conjunction with the diving mask.

Repairs

Tears in the suit can be merely rejoined with adhesive, which gives a joint as strong as the material. The author's suit has been in regular use in sea water for three years and is still " going strong ".



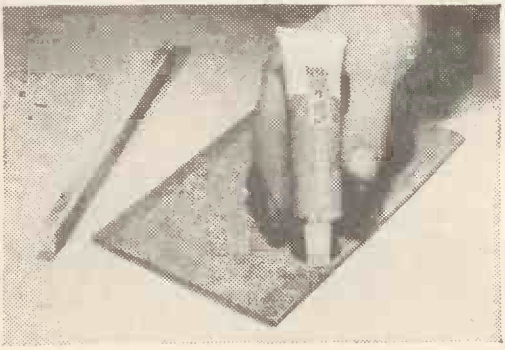
TRADE NEWS

Cleanscreen

THE "Cleanscreen" consists of a ⅛in. thick rubber squeegee let into a solid, easy to hold handle and backed by a strong plastic flange, which extends to just short of the non-scratch rubber wiper blade.

Although the 4½in. wide rubber wiping blade is strong and flexible, the plastic backing blade gives the extra rigidity and may itself be used to shift even hard frozen snow in winter, and obstinately stuck insects and road film in summer.

Made in Derby, the "Cleanscreen" is at present being marketed by Multifabs Ltd., 25 The Wardwick, Derby. It can be obtained by mail order for 5/11d. plus 1/- post and packing. The makers are confident that this simple but very practical window cleaning aid will receive a warm welcome from many motorists.

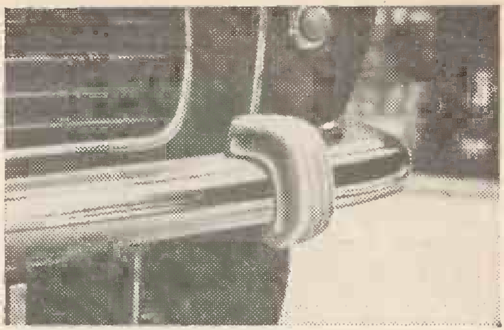


Evo-Stik

TUBES of Evo-Stik "Impact" Adhesive are now being sold with this exclusively designed cap on which is moulded a serrated plastic spreader.

The cap, which is unbreakable, is made of a special flexible plastic and therefore can be easily removed. The spreader provides greater control over the distribution of the adhesive on the area to be bonded, giving a speedier bonding operation and reducing the likelihood of the user's hands being soiled. It is most suitable for work on small areas. A special nozzle built into the cap seals the tube when not in use.

The cap was designed by Evode Ltd., manufacturers of Evo-Stik "Impact" Adhesive, in conjunction with the tube makers.

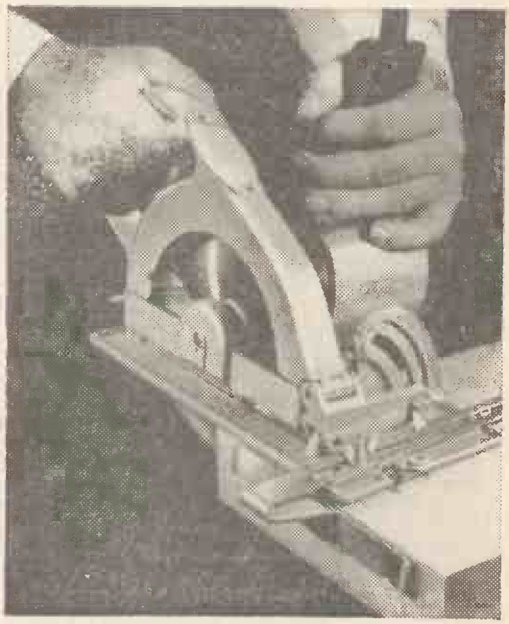


Tudor "Deefenders"

FROM Tudor Accessories of Hayes come "Deefenders" an accessory that takes the impact out of bumper collision.

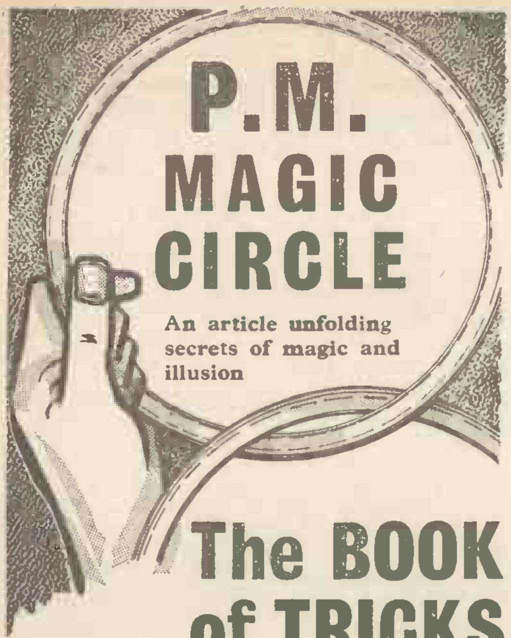
Moulded from resilient white rubber and designed to blend with the contours of most popular cars they snugly sit on to the bumper blade and absorb these costly knocks, bumps and scratches. Easily fitted, the existing bumper bolt holes form the anchor points. This accessory retails from 30/- per pair.

Now available for:— B.M.C. Mini Range, Ford Anglia 105E, Hillman Minx and Super Minx, Morris Minor, Singer Vogue, Vauxhall Victor.



Power Driven Saw Has Special Dust Ejector

THE new Mark II Nu-Rip saw attachment, powered by the Neonic drill. This has a special device which ejects sawdust through the handle and away from the working surface. It gives an uninterrupted view of the guide lines which makes cutting more accurate.



P.M. MAGIC CIRCLE

An article unfolding secrets of magic and illusion

The BOOK of TRICKS

1

The "Book" ready for use.

BRIGHTLY coloured silk handkerchiefs, clocks, rag dolls and a host of other production material pour out of the pages of the Book of Tricks after the volume has been shown to be empty. The miniature conjuring illusion is mounted on a rotating stand so that the whole exterior—front and back—of the book can be shown to the audience. Front and rear book covers are opened wide to give a clear view right through the apparatus then paper pages on thin ply frames are fitted into the book front—Fig. 1—and the production is made by plunging the hand through the paper to bring out the various articles.

Book Case and Page Frames

Mark out the sides and ends of the book case on $\frac{3}{8}$in. plywood with the pieces $8\frac{1}{2}$in. wide. Sides are $19\frac{1}{4}$in. high with top and base pieces 16in. long. Notice how the ends of the top and bottom pieces are curved to act as formers for the rounded binding strip, Fig. 2. Glue and pin the frame pieces together then make and fit an additional inner frame using lengths of $\frac{1}{2}$in. thick planed wood 7in. wide. The inner frame is fitted so that its back edge is flush with the rear edge of the outer book frame. Affix the frames with small screws to make a rigid box of the book frame.

Saw out an extra curved ply former to fit midway behind the binding strip and nail to the book case. Actual binding piece is bent from a 9in. by 20in. strip of thin aluminium by pressing round a large diameter tube to obtain an even curvature. Slots for the hinges to mount front and rear covers are cut in the edges of the metal strip at positions 4in. from top and bottom but it is advisable to leave the final fixing of the binding strip until the covers are hinged in place.

Three frames for the production pages are cut from pieces of $\frac{1}{4}$in. ply and are made to be an easy fit in the recess formed by the thick inner frame of the book case. Centres of each frame are cut away and a small bead is fastened to the upper right-hand corner of each frame to give a finger grip when the frames are removed from the hook during the routine.

A short length of thin clock spring is bent and screwed into the frame recess to give a positive grip on the page frames. Screw holes can be punched through the spring using a small pin punch on a block of lead. The pair of wedge blocks used to mount the book on the rotating stand measure 8in. by 2in. and they slope from $1\frac{1}{2}$in. at the front to 1in. at the rear. They are drilled to take the fixing woodscrews plus a single central $\frac{1}{4}$in. hole for the mounting coachbolt.

Front and Rear Covers

Cover doors for the book are of $\frac{1}{4}$in. thick ply and measure 14in. wide by 20in. high, Fig. 3. The doors are hung to the case with 2in. by 1in. brass hinges and the sketch shows how these hinges are fitted to the main case with a $\frac{1}{4}$in. out-set to allow for the thickness of the doors. Fixing the doors this way permits 180 degree opening—necessary for routine performance of the trick.

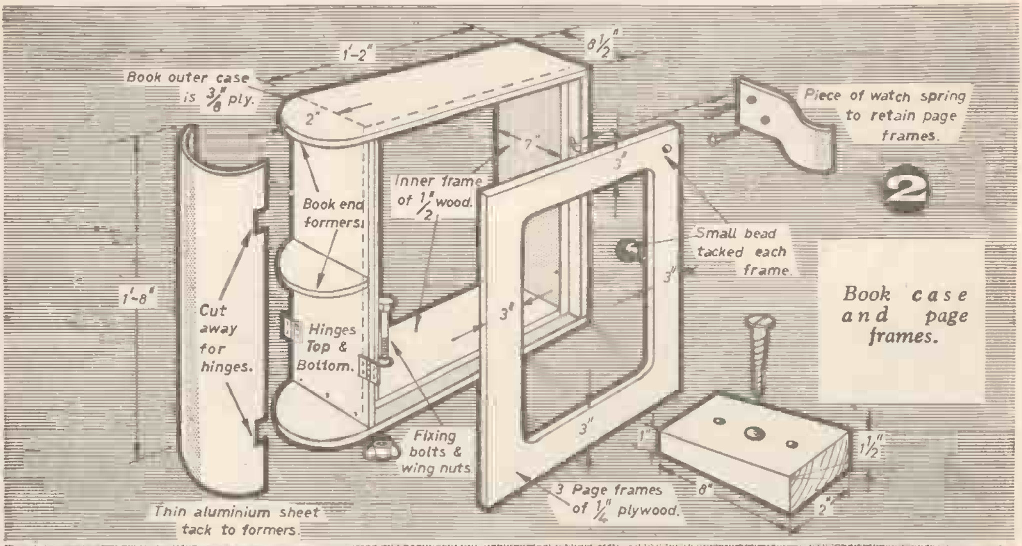
The secret compartment that holds the production load is made in the shape of a "V" and is built up of $\frac{1}{4}$in. ply. This trap has a front and back panel 10in. by 14in. and ends shaped like letter "V" with rounded top edge. These sides measure 9in. across the top and taper to ½in. at the bottom (Fig. 3).

The "V" trap works in an opening cut in the rear hinged cover as shown. This hole is 9in. wide by 12in. high and is located in the centre of the rear cover 2in. up from the bottom edge. It is necessary to assemble the actual trap inside the opening using glue and panel pins. Base of the trap makes a sort of groove which acts as a pivot point leaving the unit to swing either one side or the other when the trap is pushed to one side, only the raised panel is visible on the other side of the cover.

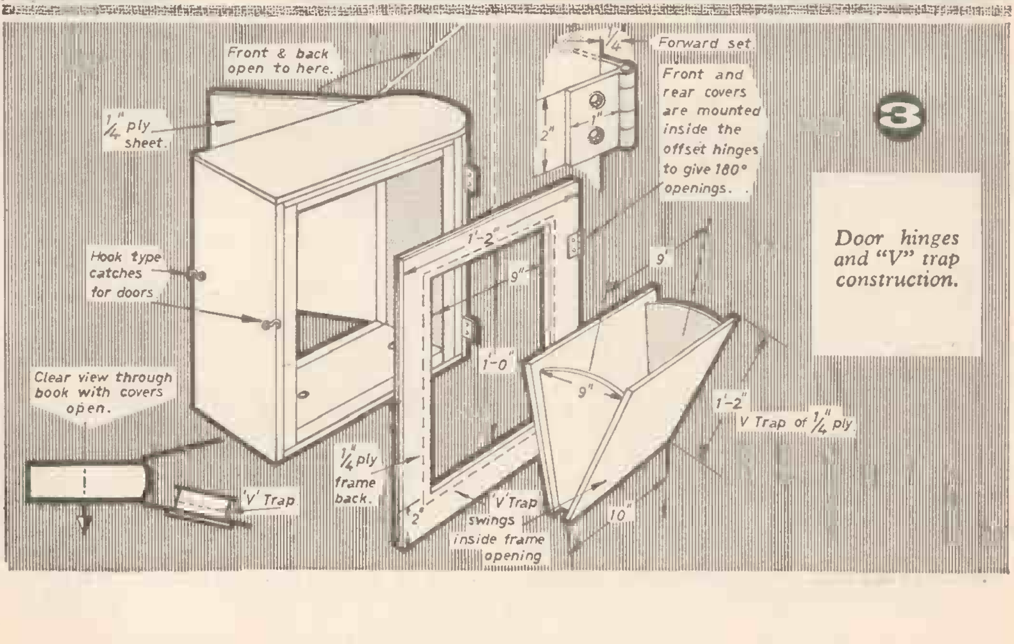
Rotating Stand

The book stand consists of two frames joined by four inward tapering dowel legs (Fig. 4). The base frame is of 3in. x 2in. section with half-jointed corners to make a square 2ft by 2ft. Screw the joints from below then round off the corners with wood shaping tool. The top frame is of 2in. square section timber and is half-jointed to make a square 16in. by 16in. Some care is necessary in drilling the dowel holes as they must be put in on the splay. Glue and screw the legs home and fit the four castors to the underside of the base frame.

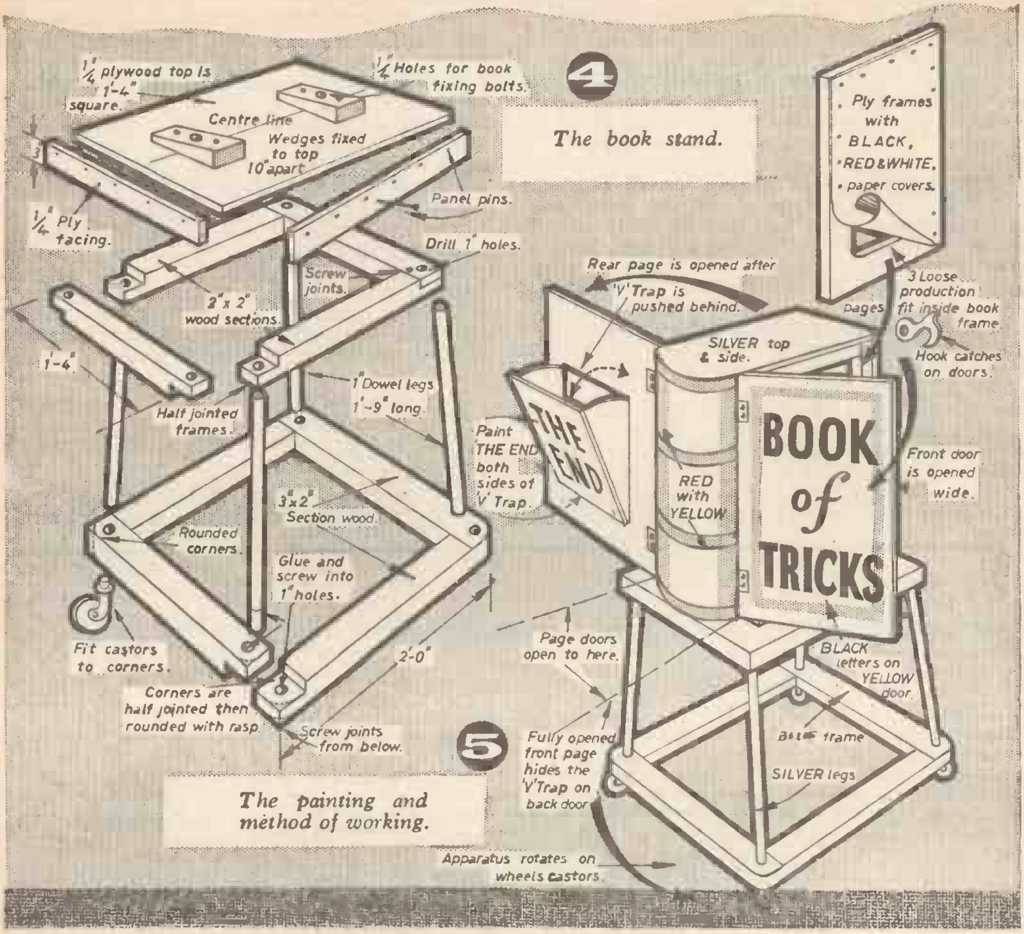
Finish the stand by pinning a 16in. square sheet of ¼in. ply to the stand top and mounting the wedge blocks in position on a centreline of 10in. apart.



Book case and page frames.



Door hinges and "V" trap construction.



The book stand.

The painting and method of working.

Drill the bolt holes through the ply platform then temporarily support the book in place and mark and drill the holes for the fixing bolts in the frame. After drilling, the book is mounted with two 3in. long coachbolts with the wingnuts underneath. Tack decorative ply facings round the platform edge.

Colour scheme for the apparatus is as follows:—Blue frames for the stand with silver leg dowels. Silver page ends for top and side of the book case and red binding strip with yellow bands. Book cover doors are yellow with the lettering BOOK OF TRICKS in black. Put a red line round the "V" trap panels on both sides and write THE END on each side, too.

Cover the three production pages with coloured paper—black, red and white—using either drawing pins or glue and decorate with suitable cut-out letters or designs as shown in Fig. 1. Of course, the pages may be left bare if desired.

Performing the Trick

Fig. 5 shows the apparatus ready to use with the load trap swung to the rear. All kinds of colourful things can be loaded into the trap ready for the production later on but it is always a good finish to pull out lots and lots of silks, so load these into the trap first. When the "V" trap is full, it should be pushed inside the book and the back cover fastened with the simple hook and eye catch.

The three production pages are fitted into the front of the book and the front cover closed and fastened. Rotate the complete unit to show all round, then face the book to the front and open the front cover wide. As you do this, pull the "V" trap to the rear—outside—with the other hand. Remove the pages one by one and stack them against a chair. Next, open the rear cover and show right through the book pushing your hand and arm into the book case.

Close the rear cover and fit the first page into position. Push the "V" trap forward as you stand at the side of the book and you are ready to break through the paper frame and produce the goods from thin air. Before you fit the second and third pages, show the book to be still empty by swinging the trap to the rear.

SEARCH FOR OIL UNDER THE NORTH SEA

THREE groups of companies—Shell, British Petroleum and Esso—are to undertake a preliminary survey of an area which might have petroleum prospects. The survey will cover some 30,000 square miles of sea outside the three-mile limit extending northwards from Lowestoft to the Firth of Forth.

The Shell Company of the United Kingdom Limited will be responsible for the survey and, weather permitting, a start will be made early in July. Work will continue for the next three to four months, will be suspended during the winter and be resumed for another four months in the summer of 1963.

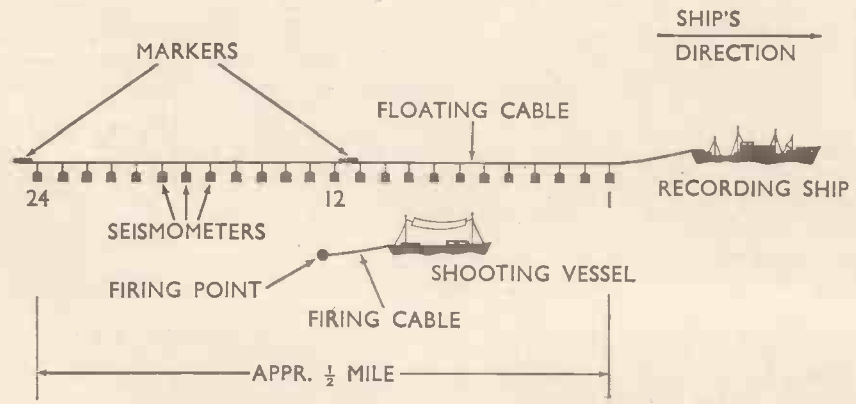
The cost of the survey will be shared equally among the three participants. The method to be used, known as a seismic survey, has long been employed on land to give geophysicists an indication of the rocks underground. Small explosive charges are set off just below the surface and recording instruments measure the impulses reflected back.

A similar technique has also been used for a number of years for exploration under the sea. In the North Sea search small charges will be fired just below the surface of the water; each of these creates quite a spectacular water spout since for technical reasons most of the energy released by the explosion must break the surface, the underwater effect being relatively small. However, it is sufficient for the very sensitive seismometers which are used in the operation to pick up the impulses which are reflected from the rocks below.

The record thus produced, which looks like a complicated graph, gives the geologists a "picture" of the rock structures under the sea bed. A seismic survey does not indicate the presence of oil. It only shows whether structures are present in which oil might have accumulated. The only means of proving whether oil is there or not is by drilling a well.

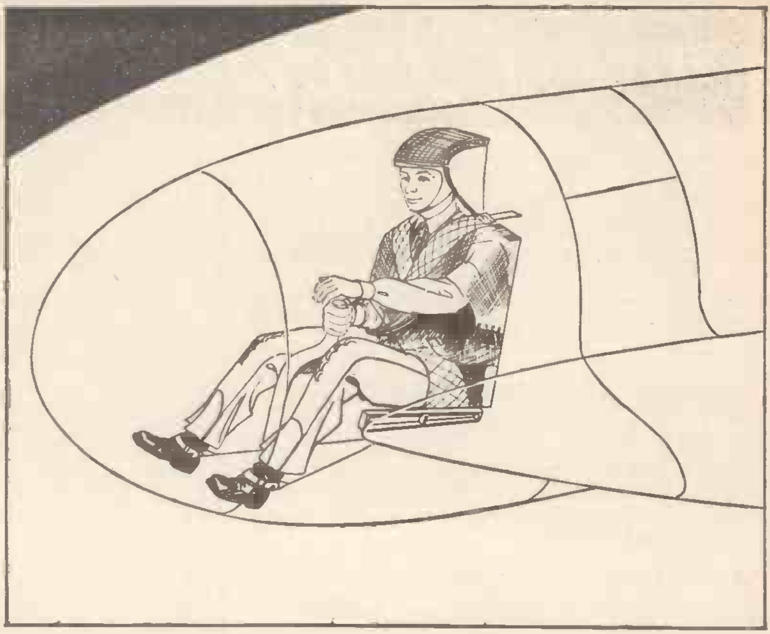
In many parts of the world the search for oil is turning more and more to exploration under the sea bed as the more obviously promising areas on land are diminishing.

A Notice to Mariners is being issued by the Admiralty warning all shipping of these activities.



OFF-SHORE OIL EXPLORATION – HOW SEISMOLOGY IS DONE

ESCAPE SPACE CLOTHING



IT is possible that a pilot of the future will be encased in a "corset" during a high-altitude escape from a troubled aircraft. This protective device will be as effective in controlling bulges as milady's girdle.

The corset is a restraining system of inflatable bladders, netting and straps that will draw an astronaut tight in his capsule to prevent injurious movements during his flight from danger. He will be unable to move a muscle within seconds after hitting the emergency escape button.

Developed for the Wright Air Development Division of the U.S. Air Force's Research and Development Command, the new gear can be adapted for any of several advanced flight vehicles such as Dyna Soar, the X-15, the B-70 and other orbital and re-entry aircraft.

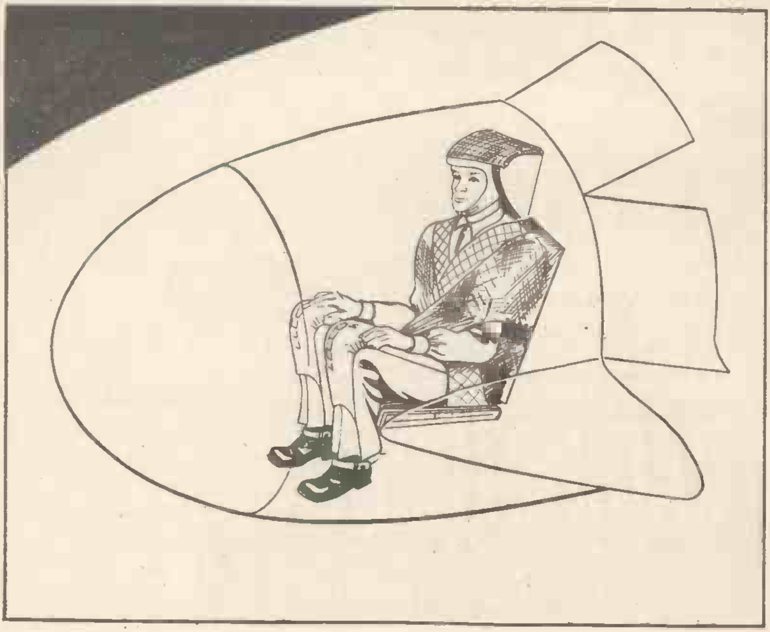
After a pilot pushes the emergency escape button he is merely "along for the ride". Straps on his shoes draw his feet inside the escape capsule, bladders around his legs, arms, body and head inflate, and the netting becomes taut. The capsule doors close and the escape unit is pressurised, air-conditioned and ejected. As the capsule descends, parachutes open.

All this will happen very quickly. From the moment the pilot activates the emergency system until his main parachute billows only 10 seconds elapse. Upon reaching the ground the pilot turns a valve to deflate his bindings.

Artist's drawing shows how inflated bladders and netting are used in a new restraint system to prevent space pilots from making injurious movements during emergency escape.

Top drawing: Shows position of the "corset" during normal flight.

Bottom drawing: When the pilot pushes the escape button, straps draw his feet inside the capsule, and bladders inflate around his legs, arms, body and head.



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A stamped addressed envelope, a sixpenny crossed postal order, and the query coupon from the current issue which appears at the foot of page 30, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the reader. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Hoover Steam Iron

I WISH to renew the 3-wire lead to my Hoover Electric Steam Iron, Model 0114. Having studied the iron closely I cannot see how to remove the handle of the iron in order to do this.—J. Charlton (Coventry).

THE temperature-regulating dial can be sprung off fairly easily, to reveal a hexagon-head screw. When this is removed the interior of the iron becomes accessible.

Walkie-Talkie Transmitters

IF I build a simple radio-control transmitter and receiver but fit a microphone and headphones instead of the key and relay, shall I be able to transmit sound? As these sets are a different wavelength to the normal amateur bands will a licence be needed to operate it? Alternatively can you supply details of a simple two-way walkie-talkie type of transmitter and receiver?—E. Pearce (Wilts.).

NO difficulty arises about transmitting solely for model control on the frequencies allocated for this purpose. The transmission of speech on these frequencies is, however, not permitted. It is illegal to transmit for any other purpose or on any other frequency, whether by speech or otherwise, without holding an amateur transmitting licence. These are only granted on passing a quite advanced examination in radio theory and morse sending and receiving. Full details may be obtained from the Engineer-in-Chief, G.P.O., London. This also applies to the various ex-government walkie-talkie sets sold by surplus shops. In any case these require extensive alteration to operate on the amateur frequencies.

Wood Preservative

I WISH to make a wood preservative using copper naphthanate. Can you tell me what solvent to use and in what quantities?—J. Goddard (Surrey).

COPPER naphthanate can be a very effective wood preservative if a sufficient quantity is used. This will depend largely on the condition of the wood being treated. An effective general-purpose solution can be made by making up a 5% solution of copper naphthanate in white spirit or naphtha (5 oz. in 100 fl. oz). Two coats of this solution may be given quite safely. If used on large areas of wood such as in a loft be very careful not to use any naked lights nearby until the solvent has completely evaporated as this creates a dangerous fire hazard.

Imitation Alabaster Casts

I WISH to produce a number of plaster casts, to resemble Alabaster and Onyx when finished. Can you advise me of any plaster casting materials that will produce these effects?—W. Westcott (Hants.).

THERE is, unfortunately, no casting material having the character of a quick-setting plaster that also possesses the surface characteristics that you desire. This is because all such materials set hard by chemical combination with the water that was mixed in. Since this was evenly dispersed throughout the plaster, the result is that the hardened object has a surface consisting of a mass of small pores, and such a surface inevitably has a matte finish and an opaque appearance. To obtain the lustrous and slightly transparent alabaster finish, it is necessary to dip the objects into hot paraffin wax and to polish them when dry. A light veining effect is obtained by lining with wax crayon before dipping; the colour is carried some way in by the hot wax.

Rewinding 100 volt Motor

I WISH to rewind a 100/110 volt universal, single phase motor taking 3-4 amps, continuous rating, so that I can use it on a 230-250 volt supply at the same current consumption. Can you give me details of the new windings required?—L. Tucker (Dorset).

IN order to convert this 110 volt motor for operation on 230-250 volts each armature and field coil should be rewound with approximately 230% of the present number of turns, using wire having a cross sectional area of approximately 44% of the cross sectional area of the present wire (approximately 66% of the present diameter). Care should be taken to make an exact copy of the present coils and the lead angle between the armature coils and commutator segments.

Surplus Gunnery Telescopes

CAN you tell me if the naval gunnery telescopes often advertised for sale are any good for astronomical purposes. What is the minimum magnification considered suitable for astronomy?—D. Stanley (Middx.).

MORE important than magnification for astronomical purposes is the diameter of the object glass, since the resolution obtained is dependent on this. If the object glass is less than 2in. in diameter the telescope is unlikely to be any use for astronomical work. A magnification of at least 30 times is required and the telescope needs to be fitted with a suitable mounting.

Rust in Hot Water System

TWO years ago I installed a hot water system in my house with a normal 30 gallon galvanized tank fitted above a copper storage tank and a steel boiler. However, if the water gets really hot it comes out of the taps a rusty, dark colour. Is there anything I can do about this?—W. Trueman (Staffs.).

YOUR trouble is almost certainly due to the steel boiler. Rust in the water appears to be quite harmless in many cases but can cause irritation to some people's skin. Messrs Allbright & Wilson Ltd, 49 Park Lane, London, W1, advertise their Micromet treatment for preventing red water in hot water systems. We suggest that you put your problem to them to see if this will help you.

Waterproof Cement Renderings

I HAVE a yard which needs cement washing twice a year. Some friends of mine only need to do a similar yard every two years whilst rain seems to wash the surface off mine. Can I mix anything with the cement wash to make it stick better?—J. Kenyon (Lancs.)

WE suggest you write to Liquitile Supply Co., 48 High Street, Camberley, Surrey, for details of "Uni-Bond." This is an adhesive which can be diluted for use with cement renderings etc. and should prove very helpful in keeping your cement wash in good condition for longer periods.

ON THE ICE CAP

(Continued from page 25)

Automatic weather recorders radio information back to the bases, providing more easily acquired, and often more reliable, figures than those obtained by man himself. Weather compilations are sent out by Russian, Argentinian, Australian and French bases, as well as by McMurdo, which radio-teletypes all this information to the International Antarctic Analysis Centre for Weather, in Melbourne.

Planes, from Super Constellations to the small Otters or helicopters, provide a quick, efficient transport system that has also allowed bases to be established where previously communications were too difficult. For instance, right at the South Pole itself. Improved designs of icebreakers and trucks; caterpillar tractors instead of sleds and barking dog teams—these also have solved problems. The old difficulty of obtaining fresh water exists no longer with the huge snowmelters available to modern exploration groups. After the snow is melted the water is filtered to remove lava dust and ash. Medically it is also checked periodically to see that it is fit for consumption. Yet no one can regret these new innovations. And even with them, the Antarctic is still cut off from the rest of the world (except by radio) for more than six months of the year. There is still, as there was with the first Antarctic exploration, a spirit of adventure, allied to a desire for knowledge. A solar disturbance can still black out even radio contact, so that in spite of all man's science Nature can yet be the master on the great ice cap.

The MARINER II SPACECRAFT

(Continued from page 5)

Computer and Sequencer. All events of the spacecraft are contained in three CC&S sequences. The launch sequence controls events from launch through the cruise mode. The mid-course propulsion sequence controls the mid-course trajectory correction manoeuvre. The encounter sequence provides required commands for data collection in the vicinity of Venus.

The CC&S provides the basic timing for the spacecraft subsystems. This time base will be supplied by a crystal control oscillator in the CC&S operating at 307·2 kc. This is divided down to 38·4 kc for timing in the power subsystem and divided down again to 2,400 and 400 cps for use by various subsystems. The control oscillator provides the basic "counting" rate for CC&S to determine issuing of commands at the right time in the three CC&S sequences.

The subsystems clustered around the base of the spacecraft are insulated from the sun's heat by a shield covered with layers of aluminum coated plastic film. At the bottom of the spacecraft, just below the subsystem modules, is a second temperature control shield. It prevents too rapid a loss of heat into space which would make the establishment of required temperatures difficult to maintain. The two shields form a sandwich that helps to minimise the heat control problem

Temperature control of the attitude control subsystem is provided by louvres actuated by coiled bimetallic strips. The strips act as coil springs that expand and contract as they heat and cool. This mechanical action opens and closes the louvres. The louvres are vertical on the face of the attitude control box and regulate the amount of heat flowing into space. This is a critical area, as some of the equipment may not function properly above 130°F.

Paint patterns, aluminum sheet, thin gold plate, and polished aluminium surfaces are used on the Mariner for passive control of internal temperatures. These surfaces control both the amount of internal heat dissipated into space, and the amount of solar heat reflected away, allowing the establishment of temperature limits. The patterns were determined from testing of a temperature control mode. The TCM was subjected to the variations of temperature anticipated in the Venus mission in a space simulation chamber at JPL.

Communications with the spacecraft will be in digital form. The command subsystem aboard the Mariner will decode incoming digital commands and send them to the designated subsystems. Data from engineering and scientific sources will be encoded to digital form for transmission to earth.

Synchronising pulses will be spaced at regular intervals between data signals from Mariner. Ground bases receiving equipment will generate identical pulses and match them with the pulses from the spacecraft. This will provide a reference to determine the location of the data signals allowing receiving equipment to separate data signals from noise.

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