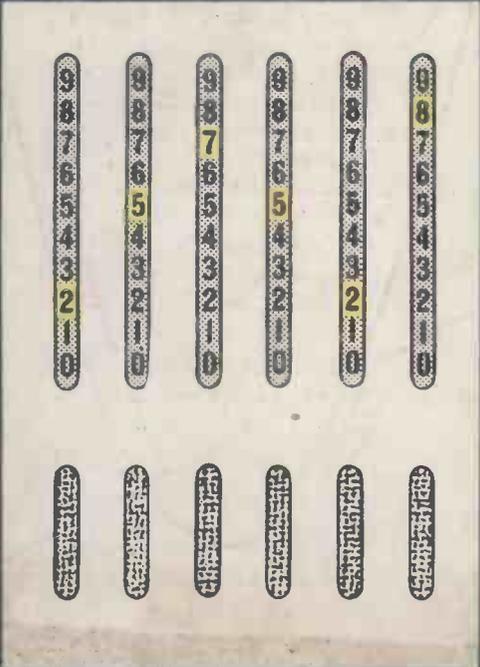
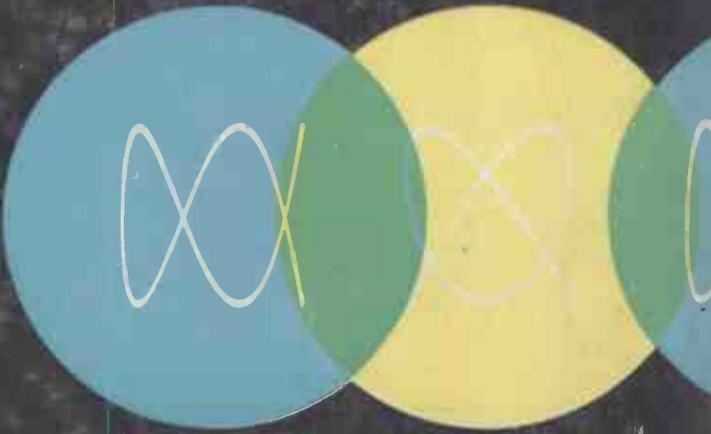
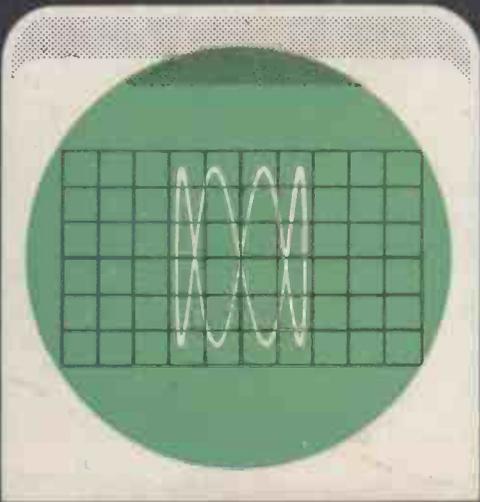


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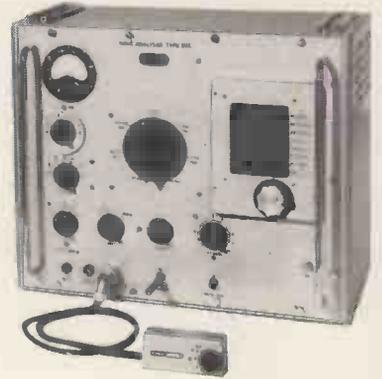
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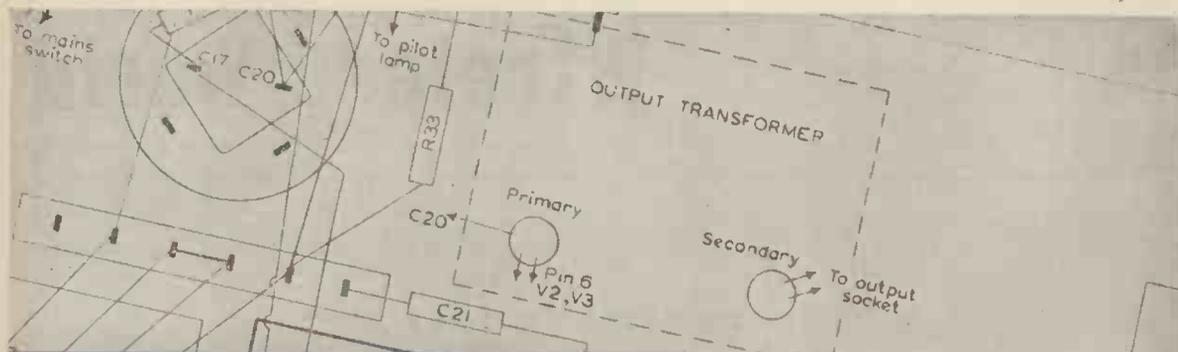
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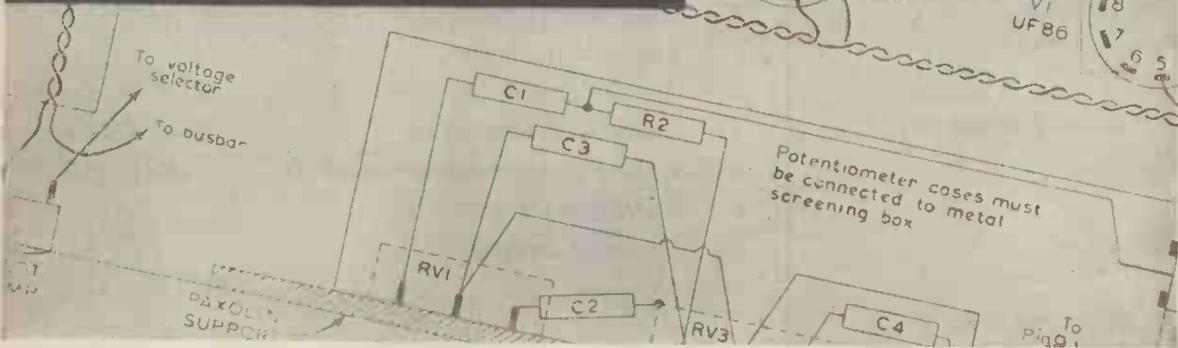
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Over the Hump

THIS month the 60th anniversary is being celebrated of one of the most famous and, let us face it, controversial events in the history of wireless communication. It was in December, 1901, that Marconi announced that he had been able to receive at St. Johns, Newfoundland, the succession of triple dots sent out by the 20-kW spark station at Poldhu on a daily schedule from 3 p.m. G.M.T. onwards. The signals were heard at 12.30 p.m., 1.10 p.m. and 1.20 p.m. local time on 12th December and again less distinctly on the following day. On the 14th December Marconi abandoned further experiment owing to the weather, cabled the news of his success to his Company and informed the Press.

The whole project had been carried through under a certain amount of stress—of time (in order to ensure priority over possible rivals) and of weather. Widespread gales had brought down the original Poldhu aerial and a smaller temporary aerial had to be used; the balloons and kites used instead of tall masts at St. Johns had proved to be well nigh unmanageable in the winds then prevailing, and the variation of capacitance with the pitching of the kites prevented the use of the latest syntonic (tuned) receiver. The experimenters did have, however, a variety of sensitive coherers (detectors). These included "microphone" types consisting of loose carbon granules or a mixture of carbon dust and cobalt filings (Marconi's own formulation) and a sensitive self-restoring type, due originally to Tomassina and later used by the Italian navy, in which a globe of mercury was contained between carbon and iron electrodes. All these were used in series with a battery and a telephone earpiece—a far more sensitive arrangement than the earlier "tapper" coherer, relay and Morse ink.

The news which Marconi gave to the world was received with astonishment and by his competitors with incredulity. But his confidence was unshaken. Within three months he had set out to repeat the experiment, this time on board the s.s. *Philadelphia*, outward bound, using this time the syntonic receiver and the self-restoring Italian navy coherer. In daylight signals from Poldhu could be received only up to 700 miles, but at night messages were recorded on tape up to 1,550 miles, and the letter S signals up to 2,099 miles.

So the scientific sceptics, whose calculations of diffraction over a curved surface had predicted failure of any attempt to span the Atlantic, were refuted. The Canadian Government was sufficiently confident to advance £16,000 for a transmitting station at Glace Bay and by successive increases of wavelength and power during the next year or two

good contact was established at night, but it was not until the summer of 1905 that reliable signals were recorded at Poldhu from Glace Bay, with both stations in daylight. Eventually the Clifden station took over the transmission from this side of the Atlantic and a limited public telegraph service was opened in October, 1907, and an unlimited service from February, 1908, continued until the Clifden station was burnt down in 1922.

Looking back to that boisterous day in 1901, with our present knowledge of radio propagation and of the trials and difficulties which followed, we must be grateful for the fluke which gave Marconi the optimism and courage to persist. He was extremely lucky. No one then knew that daylight was the worst time to conduct such experiments, but this "mistake" was offset by the fact that he could not have chosen a better year than 1901, which was at sunspot minimum, or a better month of that year, when the absorbing D layer of the ionosphere was to all intents and purposes non-existent. The difficulties in repeating the initial success could be partly accounted for by the rise in sunspot activity in the following years and it was probably not until increasing absorption had been overtaken by the rate of increase of powers and wavelengths, that the fruits of the 1901 experiment were safely gathered.

To commemorate the anniversary the Science Museum, South Kensington, is arranging an exhibition of early Marconi apparatus which will be on view from 13th December to 25th January, and on the 12th December the Cornish Group of the R.S.G.B. in conjunction with the Newfoundland Radio Club are planning to exchange messages on the amateur bands between Signal Hill and Poldhu. This is a most imaginative gesture, and we congratulate all concerned in advance on what will undoubtedly be a successful and enjoyable event. Would it be asking too much to suggest that on a future occasion, near sunspot minimum, they endeavour with the permission of the P.M.G. to repeat the contact on some wavelength between 1,000 and 2,000 metres, using at the receiving end all the modern techniques, but making the transmitted power as near as can be estimated to that of the original Poldhu? It is unlikely that the powers that be would take kindly to a 20-kW spark but might be lenient towards a temporary c.w. transmitter of equivalent and therefore lower spectral power level. The results would be illuminating and would, we think, give added force to Sir Oliver Lodge's assessment of Marconi's achievement that "it constituted an epoch in human history on its physical side, and was itself an astonishing and remarkable feat."

OPEN LETTER TO THE PILKINGTON COMMITTEE

Dear Committee

CONCERNED as you are to advise about the future of our broadcasting service you will doubtless have looked closely at its past. And having done so you may have concluded that the technical means by which broadcasting is consummated has been a dominant factor in determining the ends to which it has been put. Assuming this is an agreeable conclusion then it follows that the future of broadcasting will be shaped, in large measure, by the available technical facilities. The acceptance of this important generality should excuse the intromission of one who was a Founding Father of the B.B.C. and who, *circa* 1925, as the B.B.C.'s first Chief Engineer, planned a technical system for programme distribution which accorded with the ideological policies laid down by Lord Reith.

The creation of the B.B.C. was not, as some have pompously stated, "a wise measure of sociological planning" it was in fact a means to solve an intractable technical problem. The original demands from private enterprise to be given channels for the purpose of advertising greatly exceeded the number which could be used simultaneously without mutual interference. In these circumstances it was decided to grant a monopoly to one organization which was ordered to do broadcasting "to the satisfaction of the Postmaster General." This organization was to be known as the British Broadcasting Company, later on it became the British Broadcasting Corporation.

A strange beast this B.B.C.! By civil service, out of compromise, tended in its youth by rich uncles, handed over in adolescence to public trustees, obedient to a constitution which defies a basic principle of democracy, it yet became the fervent supporter of free speech; strongly opposed to radio advertising yet making large profits through a publications department, sailing on "heedless of the gulls screaming round its mast," and as sensitive to criticism as a newly fledged debutante, the B.B.C. (may it live for ever!) is quintessentially British; and it came into being solely because of the limitations of communications technology.

Is a Monopoly Desirable?

But the B.B.C. no longer enjoys a complete monopoly; to the great sorrow of many sincere folk commerce has taken over part of the service (television) and is now insinuating its persuasions to have a similar control over a parallel sound-broadcasting service; it is up to you to recommend what to do, whether to give or to withhold.

In this connection you are in my opinion asked to answer an unanswerable question, namely, is a vicious principle justified by an admirable practice?

The vicious principle is that which gives a single authority control over a powerful medium of propaganda, the admirable practice is demonstrated by the way the B.B.C. performs its duties.

But suppose that technical advances have abolished the channel shortage, what then! It might be said that, in these circumstances, the justification for the B.B.C. no longer exists and private enterprise might just as well take over. Assuming the abolition of channel shortage I am sure that the abolition of the B.B.C. would be an altogether retrograde step; while the B.B.C.'s institution was fortuitous its demonstrations have earned it a respect which should ensure its continuance.

It is of course possible and moreover, in my opinion, essential to preserve the B.B.C. but not necessarily by a continuance of its sound-broadcasting monopoly. It is my belief that freedom, in all its implications, is more important than the certainty of its abuse; the price of liberty is high but worth paying. If the channel shortage could be abolished or alleviated then broadcasting could be refreshed from more and more contrasted sources and would therefore match the pattern of liberal democracy more closely than it can today.

Criteria for a Democratic Service

When, some 35 years ago, I was acting as the authority's first Chief Engineer, I laid down certain principles and, with the limited means at our disposal, did my best to see them put into practice. These principles, which I consider to be sound even today, were that the transmission service should be planned so that

- (1) everyone receiving the programmes should be assured of a reproduction of them free from interference;
- (2) the quality of reproduction, in its faithfulness to the original, should, given a good receiver, be capable of reaching a high standard;
- (3) that the listeners (in today's set-up the viewer as well) should be given a wide range of choice between contrasted types of programme. This implies that the claims of minorities are of paramount importance.

It may be of some interest to examine today's broadcasting service in the light of these principles.

Interference

As to clear reception, reception that is free from interference, my own experience makes me say that while there is a vast improvement now that the v.h.f. service for sound broadcasting has been instituted the very fact that quality has greatly

improved makes the occasional unwanted noise and variabilities that accompany reception the more annoying. Passing motors too often cause plucking fingers to tweak my loudspeaker, passing aeroplanes pulse-modulate reproduction, a local electric motor sometimes imposes a whine while the mains hum drugs the ears. I use a low-priced receiver, which I suppose is typical of that used by a majority and so my judgment is not that of the high-fidelity enthusiast which could well be more favourable. I do not own a television set but often, by courtesy of friends and relations, watch the programmes. From time to time I am annoyed by the sudden intrusion of snow storms blotting out the picture; it could all be better, it has all been worse.

Quality of Reproduction

Still making it quite clear that I get my reception of sound programmes by the use of a low-priced receiver I would say that the quality of reproduction, while it gives a potent reminder of music in the original does not allow critical judgment of performance. Speech is clear and, apart from occasional interference and continuous hum, the latter being no fault of the sender, all reproduction has a silent background.

The small screen of a television set is its handicap. Because of its more comprehensive technical characteristics the larger cinema screen and the associated tricks of loudspeaker placing and conditioning makes a contrast to television in its more convincing effects upon an audience. This is not to say that television is necessarily second rate, it is to say that its technical limitations impose a greater strain upon the producer to get his effects than were more abundant facilities available.

Range of Choice Between Programmes

Coming to my third principle, that demanding a greater number of and a greater contrast between the character of programmes, it seems to me that the present lack of choice and the consequent failure to cater for minorities, in anything like the degree I would favour, constitutes the major criticism of the existing set-up.

There is a large and respectable body of opinion which denies the justification for the wide range of choice that I believe to be desirable. Strange, is it not, to hear the same voices deploring the shrinking of the provincial press and at the same time denying the need for local broadcasting? The liberal mind is often open but, when it receives an impression, it is inclined to snap shut and not let go; like those flowers which catch flies. It is wrong to assume that an increase of facility must imply an increase of futility; it can also favour serious causes. Those likely to turn up a scornful nose at what they consider would be the vulgarities which would invade a more provident technical system of broadcasting will be more likely to welcome the suggestion to increase the time given to, for instance, educational programmes. My occasional overhearing and over-seeing these programmes has convinced me of their value and, believing as I do, that the most important aim of present day sociological organization should be in furthering education, in the full meaning of that term, I therefore believe that the provision of more channels and their use for education would

be a major contribution to the community's eventual health and happiness.

The B.B.C. has given us a fine example in catering for a minority by its institution of the Third Programme, but it is sad that lack of channels makes it necessary to use the Third Programme wavelength for other purposes. Not that these other purposes are inferior, they too cater for minorities, but if only there were more channels there would be no reason to dilute one type of programme by another and another by one.

Is it not true that there is constant compromise with respect to the demands of Welsh cultural bodies to possess an exclusive channel for their use, and is it not desirable that they should?

The vulgarities which would doubtless invade other channels would seem to me to be an inevitable consequence of satisfying a majority. Why balk the fact that the majority is not cultured and why not see that the problem of making it more appreciative is much deeper than shoving "cultchar" at it? The way to abolish the gutter press is to abolish the gutter, not the press.

Summary of Desirable Characteristics

Summarizing the examination of contemporary practice in the light of my three principles shows that interference, while not a serious matter, too often dilutes the pleasures of looking and listening, that the quality of reproduction given by an ordinary set, while adequate, leaves a good deal to be desired and that the range of contrasted types of programmes available for choice is woefully limited. Thus we could make an embracing summary by saying that what is needed is the provision of not only more channels but channels relatively clear of interference to which are coupled receivers which do more justice to the potentialities of good quality, inherent in the transmission, than do the average types in use today. How to achieve these aims demands some clear thinking.

Wire Broadcasting

It is obvious that the use of conductors (wire networks) to join the output from microphone (or camera and microphone) to the household receiver has potential merit. Interference can be virtually done away with, aeroplanes cannot modulate waves passing in conductors, induced voltages from domestic machines are of such relatively low intensity as to be dominated by the wanted signals, while the authority responsible for the design and maintenance of the receiver can assure the user good quality reproduction. A further merit of the use of wires is that the number of channels that can be made available is certainly greater than that provided by radio as it exists today. These are purely technical advantages; there are contrasting disadvantages.

Objections to Wire Broadcasting

Concerned only with technical issues the disadvantage of the use of conducting networks for the dissemination of programmes is that the wires will not reach economically beyond the confines of a densely populated area. Concerned with commercial vested interests there is opposition to wire broad-

casting by those who profit from the manufacture and sale of radio receivers.

If for no other reason than that portable sets and car radios cannot be served by the wire it would be plain silly to consider shutting down the radio senders. This must set a limit to the oppositions of vested interests, but without doubt it persists. Perhaps it may be lessened by the popularity of the transistor portable.

But some of the arguments advanced against wire broadcasting demonstrate in their futility how fearful its opponents can be. When I was proselytising wire broadcasting a serious writer, whose strictures were published in a respectable technical journal, argued how dangerous it was to suggest setting up a system which could be so easily seized by a dictator, or a would-be one. This argument neglected the point that a pirate radio station could be far more widely heard than transmissions through wires and that once a dictator had power it would not only be the broadcasting services that he commanded. And as to the use of radio receivers to pick up encouraging messages from abroad, if the country were enemy-occupied it is certain that jamming would be used if the occupying authorities thought it to be worth while.

Use of the Electric Power Network

R. E. H. Carpenter and I devised, *circa* 1930, a system for diffusing sound programmes through the electric power network. Fortunately for the Trade, it was found that an Act of 1882 forbade the practice, and in a Parliamentary debate Members demonstrated their loyalty to vested interests and refused to repeal the Act. So much for the liberty of inventors.

I see from your terms of reference that you, as a committee, are required to consider the use of wires for disseminating programmes. Well! Well!

Use of the Telephone Network

It was suggested, *circa* 1930, notably by the British Post Office, that the telephone network could be used for distributing programmes. The frequencies of the carrier waves injected into the network were to be within the long-wave band, i.e. those used by radio senders such as Droitwich, Hilversum, Paris. The reception would be available on an ordinary radio set equipped with a long-wave switch which was plugged into the network. It would appear that the Italian authorities already have such a system.

The limitations of the scheme are, of course, that it is available only to telephone subscribers. I should think also that if the subscribers' telephones were served by open-wire conductors that there would be severe interference from long-wave senders of telegraph signals but I am prepared to be wrong. Also, of course, the quality of reproduction would be typical of the ordinary radio set.

Overlapping in the Absence of Planning

The fact that the wire broadcasting method is chiefly practicable in urban areas makes one ask if it is reasonable to deny a facility to some because it cannot be given to all. The Corporation understandably considers it as a duty to spread its radio service throughout the territory for which it is

responsible, but it is questionable whether this practice need be carried so far as to cause overlapping and, therefore, in a national sense, unnecessary expenditure. In recognizing this problem I suggest in my summing up, the formation of a technical committee of all the talents to plan a national system of programme distribution, taking into account local conditions and modern technology.

Potentialities of Centrimetric Wave Broadcasting

In contrast to the use of wire networks to increase facility it may be of interest to consider a scheme, impractical, perhaps, but worth describing, relying upon the use of centrimetric-wave radio. The telecommunications engineer will agree, other problems inherent in the scheme assumed solved, that the use of centrimetric waves to carry programmes would allow the simultaneous diffusion of enough programmes to satisfy the most importunate desire for increased facility. The basic problem would be to avoid shielding, meaning the casting of radio shadows by buildings, hills and so forth. There is an analogy with light. A single source of light suspended above a densely populated area would illuminate some parts but cast shadows in others. A canopy of light over the whole area would disperse the shadows and create a uniform illumination everywhere below it. Centrimetric waves would not, to their advantage, cast such clear-cut shadows as light, but the analogy is a fair one.

According to my suggestion a number of senders, transmitting centrimetric waves, would be installed on high buildings, towers, hills and high ground, and would thus spray the houses of an urban area with their radiations. The sending aerials would comprise a number of half-wave types interconnected by folds of conductors not contributing to radiation and would be extremely efficient. Only the receiving aerials would be directional, looking like pudding basins and oriented to catch the strongest signal; they would be coaxially connected to the householders' receiving sets. These aerials would be less conspicuous than those picking up television transmissions today.

Interference would be negligible and quality of a high standard. The simplicity of the senders would make it practicable to leave the installation unattended as is successfully done with more complex equipment.

The disadvantage of the scheme, assuming that the effects of shielding could be wholly overcome (which is doubtful) is that the area over which the signals would be received would be limited to urban areas. But as I read the last sentence it struck me that we need not be too pessimistic about rural areas; on a clear day and standing on the heights of hills and mountains it is surprising how far one can see. Centrimetric waves penetrate fog and rain and so the analogy of sight need not deny the practicability of the suggestion to serve rural as well as urban areas by these very short waves. There would be shielding everywhere but in what degree? The experts will give you the answer.

The adoption of centrimetric waves would, of course, mean radical and costly changes to our present-day transmission system; perhaps in time the medium- and long-wave stations might be shut down

leaving only those using v.h.f. to serve portables and car radios.

It is said, moreover, that there are more important uses for centimetric waves than their employment in the broadcasting service—one can guess what these more important uses might be and feel that in a sane world. . . . But the world is not, in some aspects, sane.

Television—Lines and Colour

On other issues the future of television and recommendations about lines and colour must engage your attention—I saw a comparison of pictures using 405 and 625 lines. My impression was that there was a distinction without much difference. It would seem to me to be advisable to recommend the 625-line system for no better, but no worse reason than that the majority of other systems throughout the world use the greater number of lines—export and all that.

And colour! No sane person would argue that, other things being equal, the introduction of colour to television would be anything but desirable. But other things are not equal and should make one pause.

I was particularly struck by the implication of a polemical question put to me by an American engineer: "Would you," he asked, "pay two to three times more to see a colour film than you would to see a black and white?" I said, "Certainly not" and so drew the obvious conclusion that it was not worth paying two or three times the cost of a normal type of television receiver to get colour reproduction. If it cost no more to produce colour the debate would hinge upon the quality of the picture, but in the circumstances the cost factor is dominant.

Eckersley's Law

In spite of the dominance of the cost factor I go further in questioning the advisability of setting up a colour transmission service in what I consider to be the present inadequate state of its development. I cite Eckersley's law defining an enjoyment factor. The law is that the product of the value of two numerics one proportional to the fidelity of reproduction and the other to the intrinsic interest in the matter reproduced is equal to a constant. Thus delight in the fidelity of reproduction of a dull programme compensates precisely for its dullness; conversely the outpourings of transcendental talent, or the demonstrations of dramatic interest, heard through distortion, has an enjoyment constant of equal value to that derived from "dull" multiplied by "hi-fi."

The impact of an exciting programme can be considerable, colour or no colour, and if the colour is of poor quality it subtracts from not adds to excellence. I have seen silent films in black and white which have stirred far more emotion in me than the most orchidaceous all-talking, all-singing, all-dancing affairs the impact of which is made by exuberance and elaboration. "The play's the thing" and one's sensibilities can be awakened by simplicity allied with taste without need for adventitious aids. Putting aside considerations of cost and quality the potential delights of witnessing a colour television broadcast from, for instance, the Chelsea

Flower Show can be sympathetically appreciated but, as I see it, the result, in present-day colour, would be an oleographic horror; I would not pay an extra penny piece to see it. So let us wait a while, wait for technical developments reducing cost and improving quality.

These views will be unpopular but may perhaps seem the sounder when my critics are confronted by a dealer whispering the cost of a colour receiver.

In my view the efforts expended in developing colour television would be better devoted first to increasing the area of the television screen. While agreeing that there is a practical maximum to screen size I feel it has not yet been reached. I have listened with respectful attention to theories about subtended angles related to distance separating viewer and picture and have been told that a bigger screen viewed at a larger distance gives no better impression than a smaller looked at from a lesser distance, but I remain unconvinced. Has it not been said that it can be proved from a law of aerodynamics that a bumble bee cannot fly but the bee, not knowing the law, goes on flying?

Improvements in television technology, namely, colour and larger screens demand a wider sideband. Thus my basic plea for more channels, if accepted, would imply a wider total spectrum to contain all broadcast transmissions. If this spectrum were wide enough then there would be room not only for more but for wider channels; and centimetric waves would provide this wider spectrum.

A Committee of All the Talents

Have I by now succeeded in drawing a single thread of argument through the warp and woof of my discursions? Have I convinced a reader that the potentialities of broadcasting have not yet been fully realized because of the restrictions of its technology? The sheer weight of tradition has so far confined the service within narrow limits and deprived it of a full exhibition of its powers. And if restriction has been inherent in tradition can we dismiss tradition and discover a way to expand the technical means at our disposal so as to give a new stimulus to broadcasting?

Had I my way I would attempt to gather together a technical committee of all the talents and ask it to frame a plan capable of giving a majority of listeners a multi-programme service.

The basic difficulty in achieving a plan is the rivalry of vested interests be they of prestige or profit. I see the B.B.C. is anxious to demonstrate an ability to provide local programmes and estimates that it will cost £30,000 a year to stir the blood of Bournemouth. Would not a local committee be the right authority to provide occasional local programmes and get the money to run them from local advertising? This in passing, but as an example of rivalry rather than combination.

Is it necessary to be so tender about vested interests be they of commerce or prestige? To form our technical committees we have bodies skilled in installing and running wired systems; the Independent Television Authority could surely subscribe ideas, the B.B.C. stands in its integrity as the most experienced body concerning all aspects of broadcasting, the Post Office could add its quota of experience in the linking of studio output with transmitter input; in sum could not a combination of

authorities frame a national plan of broadcasting to provide a wider range of programme distribution than exists today?

Conclusions

In all I have said the principle that liberty is of paramount importance rules my thinking. That its abuse is often nauseating is obvious but for the sake of principle must be tolerated. The B.B.C. sets an admirable example and because it must choose it must also refuse; without selection it would be formless. I doubt very much whether a continuing insistence upon uplift lifts up anything, but I passionately support the B.B.C.'s policy. But there

are other policies; let us benefit by them as well.

Open up the channels then and let the flood of opinion, the phases of art, the dichotomies of politics, the shocks of minority opinion be diffused to the public and broadcasting will be the greater for it. But find the best advice how to achieve these ends technically.

Yours sincerely,

P. P. Eckersley

BEGINNINGS OF THE B.B.C.

The History of Broadcasting in the United Kingdom: Vol. I.—The Birth of Broadcasting. By Asa Briggs. Pp. 425+xiii; 50 illustrations. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 42s.

This is the first volume of a projected series on the history of broadcasting which will carry the story up to the ending of the B.B.C. monopoly in 1955. The present book covers the background, origins, organization and administration of the service up to the end of 1926, when the British Broadcasting Company became the Corporation.

In writing this volume Professor Briggs has drawn on much unpublished material, including Lord Reith's diary. He has produced a highly detailed and extremely well-documented study which puts order into the confused and confusing story of how broadcasting started.

Even before the B.B.C. was formed at the end of 1922, opposition had come from every conceivable quarter; the press and news agencies, the Services, the entertainment industry, the gramophone companies and others voiced their objections. The opposition "displayed a remarkable variety of fears and prejudices". Just as America had "blundered into chaos", so, it seemed, "British broadcasting was to be forced into a strait jacket". Highly restrictive rules were either proposed or put into effect at various stages; for example, the ban on controversy and on the broadcasting of news which had not already been published in the press. Hours of transmission were severely

restricted and frequent breaks in programmes were required.

There were money troubles as well. The Company was "arbitrarily and inequitably financed", partly by a share of the licence fees and partly from royalties on receivers sold by member-firms. But "piracy" was widespread; for this the public was not entirely to blame, as there was great confusion over the different forms of licence, particularly that for home constructors.

In the face of all these difficulties a lesser man than the first General Manager might well have given up the struggle. "Reith did not make broadcasting, but he did make the B.B.C." He emerges from this book, not as the ruthless autocrat of popular fancy in the mid-1920's, but as the skilful, patient and resilient negotiator and administrator who set the pattern for the public corporation while the B.B.C. was still a commercial company.

If Reith (ably backed on the technical side by P. P. Eckersley, the B.B.C.'s first chief engineer) emerges as the hero of the book, it is pleasing to observe that Prof. Briggs finds no real villain, though clearly he considers the Post Office control to have been at times rather heavy-handed. Of the radio-electric companies who put up the money at the start, he says: "For bearing [the risk of initiating a broadcast service] the 'Big Six' received no concessions. Together they made up a monopoly, but it was a monopoly which enjoyed no monopoly profits and few monopoly privileges. It was the Post Office who did best financially out of the deal".

H. F. S.

"RADIO AND ELECTRONIC LABORATORY HANDBOOK"

THE widening sphere of activities encompassed by the term "radio experimenter" is reflected in the title of the seventh edition of this very popular work. "Radio and Electronic Laboratory Handbook," by M. G. Scroggie, B.Sc., M.I.E.E., is a completely revised and enlarged version of the earlier editions. The no-nonsense approach is retained, and although the discussion is as thorough and complete as in many more self-consciously "long-haired" books, the treatment is considerably more lucid and unobscured by jargon than is usually the case.

The author discusses the setting-up of an experimental laboratory, with suggestions for the choice of relevant instruments. The latest types of measuring instruments are described, with many references to commercial pro-

ducts, and several circuits for items of test gear are included. A chapter on the provision and use of standards is followed by discussions of the measurement of circuit parameters, equipment characteristics and signal measurements, at all frequencies up to v.h.f. The recording, examination and interpretation of experimental results are dealt with, and an extremely comprehensive, 80-page reference section contains most of the information that one never seems to be able to find when it is wanted. New sections include those on digital equipment, and the testing of semiconductors and f.m. receivers.

The book is published for "Wireless World" by Iliffe Books Ltd., and costs 55s.

TECHNICAL NOTEBOOK

New Distortion Criterion discussed in an article under this title by E. R. Wigan in the April and May 1961 issues of *Electronic Technology* is that the subjective unpleasantness of a distorted sound is assessed from the rate of deviation (with time) of the distorted sound from what the listener considers to be a normal undistorted sound. If we interpret this criterion simply as the rate of change of the difference between the distorted and undistorted signals, the unpleasantness should increase both with signal frequency and amplitude and both these effects were confirmed (the latter indirectly). The effect on the criterion of the listener's opinion of normality was shown by presenting him with a distorted background. This he took to be normal, thus reducing the subjective unpleasantness of other more distorted sounds. When, with an unknown language, very little opinion of normality was possible, listeners found it very difficult to make any assessment of the distortion. By changing the background, the memory time for such impressions of normality was found to be of the order of four seconds. A subjective grading of unpleasantness suggested that this was proportional to the square of the rate of deviation from normality. A suggested mathematical criterion which is consistent with these and other results is $C_t = n^2(p_n - i)\%$ summed for all terms from $n=2$ onwards for which $p_n > i$, where n is the harmonic number, p_n the percentage amplitude of the n th harmonic compared with the undistorted signal, and i the just audible percentage harmonic distortion (under the conditions of the experiment). The rate at which the individual terms decrease due to a finite t can be found by comparing signals of different bandwidth. In this way the minimum audible 500c/s distortion was estimated as 0.3%.

Fire and Water, especially salt water, are two of the classic elements which are usually regarded as fatal to electronic apparatus. But this is not necessarily true, as has been recorded in the February 1961 issue of the *American Naval Research Reviews*. The first step in the process is the immersion of the equipment which has been damaged by fuel oil, smoke and tars from fires or salt water in an emulsion of chemicals containing a hydrocarbon solvent (to remove the "greasy" substances) and water (to dilute and carry away the salt water). A surface active agent holds the solvent and water in emulsion until an oil-fouled surface is contacted when the

solvent is released. Ultrasonic agitation is employed to "scrub" the apparatus and, when primary cleaning is complete, the emulsion is flushed away either by a water sprayer or again by ultrasonic agitation in an immersion tank.

The majority of the flushing water is then blown out by oil-free compressed air and the remainder is removed by a water-displacing compound. This either physically displaces the water or, in deep interstices, combines with it to form a substance known as an azeotrope, which has a lower boiling point than water and, when it evaporates, carries off the water with it. A drying period in a warm "oven" completes the process and the water-displacing composition leaves behind a corrosion- and moisture-resistant film. More than 90 per cent of equipment damaged by fire but not actually burned in the U.S.S. Constellation is being recovered satisfactorily by this rehabilitation process.

"Aperture Distortion" occurring in television systems causes lack of sharpness in the picture: the effect is due to the finite width of the camera spot "gradually" moving across a black-white boundary and so "slowly" changing the output signal from black through grey to white. This is corrected by electronic artificial sharpening of transitions, but usually the technique is applied only to the higher frequencies, that is, those representing vertical transitions. In *Journal of the S.M.P.T.E.* for June 1960 W. G. Gibson and A. C. Schroeder suggest correction for the effect of the aperture in the vertical direction, i.e. on horizontal edges.

Correction is achieved by deriving a "detail" signal by subtraction of adjacent lines from each other (thus leaving only the change that has occurred between the lines), and this signal is mixed with the original signal so as to reinforce the transition. Naturally, this involves the delaying of whole lines of the picture so that the detail signal can be derived and used: quartz-crystal mechanical lines are used, operating at about 30 Mc/s.

The technique does not suffer from some of the defects inherent in correction for vertical edges: for instance, the signal-to-noise ratio is not markedly degraded. Also it has the advantage that it can be used on a composite signal (including colour) so that only one unit is required for all signal sources at a station. The authors hold out the hope that the system may help to reduce the

"lininess" of images by compensating at the transmitter for a display-tube spot expanded in the vertical direction.

First Colour TV Receivers available for sale from the Zenith Radio Corporation in U.S.A. use a new colour demodulator system. This employs two "sheet-beam" valves (Type 6JH8) which have, additional to the usual valve structure focus, accelerator and deflector electrodes and two anodes. The electron beam, controlled in intensity by the first grid, is forced into flat or sheet-like form by the focusing section and speeded up by the positive potential on the accelerator. Potentials applied to the deflectors switch the beam from one anode to the other.

For colour demodulation two colour-difference signals, R-Y and B-Y, are applied to the control grids of the two valves. These signals are, of course, on the 3.58 Mc/s sub-carrier and are in phase-quadrature (90° difference) with one another. The deflector plates are energized from the local oscillator synchronized with the "burst," or colour phase-reference, signal, the R-Y stage with a direct push-pull output, and the B-Y with a push-pull quadrature output. Thus the beams modulated with the colour difference amplitudes are switched from one anode to the other of the sheet-beam valves, so giving outputs which are of opposite polarity. The four outputs consist of B-Y and R-Y signals direct and two "negative" signals, from which G-Y is obtained, for application to the c.r.t. control grids. The luminance or Y signal is applied to the c.r.t. cathode. The use of the sheet-beam valves saves two waveform inverter stages which are otherwise necessary to obtain the G-Y signal.

Meter Relay—the MagTrack—introduced by the Weston Instrument Division of Daystrom increases the normally rather low contact pressure produced between a moving meter pointer and a fixed contact pointer both by attaching to the pointer a soft iron bead which is attracted by a magnet attached to the fixed pointer, and by means of a second aiding coil (suitably wound on the same frame as the measurement coil) which is energized on contact. The magnet provides sufficient force (≈ 30 mgm) to break through any insulating film which may have accumulated on the contacts and the additional pressure (≈ 2 gm) provided on contact by the aiding coil moves the flexible contact to provide a wiping action.

I.T.A. Plan for V.H.F. and U.H.F.

EXPANDING THE TELEVISION SERVICE AND CHANGING LINES WITHOUT DUPLICATION

THE Television Advisory Committee in their 1960 report emphasized the importance "of planning the use of Bands IV and V (and when the time comes the re-engineering of Bands I and III) from the start as an integrated whole." They also stated (paragraph 32) "If 625-line standards were adopted for the higher bands then eventually they would need to be introduced into Bands I and III in order to achieve a single standard. We [the Committee] consider that such a changeover is capable of achievement given a long-term programme in which the aim and phases are made clear to all concerned and as a consequence have the full co-operation of the broadcasters, the viewers and the radio industry."

The drafting of a detailed plan did not come within the terms of reference of the T.A.C., but there has subsequently been no lack of proposals and counter-proposals from various authorities and from industry. Some of these have been quite complex and have involved the starting of a third service in Band III, duplication of the existing services in Bands IV and V and an eventual reshuffle of these services between u.h.f. and v.h.f.

The Independent Television Authority, while not dissenting from the T.A.C. recommendations for an eventual change to 625-line standards, has in the past advocated delay in its adoption, until a scheme could be evolved which, as it was one of the first to point out, avoided "the absurdity that, if we changed the national line system, we must approach the point at which we have emptied our best television frequencies in Bands I and III of all television." It now puts forward a scheme which permits an early start of new programmes on 625 lines (which it now positively endorses as desirable for the future), which avoids any transfer of the two established national services from Bands I and III and which gives a practicable interpretation of the T.A.C. recommendations.

The I.T.A. proposals contained in a pamphlet "405:625. A plan for changing to 625 lines while retaining v.h.f. transmission" issued last month are basically as follows (and we quote):

So that we may continue to use the v.h.f. bands with their substantial advantages and avoid the duplication of services, the Authority proposes for consideration that there should be designated a "405-625 transition period," during which existing 405-line sets would wear out physically. This period would last for seven to eight years. At the end of the period, all transmissions would become 625-line, and all 405-line transmission would cease. This change would take place on an "appointed day." During this transition period, the following arrangements should be systematically introduced:

(i) At all the existing v.h.f. transmitting stations of both the B.B.C. and I.T.A., "shadow" plant, consisting of new transmitters and aerials arranged for 625-line operation on their appropriate new v.h.f.

channels, should be installed. This would enable the two existing services to be switched simultaneously and without interruption to 625-line transmission on the appointed day.

(ii) There should be placed on sale from the start new dual standard receivers capable of 625-line reception in v.h.f. and u.h.f., and also capable of receiving the existing services as they are today transmitted. It should be the plan that these dual standard receivers, by the normal process of replacement, should have supplanted the existing 405-line v.h.f. receivers by the appointed day.

(iii) As early as possible, the planning and building of a national network of u.h.f. stations should begin, and arrangements be made for the introduction area by area of one or two new programmes on 625 lines. The network of u.h.f. stations should be progressively expanded to give as much coverage as possible, making the best pace that proved practicable.

The I.T.A. point out that the pace will be governed by the success or otherwise of acquiring sites for the thirty or more u.h.f. stations, additional to those on existing v.h.f. sites, which will be needed to give national coverage. It is estimated that nine of these lie within the boundaries of National Parks and at least five more near areas of natural beauty. These are difficulties which face any extension of the television services into Bands IV and V.

Advantages claimed for the I.T.A. proposals are:

(i) The superior v.h.f. bands are retained in permanent use without interruption for two of the national services.

(ii) The temporary duplication of two services, with the formidable waste of capital, revenue, and manpower involved, is avoided. New v.h.f. transmitters and aerials must, of course, be installed at the existing v.h.f. stations to provide the "shadow" equipment eventually to be used to take over and transmit the present two services on 625 lines on their new v.h.f. channels, but this provision is far less costly than the transfer of these services to a u.h.f. network of stations, only some twenty main v.h.f. stations for each of the present two programmes needing to be so equipped compared with the sixty-four main u.h.f. stations required to give approximately the same coverage.

(iii) The permanently heavier running costs of an all-u.h.f. transmission system are avoided, and so is the liquidation of the v.h.f. stations.

(iv) Duplicated transmissions require standards conversion, which further degrades the picture quality of the already lower grade 405-line service, and this degradation is also avoided.

(v) The transition to 625 lines could be achieved much more quickly, perhaps in half the time, for the termination of 405-line transmission would not have to wait for the completion of coverage by the u.h.f. 625-line transmissions. The shadow plant could be installed comfortably within seven or eight years. It is difficult to see how the building of the u.h.f. network could take less than twelve to fifteen years.

(vi) The new type of dual standard v.h.f.-u.h.f. receiver produced during the transition would be basically similar to those required by Continental and

Commonwealth countries, so their export would be assisted. The 405-line facility would simply be left out for export and finally, after the switch to 625 lines, it would be left out for the home market as well.

The design of the proposed new British receiver and the sequence of events in the changeover plan are envisaged in the following terms:

It is, of course, an essential part of the plan for retaining v.h.f. for the main British services that the standard receiver becomes and remains a v.h.f.-u.h.f. set if there are also to be u.h.f. services. The method of transition here proposed requires the incorporation of a small but essential additional piece of equipment in the new dual standard receiver. Over and above its ability to receive, or be converted to receive, the new 625-line u.h.f. services, the new set must also be capable of receiving, or of being converted to receive, the present two services when, on the appointed day, they are switched to 625 lines on their new v.h.f. channels. Provided that the parameters (the vision-sound carrier spacing, the width of the vestigial sideband, the polarity of vision modulation and the choice of frequency or amplitude modulation for the sound channel) adopted for the 625-line transmissions in both v.h.f. and u.h.f. are the same, this addition is both easy and cheap to provide, the cost being in terms of shillings rather than pounds. It involves no more than the equipment of the normal v.h.f. turret tuner with two additional "unchristened" channel positions, marked "X" and "Y," not initially fitted with coils. During a period of a year or more before the appointed day for changing the present two services to 625 lines on their new v.h.f. channels, local dealers would progressively clip in to these "X" and "Y" positions the coils or "biscuits" needed for the two new 625-line v.h.f. channels to be used in the area of the set. The task of the dealers would be eased by arranging for the "shadow" 625-line transmitters to radiate trade test transmissions on their new v.h.f. channels each morning, instead of the 405-line transmitters as at present, this practice being put into operation in all areas a year or so in advance of the appointed day. This is no new process for dealers. They have already experienced it several times on a smaller scale for, when the I.T.A. has opened new transmitting stations, many thousands of so-called multi-channel sets in the new area needed coils to be clipped in to unequipped positions on their v.h.f. turret tuners to enable them to receive the new channel. In these areas the dealers were able to accomplish this task in a few weeks, but no one will wish to underestimate the careful and efficient planning, by manufacturers and dealers alike, necessary to repeat the process on a national scale. Indeed, the feasibility of the plan rests on this particular operation. It would be a substantial alleviation that all receivers sold a few years before the appointed day would already have had their "X" and "Y" positions fitted with the necessary coils by the manufacturers, for the new channels would by then have been made known to them.

Whatever method of transition is chosen, it is little use to pretend that the complications will not be painful for the broadcasters, the manufacturers and the public alike. Equally, whatever method is chosen, the operation will be expensive. These considerations make it all the more important that, when the end is reached, it should be the ideal end, and not the second best end, shortsightedly determined by the choice of what might seem the easiest way out during the transition. History already contains a bitter lesson for us. Our present dilemma is the direct result of the great technical catastrophe of sixteen years ago, when television broadcasting was resumed on 405 lines at a time when refined line systems were perfectly feasible. The choice of the relatively coarse

line system with which we are already technically dissatisfied then seemed the easiest way out. It will now cost many millions to correct matters. It would be tragic to fall into a second error by finding ourselves, at the end of the period of transition, with a broadcasting system that was still technically defective. If we are to make the change at all, we should steadily ask what it is we wish to have in the end, and we should accept whatever transitional complications are necessary in order to reach it. This end, it is the argument of this present paper, is a 625-line broadcasting system making full and continuous use of the v.h.f. bands, in which the two main services have been uninterruptedly contained.

We do not go all the way with the I.T.A. in condemning the restarting of television in 1946 on 405 lines. Nor are we convinced that the advantages of a change now to 625 lines will outweigh the disadvantages of the "expensive and painful complications" which will bear heavily on all concerned—not least on the public. It is true that we might have adopted a higher standard in 1946, but we could not have been expected to guess that the figure of 625 would be the one to find favour. If any other standard than 405 had been adopted it would have been the American 525, the only other higher standard then in the running.

Whatever may be the final conclusions about our line standards, we have no doubts about the desirability of extending the television services by the provision of more channels, the case for which has been so ably stated by Capt. Eckersley elsewhere in this issue. This will certainly cost a lot of money, and if the need for larger pictures and a higher line standard are part of the bargain, then there can be little doubt that the I.T.A.'s latest proposals provide the best solution so far advanced.



FRAME-GRID AERIALS?—These five helical aerials have been designed by Cossor Radar & Electronics and are for use by the War Office at the Guided Weapons Trials Establishment on the coast of Anglesey. They will operate in the frequency range 100—400Mc/s employing circular polarization and will be for telemetering missiles.

AIRBORNE HOMING SYSTEM

USE OF A PHASE-SHIFTING NETWORK

BY H. M. BOYLE,* B.Sc., A.Inst.P.

THE principle of measuring phase difference to provide direction finding information is well known. A new method for achieving the measurement was developed by Johnson and Beresford of R.A.E. in 1952 and is covered by British Patent No. 787,894. It involves the use of a phase-shifting network between two aerials used for the reception of the transmission on which it is required to home. Subsequent developments by the Plessey Co. have used the phase-shifting network principle in airborne homing equipments but the associated circuitry, both of the phase-difference measurement and of the equipment as a whole, has been much simplified and is described below.

board aerial and ϕ' is the delay contributed by the phase shift network. This results in a square wave modulation of the carrier at the switching frequency and at a depth depending on ϕ . When $\phi = 0$ the two expressions above are equal and the modulation depth is zero. For any other value of ϕ , positive or negative, the modulation depth will increase, and the modulation is in phase, or in anti-phase, with the switching waveform according to the sign of ϕ . Thus the phase difference has been transformed into a modulation of the carrier and homing information provided. This can be seen by expanding expressions (1) and (2) above:

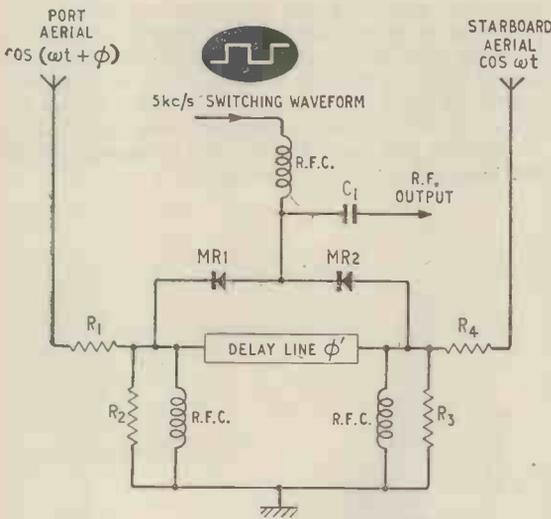


Fig. 1. Circuit for modulating a receiver carrier to provide homing information

The method of phase measurement takes the following form, the circuit being shown in Fig. 1. The diodes MR1 and MR2 are made to conduct alternately by the application of a low frequency switching waveform. The r.f. output can therefore be expressed as:

$$\cos(\omega t) + \cos(\omega t + \phi + \phi') \quad \text{Diode MR2 conducting} \quad \dots \quad (1)$$

$$\cos(\omega t + \phi') + \cos(\omega t + \phi) \quad \text{Diode MR1 conducting} \quad \dots \quad (2)$$

where ω refers to the carrier frequency of the received transmission, ϕ is the phase delay of the signal at the port aerial relative to that at the star-

$$\text{i.e. } 2 \cos \frac{(2\omega t + \phi + \phi')}{2} \cos \left[-\frac{(\phi + \phi')}{2} \right] \quad (3)$$

$$\text{and } 2 \cos \frac{(2\omega t + \phi + \phi')}{2} \cos \left[-\frac{(\phi - \phi')}{2} \right] \quad (4)$$

These can be rewritten as:

$$A \cos \left[\frac{(\phi + \phi')}{2} \right] \quad \dots \quad (5)$$

$$\text{and } A \cos \left[\frac{(\phi - \phi')}{2} \right] \quad \dots \quad (6)$$

For negative values of ϕ expressions (5) and (6) may be written as:

$$A \cos \frac{(-\phi + \phi')}{2} \quad \dots \quad (7)$$

$$\text{and } A \cos \frac{(-\phi - \phi')}{2} \quad \dots \quad (8)$$

which become:

$$A \cos \left[-\frac{(\phi - \phi')}{2} \right] = A \cos \frac{(\phi - \phi')}{2} \quad (9)$$

$$\text{and } A \cos \left[-\frac{(\phi + \phi')}{2} \right] = A \cos \frac{(\phi + \phi')}{2} \quad (10)$$

These expressions are (5) and (6) reversed and the phase of the modulation is therefore changed for negative values of ϕ .

For completely satisfactory operation of this circuit in the u.h.f. band (225-400 Mc/s) several points were investigated and a summary of these, and their solution, is now outlined.

It can be seen that it is essential to maintain the symmetry of the circuit, so that the indication of heading zero is not affected. At these frequencies, lead inductance and stray capacitance assume major importance and it was with a view to controlling these and maintaining symmetry that a "block" form of assembly was adopted. This method has the added advantage that the block acts as its own

* The Plessey Co. Ltd.

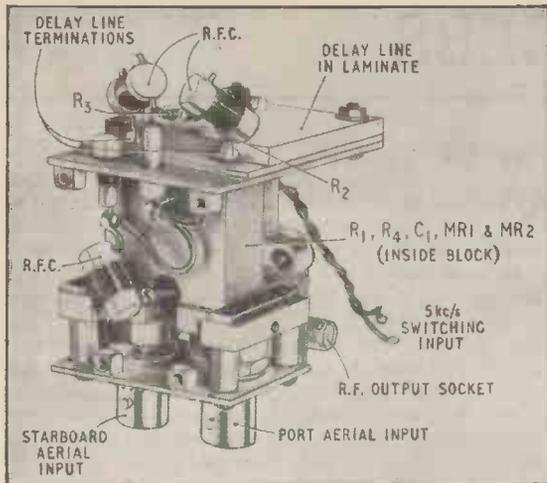


Fig. 2. Practical assembly of the circuit in Fig. 1

jig during assembly. Briefly, the resistors R_1 and R_4 and the diodes MR_1 and MR_2 are mounted in holes bored in a block of aluminium, the hole dimension being chosen to give an air-spaced transmission line, in association with the components and their leads, to give optimum performance over the band. The delay line consists of a brass horse-shoe embedded in a dielectric of glass fibre laminate and spaced by the dielectric from the ground plane (the aluminium block) to give the required characteristic impedance. The assembly is shown at Fig. 2.

The choice of diode in itself constituted a major problem at the time (1956). The requirements are low forward resistance and high back impedance. The Transiron T19G diode was chosen finally, having a mean forward dynamic resistance of 6Ω and a minimum back impedance of 400Ω (capacitive). Germanium diodes were found more suitable than silicon because of their lower cut-on voltage in the forward direction, which eases the requirements for the switching waveform. Failure to cut the diode on quickly will result in "holes" in the carrier at 10kc/s, which were considered undesirable.

The choice of ϕ and ϕ' is affected by a number of factors, but in practice the aerial spacing was chosen to be 20 cm, which gives ϕ a value of approximately 96° at 400Mc/s at 90° heading. The delay ϕ' was chosen as 13.6 cm, giving 65° at 400Mc/s.

Some points of interest are worth noting before leaving this part of the circuit.

The switching frequency, although uncritical, is chosen to be approx. 5.0kc/s, which is outside the normal audio pass band of the associated receiver.

The circuit introduces a certain r.f.

loss which is of no importance except in areas of weak signal. If it is desired to restore the signal to its previous level, an r.f. amplifier of good noise figure must be incorporated. This was done in one of the Plessey developments, the amplifier being tunable and controlled by the associated transmitter-receiver.

It should be noted that the circuit in no way affects the normal intelligence on the carrier and that only very heavy modulation will affect the homing function, resulting in a loss of homing sensitivity.

The complete system is shown in Fig. 3. The 5kc/s modulated carrier is passed into the associated receiver for demodulation. The demodulated 5kc/s square wave is taken out via a stage provided specifically for the purpose and passed back to the Homing Unit, where the signal is fed to a phase sensitive bridge. The 5kc/s switching waveform is also applied to the bridge, via a delay, to compensate for the phase delay suffered by the signal waveform in passing through the receiver. The resulting d.c. output is proportional to the amplitude of the signal wave form (provided that the signal waveform is small compared with the switching waveform) and of a polarity depending on the sign of ϕ . The d.c. output is applied to a Standard Service I.L.S. Indicator (Type 7 or 9024) for display in the pilot's cabin.

The Homing equipment derives its power supplies from the associated receiver and is controlled by the receiver's control unit. The power requirements are small, being 0.37A at 28V for heater supplies and approx. 12mA at 225V h.t.

It can be seen that having chosen ϕ' to be satisfactory at 400Mc/s, the phase delay introduced by the delay line is less at 225Mc/s. In addition, the fixed spacing of the port and starboard aeriels means that for a given heading error, the value of ϕ is also less at the lower frequencies than at the high. Thus there is an inherent change in homer sensitivity (d.c. output versus heading error) over the band. Since it is desirable to have a sensibly constant output for a particular heading, regardless of operating frequency, a potentiometer has been fitted to the receiver, controlled by the frequency setting elements of that receiver. This potentiometer is used to control the gain of the 5kc/s signal amplifier in the Homing Unit, as the carrier frequency is varied.

It should be borne in mind that the system just described is not necessarily restricted to the u.h.f. band, although modifications to the delay line length and the aerial spacing would be required.

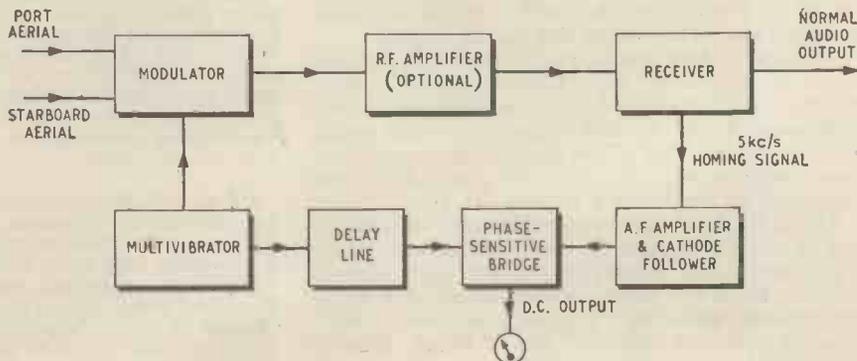


Fig. 3. Block diagram of homing system

WORLD OF WIRELESS

I.E.E. and Electronics

THE scheme put forward some months ago by the I.E.E. for the reorganization of the Institution to give a stronger emphasis to its "electronics" activities has now been approved by its members. Privy Council permission has to be sought but, in the meantime, plans are going ahead for the introduction of the scheme next October.

The present four Specialized Sections (Measurement and Control, Electronics and Communications, Supply, and Utilization) will be replaced by three Divisions: (i) Electronics, (ii) Power, and (iii) Science and General. Each Division will work through about ten relatively specialized Professional Groups. The number and scope of these groups "can be modified quickly to reflect any change of emphasis in the technological scene."

Dual-Standard TV in Eire

TELEFIS EIREANN (Irish Television Service) as already announced will ultimately adopt the 625-line television standard and their first two stations will therefore be equipped for both 405- and 625-line transmissions. They have placed a £175,000 contract for four 625-line television transmitters and associated equipment with the Pye Group. At two of the Eire stations, at Mount Kippure, near Dublin, and at Truskmore Mountain in Co. Sligo, a "combining unit" will be used to allow radiation of 405- and 625-line transmissions simultaneously from a "dual standard" aerial. The other two 625-line equipments ordered are for stations at Mount Leinster, Co. Carlow, and Mullaghanish Mountain, Co. Cork. Proposed date for the commencement of 405-line programme transmissions from the television station at Kippure is December 31st. Test transmissions are being radiated in Channel 7 with horizontal polarization, between the hours of 11.30 a.m. and 1 p.m., also from 3 p.m. to 5 p.m. and 6.30 p.m. to 7 p.m.

"Random Radiations"

THIS is the first issue since January 18th, 1935, in which "Diallist's" contribution "Random Radiations" has not appeared. As a result of ill health, and at his own request, he has felt obliged to relinquish the task of sustaining this regular feature.

As some readers may know, "Diallist" is the pen name of Major R. W. Hallows, M.A.(Cantab.), M.I.E.E., who, in addition to his regular contribution to *Wireless World*, has also frequently written under his own name. One of his special interests is batteries, and he was, for some 30 years, European consultant to the Burgess Battery Co. Inc.

Throughout the war Major Hallows, who is 76, was in the Royal Artillery and was for some time Chief Instructor, Radar, at the 6th A.A. Group School. He is the author or joint author of a number of books, including "The Oscilloscope at Work," "Introduction to Valves" and "Radar Simply Explained."

Pay TV Tests?

A PLEA to the Postmaster General for a licence to allow relay undertakings to conduct an experimental field test of Pay TV by wire was made by Barry King, chairman of the Council of the Relay Services Association, at the Association's annual luncheon on November 14th, at which Miss Mervyn Pike, Asst. P.M.G., was principal guest. Miss Pike had herself referred to the potentialities of Pay TV in her speech. The number of homes in this country served by wire television systems is now over 500,000; about 95% of all subscribers to television and sound relay systems in the U.K. are served by members of the Association.

Instruments for Export

SOME 150 delegates, representing over 70 scientific instrument manufacturers and a number of Government research establishments, attended the tenth annual convention of the Scientific Instrument Manufacturers' Association at Eastbourne from November 15th-18th. The theme was "export." After the opening session, which was addressed by Sir Charles Fitton, past president of the Institute of Export, and representatives from the governments of the U.S.A., Sweden and Australia, the delegates were free to attend the meetings of the three specialized panels (technical, marketing and economics) which ran concurrently.

The first session of the technical panel was addressed by G. W. A. Dummer, of the Royal Radar Establishment, on the subject of design for export. By way of introduction he mentioned that 6.3% of all equipment delivered to the R.R.E. under contract was outside tolerance or not working. Manufacturers may be interested to learn that the results of the R.R.E.'s specialized tests on a variety of apparatus are readily available.

Other sessions of the technical panel dealt with the "requirements of the overseas user," "problems of overseas manufacture" and "after sales service."

B.B.C. Portsmouth Exhibition.—The B.B.C. is staging a public exhibition at the Guildhall, Portsmouth, from November 29th to December 2nd, from 12 noon to 10 p.m. daily. B.R.E.M.A. are supporting the show and nineteen manufacturers will be exhibiting their radio and TV receivers. The B.B.C. is to relay TV and sound programmes direct from the Guildhall and the f.m. signal from Rowridge will also be provided for demonstrating radio.

I.T.A. Selkirk Station.—A temporary 200ft mast at the Independent Television Authority's Selkirk station will come into operation at the beginning of December. A permanent 750ft tower is being built which it is hoped will become operational not later than March 1962. The signal radiated from the temporary mast will be on Channel 13, vertically polarized, and e.r.p. will be 4kW, to be increased to 25kW when the permanent mast is used.

Microwave Valves Conferences.—September 1963 has been chosen as the date for a Conference on the Design and Use of Microwave Valves and an associated scientific exhibition, which is being organized by the Electronics and Communications Section of the Institution of Electrical Engineers. It will be held at Savoy Place, London, W.C.2. The next in the series of international conventions on microwave valves is to be held at The Hague, Holland, from September 3rd-7th, 1962. The I.E.E. also announces that a Conference on Components in Microwave Circuits will take place in London in September 1962.

Radio & Television Servicing.—The report on the servicing examinations held in May by the City and Guilds of London Institute and the Radio Trades Examination Board records that of the 2,068 candidates who sat the intermediate written exam, 1,108 (53.6%) passed. The 1960 figures were 560 entrants, 336 (60%) passes. Of the 717 who took the final examination in May 285 (29.8%) got a first class and 367 (51.2%) second class pass. This is the first year of the combined sound radio and television syllabus.

Radio Amateurs' Examination.—The Standard of papers submitted at the examination, conducted by the City and Guilds in May, "showed a welcome improvement over that of last year", says the report. A total of 1,251 entered and 866 (69.2%) passed compared with 1,274 and 699 (54.9%) in 1960.

The Physics of Semiconductors is the subject of an international conference, which is to be held at the University of Exeter from July 16th-20th, 1962. It is being organized under the auspices of the International Union of Pure and Applied Physics by the Institute of Physics and the Physical Society, 47 Belgrave Square, London, S.W.1. Provisional programmes and application forms may be obtained from the Administration Assistant at the aforementioned address.

The F.B.I. and its Japanese counterpart, Keidanren, are to make efforts "to realize at an early date a freer flow of trade between the two countries by progressively reducing and ultimately eliminating import restrictions and conducting orderly marketing, and to promote economic co-operation and technical links between the two countries by encouraging closer contact and fuller understanding between the industrialists of both countries." Following a visit by Sir Norman Kipping, Director-General, and J. R. M. Whitehorn, Deputy Overseas Director, the Federation has published a report entitled "A Look at Japan." Copies, price 10s, are available from the F.B.I., at 21 Tothill Street, London, S.W.1.

Domestic Receiver Design.—Papers of particular interest to those in the "entertainment radio and television industry" are being sought for the I.R.E. Chicago Spring Conference on Broadcast and Television Receivers, arranged for June 18th and 19th. Offers of papers, including a 50-100-word summary, should be sent to Al Cotsworth, Zenith Radio Corporation, 6001 West Dickens Avenue, Chicago 39, Ill., as soon as possible.

Television in South Africa will not arrive for at least another five years owing to the heavy cost of installation, stated Dr. P. J. Meyer, chairman of the board of the South African Broadcasting Corporation, on his return from a two-month trip abroad to study radio and television techniques.

The B.B.C. has placed an order for ten Marconi 250-kW short-wave transmitters which use vapour-cooled triodes made by the English Electric Valve Company. The new transmitters form part of a re-equipment programme for the B.B.C.'s External Services transmitting stations; six will be installed at the Woofferton station, which is used to relay the Voice of America, and two each at Daventry and Rampisham, Dorset.

U.S.S.R. Academy of Sciences were hosts to Professor T. Kilburn and Dr. D. B. G. Edwards of the University of Manchester, when they travelled to Moscow recently to deliver a series of lectures on the Ferranti Atlas electronic digital computer. Ten lectures were given altogether, over a period of five days, to an audience of technologists and engineers at the Institute of Precise Mechanics and Computing Technique in Moscow. Discussions showed that the Russians have a different approach on the general philosophy of computer design. Their policy is to build separate machines for scientific and data processing applications, and they are putting a great deal of effort into the development of faster storage and other components.

Colour Television test transmissions on 405 lines from the Crystal Palace transmitter were restarted by the B.B.C. in October. They are conducted from 1600 to 1630 on Mondays to Fridays. A simplified explanation and also a detailed specification of the system employed are available from the Engineering Information Department, Broadcasting House, London, W.1. The detailed specification is given on Information Sheet 2202/2.

The Scottish Electrical Training Scheme, launched some six years ago to train executives for the member firms in Scotland, has made outstanding progress, reports J. S. Hastie, of Scottish Cables Ltd., current chairman of directors. He said the 119 graduates and students attending the recent fifth annual conference was the highest figure since the start of the scheme, and it was planned to encourage volunteers for higher advanced courses to qualify graduates for the top posts in the industry and a start would be made shortly on an advanced mathematics course to meet this need. S.E.T.S. also plans to train one overseas student each year, returning him to his own country to work, as a gesture to the electrical industry abroad.

Westinghouse Schools Training Course.—A further "Introduction to Industry" training course will be held by Westinghouse at their Chippenham Works during the week January 8th-12th inclusive. This is for sixth-form boys taking G.C.E. "A" level examinations in science subjects in 1963. Applications should be addressed to the Personnel Superintendent, Westinghouse Brake & Signal Co. Ltd., Chippenham, Wilts., by December 1st.

Norwood Technical College, London, S.E.27, is introducing the first of two six-lecture evening courses on transistors on January 16th. The first course covers fundamentals and the second, beginning on February 27th, applications. The fee for each course is 10s.

Medium-wave DX.—A "set listening period" from 0100 to 0300 G.M.T. on December 2nd has been arranged by the group of DX enthusiasts which issues the monthly duplicated news sheet "Medium-wave News". Reports of long-distance reception will be welcomed by K. Brownless, 7 The Avenue, Clifton, York, who edits the news sheet.

WHAT THEY SAY

Component Research.—"It is perhaps not widely known that the British Electronics Industry spends out of its own resources a greater percentage of its gross turnover [on research and development], approximately 12%, than any other industry in the United Kingdom."—A. F. Bulgin, president of R.E.C.M.F., at the opening of the Stockholm component exhibition.

Problems for Pilkington.—"Never in the long history of committees and commissions have so many problems been compressed into so few words."—Miss Merwyn Pike, Assistant P.M.G., referring to the terms of reference of the Pilkington Committee at the Relay Services Association luncheon.

Personalities

Sir Gordon Radley has succeeded Lord Nelson of Stafford as chairman of Marconi Instruments, Marconi Marine, and English Electric Valve Company and has also been appointed deputy chairman of Marconi's W/T Company. Lord Nelson has also retired from the chairmanship of Marconi's W/T and is succeeded by his son the Hon. George Nelson. Other appointments to the Boards of the subsidiaries of the English Electric Company include:— F. N. Sutherland as deputy chairman and Dr. E. Eastwood as a director of Marconi Instruments; P. L. de Laszlo as deputy chairman of E.E. Valve Co.; and D. P. Furneaux as managing director designate of Marconi Marine in succession to R. Ferguson who retires at the end of the year.

J. H. Westcott, B.Sc., D.I.C., Ph.D., M.I.E.E., who is 41, has had the title of Professor of Electrical Engineering in the University of London conferred on him in respect of his readership at Imperial College. Dr. Westcott, after post-graduate research on servo-mechanisms at the college and at the Massachusetts Institute of Technology, joined the Government scientific service in 1942 and was for some time at what is now R.R.E., Malvern. He was on the Control Commission for Germany in 1945/6. Dr. Westcott, who is chairman of Feedback Ltd., of Crowborough, Sussex, was responsible for the setting up of the control systems laboratory at Imperial College which he joined in 1950.

R. J. Hitchcock, M.A., A.M.I.E.E., consultant to Cable and Wireless where he was for some time engaged on radio-frequency allocations and radio propagation problems in general, has recently visited the Bell Laboratories in America to study the problems of satellite communications. Mr. Hitchcock, who has represented C. & W. at many international conferences and is a member of several study groups of the C.C.I.R., has contributed articles to *Wireless World* on various aspects of international telecommunications. He is a member of the committee set up by C. & W. to consider "what part, if any, the company should take in the provision of satellite relays." The committee is presided over by H. C. Baker, a director, and among the eight members is P. A. C. Morris, who is in charge of the company's radio propagation section.

John V. Dunworth, C.B.E., M.A., Ph.D., F.Inst.P., A.M.I.E.E., the new deputy director of the National Physical Laboratory, was throughout the major part of the war working on the development of radar; first with the Admiralty and later with the Ministry of Supply at R.R.E. He succeeds Dr. G. G. Macfarlane, who, as announced recently, is going to Malvern as director of R.R.E. Dr. Dunworth, who is 44, graduated at Cambridge University in 1937 and did post-graduate research under Lord Rutherford. After the war he returned to Cambridge to take up his Fellowship at Trinity College and was appointed a demonstrator in physics in the Cavendish Laboratory. He joined the Atomic Energy Research Establishment in 1946, and since 1959 has been deputy director of the Atomic Energy Establishment, Winfrith.

R. E. Fischbacher, B.Sc., A.M.I.E.E., has been appointed an assistant director of the British Scientific Instrument Research Association which he joined in 1957 as head of the Electronics Department. Educated at the Royal College of Science and Technology, Glasgow, and the University of Glasgow, Mr. Fischbacher served for 12 years in the Admiralty Signal and Radar Establishment as a member of the Royal Naval Scientific Service before joining the B.S.I.R.A.

Air Comdre. A. G. P. Brightmore, M.Brit.I.R.E., Director of Electronics Research and Development (Air) in the Ministry of Aviation, and Air Comdre. F. E. Tyndall, B.Sc., Director of Radio at the Air Ministry, have exchanged posts. Air Comdre. Brightmore, who is 53, has been in the Ministry of Aviation since 1958 having previously served for two years as chief signals officer of the 2nd Tactical Air Force. At one time he commanded No. 3 Radio School, R.A.F., at Compton Bassett, Wilts. Air Comdre. Tyndall, who is a member of the Post Office Frequency Advisory Committee, has been in the Air Ministry directorate of radio since April, 1959. He is 48.

Frank Poperwell, Assoc.Brit.I.R.E., who recently joined the Derritron group of companies as technical sales supervisor, has now been appointed general manager of Reslosound Ltd. (a member of the group). Prior to joining the group a few months ago he was with the G.E.C. for 35 years where he was technical supervisor of the Sound Equipment Division. L. W. Murkham, founder of Reslosound recently sold his interest in the company to the Derritron group.

C. J. Salvage contributes to this issue a constructional article on a transistor communications receiver which he designed for use with a 6-band miniaturized transmitter. He is a keen s.s.b. amateur transmitter (his call is G3HRO) and in 1956, using his own s.s.b. equipment, participated in the first six-continent R/T link-up on 20 metres. The receiver described, and its associated transmitter, was awarded first prize at the National Mobile Rally at Woburn Abbey in September. Mr. Salvage is chairman of the Aquila Radio Club of the Inspection Branch of the Ministry of Aviation where he has been employed since 1940.

T. H. Whitaker, who has been with Cossor Radar & Electronics since 1957, is going to New Zealand early next year to supervise the installation of eight meteorological radars, three of which will be on the islands of Fiji, Funafuti, and Rarotonga. He will also instruct staff of the N.Z. Civil Air Administration on the handling and servicing of the equipment. Mr. Whitaker, who is 32, was trained as a radar mechanic in the R.A.F.



T. H. Whitaker

W. P. Raffan

W. P. Raffan, B.Sc., A.Inst.P., has been appointed head of the newly formed Solid State Division of 20th Century Electronics. He was formerly with Rank Cintel where, during the past three years he has been engaged in the development of solid state devices.

Eric K. Cole, C.B.E., M.Brit.I.R.E., has resigned from the position of deputy chairman of British Electronic Industries Ltd. (the holding company formed on the merger of Pye and Ekco a year ago) and also from the chairmanship of E. K. Cole Ltd. and its subsidiaries, which include Ekco Electronics Ltd. and 20th Century Electronics Ltd. Mr. Cole, who was elected an honorary member of the Brit.I.R.E. in 1959 "in recognition of his services to the radio and electronics industry and profession," founded the company bearing his name in 1926 when he was 25. He was appointed a Commander of the Order of the British Empire in 1958. The chairman of B.E.I. is **C. O. Stanley**, chairman and managing director of the Pye Group.

C. J. Maurer, B.Sc.(Eng.), A.M.I.E.E., of Romford, Essex, and **W. T. Warnock, A.M.I.E.E., A.M.Brit.I.R.E.**, of Stone, Staffs., both Post Office engineers, have received the Insignia Award in Technology from the City and Guilds of London Institute (C.G.I.A.). Mr. Maurer joined the Post Office Engineering Department in 1939, where he returned in 1946 after war service as a radar mechanic in the R.A.F. He is now an executive engineer and for the past six years has been working on the introduction of "international subscriber dialling". Mr. Warnock, who joined the Post Office in 1933, has been on the staff of the P.O. Central Engineering Training School at Stone since 1958, where he is now deputy principal.

News from Industry

Associated Television has formed a new wholly owned subsidiary, **Planned Holdings Ltd.**, to integrate the technical and marketing resources of all the firms in its Planned Group of companies. This new company will be responsible for the future development of the Group into the field of sound and music services. Member companies of the Planned Group are **Planned Music Ltd.** (Muzak background music system), **Planned Communications Ltd.** (line networks) and **Planned Equipment Ltd.** (Audiomatic automatic audio-visual selling and communication system). **J. B. C. Bennett, B.Sc. (Eng.), A.M.I.E.E.**, has joined the board of Planned Music Ltd. **D. Humphriss** and **H. F. Mould**, who were until recently in the Sound Equipment Section of the G.E.C., have joined the Planned Group of companies. Mr. Humphriss is regional liaison engineer and Mr. Mould public address engineer.

G.E.C. Telecommunications Group.—Two new operating companies, **G.E.C. (Telecommunications) Ltd.** and **G.E.C. (Electronics) Ltd.**, have been formed by the General Electric Company to take over the activities of its Telecommunications Group. Co-ordination and direction of these companies will be undertaken by a newly formed holding company, **G.E.C. (T. & E.) Holdings Ltd.** **O. W. Humphreys** has been appointed executive chairman of the holding company and chairman of the two new operating companies. **W. A. C. Maskell** is director of the holding company, **C. Riley** director and general manager of **G.E.C. (Telecommunications) Ltd.**, and **R. J. Clayton** director and general manager of **G.E.C. (Electronics) Ltd.** Brigadier **John Clemow** has been appointed engineering director of the latter company. The headquarters of **G.E.C. (Telecommunications) Ltd.** will be at **G.E.C. Telephone Works, Coventry**, and of **G.E.C. (Electronics) Ltd.** at **Union Works, Wembley**.

Cossor Board Appointments.—As a result of the purchase of **A. C. Cossor Ltd.** by **Raytheon Company**, of Massachusetts, U.S.A., the following have been elected to the board of **A. C. Cossor**:—**Charles F. Adams**, chairman of the board of **Raytheon**; **Richard E. Krafve**, president of **Raytheon**; and **Dr. Carlo L. Calosi**, vice-president of **Raytheon**. **Raytheon** have already announced their intention of preserving the identity of the **Cossor Group**. **Major-General Sir Miles Graham** continues as chairman and **James S. Clark** as managing director.

English Electric in France.—A new company, **La Compagnie Continentale D'Equipements Electriques (C.E.E.)** has been formed by the **English Electric Company** and the French firm, **Les Exploitations Electriques et Industrielles**, to manufacture electric and electronic control equipment for France and the Common Market countries.

Plessey—A.T.E.—Ericsson Merger.—Completion of the merger between the **Plessey Co. Ltd.**, **Automatic Telephone & Electric Co. Ltd.**, and **Ericsson Telephones Ltd.**, has been effected, and it is announced that **A. F. Roger, A.T.E. chairman**, and **Sir Harold A. Wernher, chairman of Ericsson**, have been appointed to the **Plessey board of directors**.

Decca Record Company's group net profit for the year ended March 31st is **£1,249,229** as compared with **£1,260,729** for the previous twelve months. Consolidated trading balance was higher at **£3.7M (£3.4M)**, but exports, including **£1.4M (£2.3M)** to the U.S. and Canada, were lower at **£7.1M (£8.1M)**.

International Rectifier Corporation.—Consolidated sales and earnings for the year to June 30th show a sales increase of 11% over the previous twelve-month period, and a profit margin of 7.4% after taxes. The Corporation, with headquarters at **El Segundo, California, U.S.A.**, has a 50% share in **International Rectifier Co. (Great Britain) Ltd.** with **Metal Industries Ltd.** having a similar interest.

Solartron Sold To Schlumberger.—**Firth Cleveland** have sold for just under **£2M** their 56.7% holding in the **Solartron Electronic Group** to **Schlumberger of Houston, Texas**, who themselves were linked recently with the **American Daystrom** company. **Firth Cleveland** acquired their controlling interest in **Solartron** two years ago. **Schlumberger** has other interests in electronics and instrumentation both in the **U.S.A.** and **Europe**.



Console of the 34-channel sound mixer manufactured by Pye for the Elstree Studios of Associated Television. In addition to providing mixing facilities for studio microphones it also provides echo effects and talk-back facilities.

S.I.M.A. Delegation to Italy.—In 1960, only 8% of the scientific instruments imported into Italy came from the U.K. compared with 35% from west Germany and 21% from the U.S.A. In an effort to remedy this a delegation of the Scientific Instrument Manufacturers' Association of Great Britain visited main Italian cities recently to discuss marketing problems and to collect information on the instrument needs of Italian research programmes and industry.

Cambridge-C.G.S. is the title of a new company formed jointly by Cambridge Instrument Co. Ltd. and Istrumenti Di Misura, C.B.S. Located at Casoria, near Naples, the company will initially manufacture instruments based on Cambridge designs. English members on the board of Cambridge-C.G.S. are Dr. P. Dunsheath, H. C. Pritchard and W. E. Lamb.

T.C.C.—Sprague Exchange.—The Telegraph Condenser Company and the American Sprague Electric Company have recently agreed to a mutual exchange of technical "know-how," whereby the two organizations will share their research and manufacturing experience. T.C.C. are the sole distributors in the U.K. for Sprague products.

Raytheon Company are to acquire all of the assets of Rheem Semiconductor Corp., a subsidiary of Rheem Manufacturing Company, at Mountain View, California.

Marconi Cameras For ITN.—Four Marconi Mark IV television cameras ordered by Independent Television News are now in use at the ITN headquarters in Television House, Kingsway. This is part of a general re-equipment of ITN's facilities to enable them to carry out more ambitious programmes. The installation has been designed by ITN's own engineering staff and will be their first use of 4½in image orthicon cameras.

Hudson Electronic Devices Ltd., who specialize in the design and manufacture of v.h.f. radio-telephone equipment, have received an order from the Home Office, worth nearly £30,000, for 200 of their Type AM112 mobile 15-W equipments to be used by the Police. This follows a similar order last year.

E.M.I. Electronics Ltd. have been awarded a £30,000 contract by the Independent Television Authority for the installation of a 450ft tower and aerial array in Jersey, Channel Islands.

I. S. B. Transmitters.—Marconi's are to supply to the Admiralty a large number of 500-W m.f./h.f. independent sideband communication transmitters of a new type, NT204, which embody continuous tuning from 240kc/s to 24Mc/s. Value of order is about £90,000.

Manchester Min'cabs have been equipped with Storno-Southern f.m. transistor radio telephones. A 25-W base station at Gorton feeds a standard centre-fed dipole aerial mounted on an 80ft mast, and ranges of up to 30 miles are being obtained.

British Communications Corporation, a subsidiary of Radio & Television Trust, has recently obtained a large contract for the supply of v.h.f. transmitter/receivers Type A.40 to the British Army.

Pickering Cartridges.—Goldring Manufacturing Company, of Leytonstone, London, E.11, advise that they are now marketing certain items of the American Pickering range of audio equipment in this country. These include the Unipoise 198 integrated arm and cartridge and a selection of Pickering cartridges.

Walmore Electronics Ltd., of 11-15 Betterton Street, London, W.C.2, have been appointed by Siemens & Halske A.G., west Germany, as U.K. representatives for their transmitting and special receiving valves.

Metal oxide film resistors developed in the U.S.A. by Corning Glass Works, are being manufactured in the U.K. by Jobling and marketed by Electrosil Ltd., of Colnbrook By-Pass, Slough, Bucks. The latter company was formed recently by Corning in association with James A. Jobling & Co. Ltd.

Tape heads manufactured by Wolfgang Bogen G.m.b.H. of Berlin, previously available through Gopalco Ltd., are now obtainable from R. H. Cole (Overseas) Ltd., 2 Caxton Street, Westminster, London, S.W.1. (Tel.: Sullivan 7060), who have been appointed sole U.K. agents. Components made by Bogen include mono and stereo heads for domestic tape recorders, erase heads and a range of single and multiple heads for professional applications.

ETEL Sales Move.—Electronic Tubes Ltd. advise that the sales and technical information office of their Instrument Cathode-Ray Tube Division is now at 80 New Oxford Street, London, W.C.1 (Tel.: Langham 0800).

New Telephone Numbers.—The Gresham Lion Group of Companies, Gresham House, Hanworth, Middx., advise their new number is Feltham 3655. (The telephone number of Gresham Transformers Ltd. continues as Feltham 6661.) Mullard Equipment Ltd., Crawley New Town, Sussex, have had their number changed to Crawley 28787.

Ampex Great Britain Ltd., which is responsible for the sales of Ampex equipment in the U.K., has moved to 72 Berkeley Avenue, Reading (Tel.: Reading 55341).

Dawe Instruments Ltd. have moved from Harlequin Avenue, Brentford, to Western Avenue, Acton, London, W.3 (Tel.: Acorn 6751).

Lee Products (Gt. Britain) Ltd. have transferred from Longford Street, N.W.1, to new offices at 10-18 Clifton Street, London, E.C.2 (Tel.: Bishopsgate 6711).

OVERSEAS TRADE

1962 Near East International Fair is to be staged in Tel Aviv, Israel, from June 5 to July 5, when Western visitors will find the opening times a little strange. They are 4 p.m. to midnight except on Saturdays, when they will be sunset to midnight. Electrical, cooling, heating and radio and TV products will be exhibited in a wide range of merchandise. British participation is being organized by Industrial & Trade Fairs Ltd., Commonwealth House, New Oxford Street, London, W.C.1.

Marconi's were responsible for equipping Ghana's new external broadcasting station, with its four 100-kW transmitters capable of world coverage. Marconi's have also been awarded a contract by the Ghana Posts & Telegraphs authorities for the supply and installation of a twin-path v.h.f. multichannel radio-telephone system to link the Volta river dam area with Accra, the capital. The carrier equipment will be provided by the Automatic Telephone & Electric Company.

W. G. Pye Get Russian Order.—Following an enquiry received at the British Trade Fair in Moscow this year, an order for industrial pH measuring, recording and controlling equipment worth £15,000 has been obtained by W. G. Pye & Co. Ltd. from the official U.S.S.R. buying agency, Mashpriborintorg.

Danmarks Radio, the Danish state broadcasting service, has placed an order with E.M.I. Electronics Ltd. to supply four 4½in image orthicon camera channels for use in the Copenhagen studios.

The Royal Malayan Navy has selected Decca True Motion marine radar for the six new fast patrol craft now on order from Vosper's.

Transistor High-Fidelity Pre-Amplifier

By R. TOBEY, M.A. and J. DINSDALE, B.A.

COMPREHENSIVE INPUT/EQUALIZING CIRCUITS, TONE CONTROLS AND FILTERS

IN the following article details are given of the design of a pre-amplifier, incorporating all the usual facilities, for use with the transformerless transistor power amplifier described in last month's issue.

This pre-amplifier may also be used with sensitive valve power amplifiers, such as the Mullard 510, when compactness, complete absence of hum and (with suitable transistors) improved signal-to-noise ratio, are required.

A two-stage circuit (Fig. 1) conforming fairly closely to standard valve practice, is used. The first stage provides equalization by frequency-selective negative feedback, and a wide variety of inputs may be catered for. The second stage is an adaptation of the well-known Baxandall tone control circuit, giving an ample range of control of both treble and bass by negative feedback. High- and low-pass filtering is also provided, again by the use of negative feedback.

Input Equalizing Stage.—The basic circuit is shown in Fig. 2. Any equalization curve consisting of slopes not exceeding 6 dB per octave may be

produced by a suitable choice of components R_1, R_f, C_1, C_2 . A typical curve is shown in Fig. 3.

The value of R_f sets the current sensitivity of the stage, and R_1 sets the input impedance (equal to R_1) and hence the input voltage sensitivity. Where maximum input sensitivity is not required, the equalizing networks may be derived directly from those used in valve circuits, but using component values suitable for transistors. Fig. 4 and Table I give typical values for the most usual applications.

This approach, however, does not lead to the best exploitation of transistor characteristics, since the transistor is a current-operated device, and the lower the input impedance which can be used, the greater the sensitivity. When used with low-output magnetic pickups and tape heads, valve pre-amplifiers are arranged to have an input impedance which places the L/R integration beyond the audio pass-band. For example, for a 500-mH pickup, most manufacturers specify an input impedance of at least $68k\Omega$, giving attenuation starting around 20kc/s. Greater sensitivity can be produced from a transistor pre-amplifier by using a lower impedance,

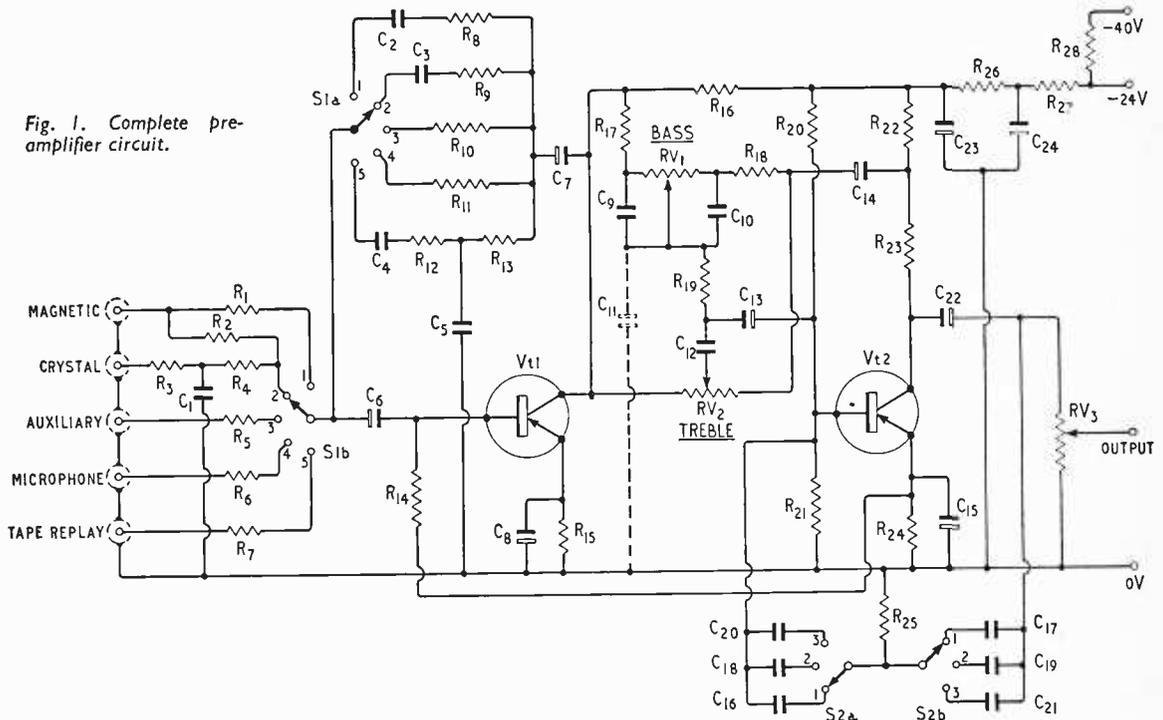


Fig. 1. Complete pre-amplifier circuit.

Fig. 2. Basic equalizing circuit.

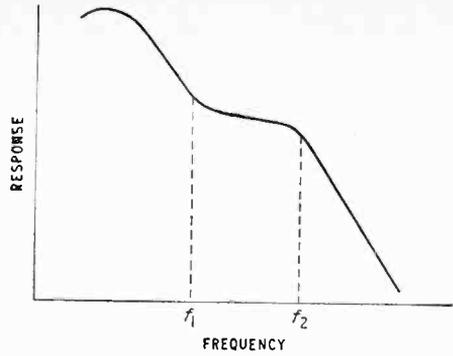
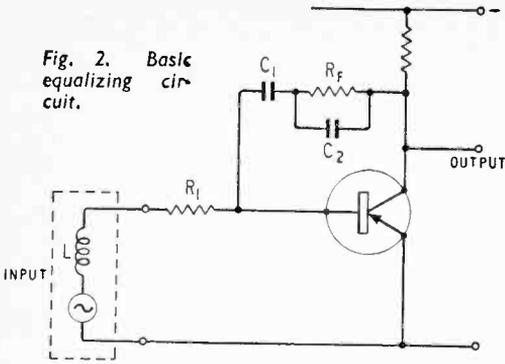


Fig. 3. Response given by equalizing circuit of Fig. 2. $f_1 = 1/2\pi C_1 R_f$ and $f_2 = 1/2\pi C_2 R_f$ or $R_f/2\pi L$.

Table 1

Component Values for Pre-Amplifier (Figs. 1, 4, 8)

Resistor	Value (kΩ)		Capacitor	Value (F) and Working Voltage
	All	Resistors are 1/2W, 5%		
R 1	3.9		C 1	2,000p
R 2	5.6		C 2	5,000p
R 3	47		C 3	0.01μ
R 4	47		C 4	0.01μ
R 5	100		C 5	8,200p
R 6	1		C 6	10μ 12V wkg
R 7	1		C 7	2μ 25V wkg
R 8	47		C 8	100μ 6V wkg
R 9	39		C 9	0.1μ 5%
R10	33		C10	0.1μ 5%
R11	180		C11	0.01μ 5%
R12	18		C12	0.01μ 5%
R13	12		C13	25μ 12V wkg
R14	22		C14	2μ 25V wkg
R15	2.7		C15	100μ 6V wkg
R16	10		C16	1,000p
R17	3.3		C17	1,000p
R18	3.3		C18	2,000p
R19	3.3		C19	2,000p
R20	39		C20	5,000p
R21	10		C21	5,000p
R22	1		C22	5μ 12V wkg
R23	2.2		C23	50μ 25V wkg
R24	1.5		C24	50μ 25V wkg
R25	2.7		C25	5,000p
R26	2.7		C26	1,500p
R27	2.7		C27	0.01μ
R28	6.8		C28	1,000p
R29	47		C29	2,000p
R30	180		C30	100μ 6V wkg
R31	220			
R32	100			
R33	22			
R34	47			
R35	62			
R36	47			
R37	33			
R38	150			
R39	47			
R40	2.2			
R41	2.2			
R42	1.8			
R43	1.5			
R44	1.5			
R45	3.9			
R46	0.33			
RV1	50 lin			
RV2	25 lin			
RV3	10 log			
RV4	5 lin			

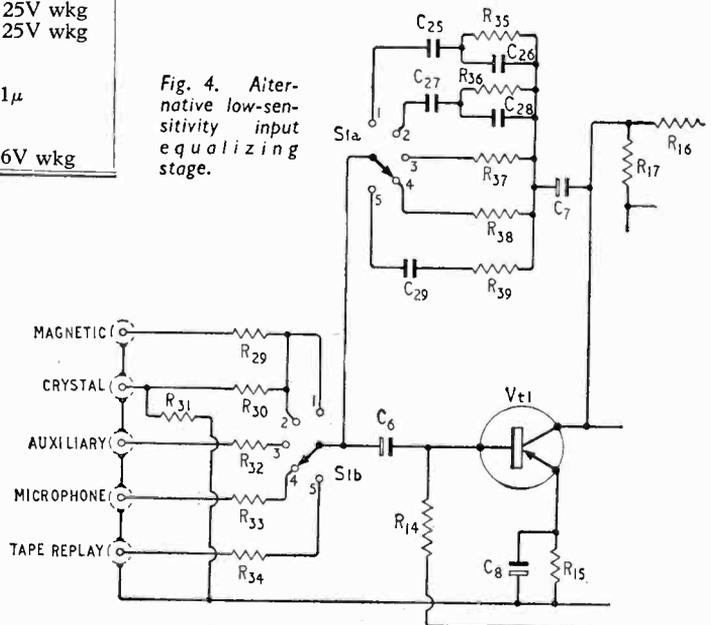
and a value can be chosen in conjunction with the inductance of the input source which gives part of the required equalization characteristic.

For example, the standard 1.p. characteristic calls for de-emphasis above 2kc/s which can be produced by feeding a 500mH-pickup into 6.8kΩ-resistor. The bass emphasis required during the playback of tape may also be produced in this way. The complete circuit diagram (Fig. 1), together with Table 1, give component values for the most widely used types of equalization, assuming in the case of the magnetic pickup and tape head, an inductance of 500mH, which is the value most commonly used. For other inductances the input resistance should be changed to keep the same L/R ratio. The performance of the record equalizing networks is shown in Fig. 5.

If it is desired to use the same equalizing networks for non-inductive pickups (e.g., a crystal pickup), the treble de-emphasis must be provided at the input. In Fig. 1 this is done by R_3 and C_1 .

Tone Controls.—The tone-control circuit gives a mid-frequency gain set by the values of R_{22} and R_{23} .

Fig. 4. Alternative low-sensitivity input equalizing stage.



a stage gain of about three being convenient. For a fuller description of the operation of this type of circuit the reader is referred to the original article (by P. J. Baxandall in the Oct. 1952 issue of *Wireless World*). The tone-control characteristics of the pre-amplifier are shown in Fig. 6. A different form of the treble characteristics, giving less severe control of the highest frequencies, is shown dotted, and these may be obtained by removing C_{11} . Without C_{11} , the "star" formed by R_{17} , R_{18} , R_{19} is equivalent at high frequencies to a "delta"-connected configuration of resistors which shunts each portion of the treble control, giving additional feedback and feed forward of current to the virtual-earth point (Vt 2 base). C_{11} earths the centre-point of the star at high frequencies and eliminates the shunting effect, hence allowing the treble control to operate as expected.

Filters.—The pre-amplifier can be designed to give a frequency response extending well outside the audio band, but in practice this is often an embarrassment. Many wide-range pickups produce peaks of considerable amplitude at frequencies above the audio band, which can give rise to audible intermodulation effects; also the modern trend to stereo pickups with their high vertical output, and small speaker enclosures giving little loading of the extreme bass, may make high-pass (or rumble) filtering a necessity. The slope of attenuation of frequencies above and below the audio band given by the filters varies with the setting of the corresponding tone control (see Fig. 6), since both filtering and tone control are achieved by feedback around the same transistor. The maximum boost position of the tone control gives the greatest slope of the corresponding filter. This ensures maximum discrimination against frequencies outside the audio band, when they would otherwise prove most objectionable.

The low-pass filter shown in Fig. 1 is provided by R_{25} and C_{16} to C_{21} . Although two passive R-C lags would have the same ultimate slope of 12dB per octave, the circuit of Fig. 1 has a sharper turnover. In theory this circuit would tend to peak below the turnover frequency, but in practice the finite output and input impedances of the transistor, in conjunction with the values used, prevent this happening.

The switch is normally in position 1, giving a turnover frequency of 20 kc/s, while positions 2 and 3 (with turnovers at 10 and 6 kc/s respectively) may be used to deal with programme material such as worn shellac discs or a.m. radio.

A smooth roll-off of frequencies below 20c/s is provided in the pre-amplifier, and below 40c/s in the power amplifier described in last month's issue. In the pre-amplifier (Fig. 1), the d.c. base current for Vt 1 is supplied from the top end of the emitter by-pass capacitor of Vt 2, so that increasing negative feedback via R_{11} results as the frequency is lowered. The input stage of the power amplifier is also arranged to give increasing feedback below 40c/s.

The overall characteristic of the filters is shown in Fig. 7.

Stereophonic Version.—The circuit diagram of part of one half of a stereophonic version of the pre-amplifier is given in Fig. 8. RV_4 is the channel-balance control, which forms part of the potentiometer R_{22} , R_{23} in Fig. 1. Rotation of this control

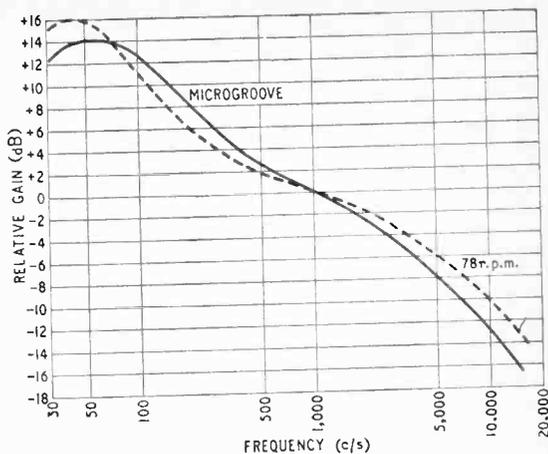


Fig. 5. Response of record equalizing circuits of Fig. 1 (magnetic pickup input).

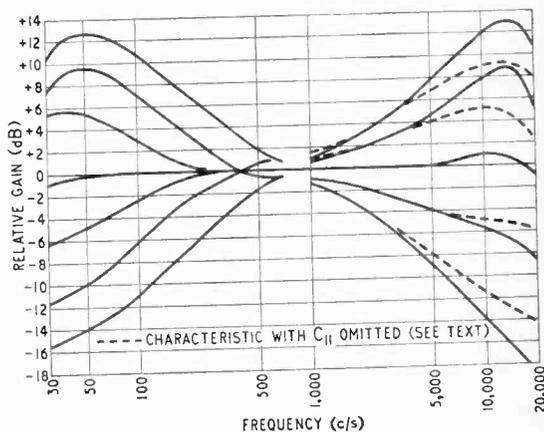
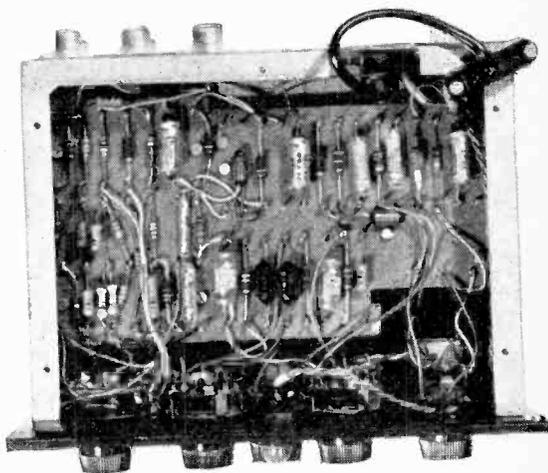


Fig. 6. Tone control characteristics with (full lines) and without (dotted lines) C_{11} . The low-pass filter was switched to 20kc/s.



One channel of the pre-amplifier viewed from the top (power amplifier and screen removed).

increases the gain of the tone-control stage of one channel, and decreases that of the other channel, hence correcting for any slight out-of-balance in other parts of the equipment. A difference of ± 3 dB in gain between channels is catered for. Gross differences in channel sensitivity, such as might be produced by using amplifiers and speakers of different types in the two channels, should be eliminated by an attenuator in the most sensitive channel.

In the prototype, switched tone controls and a single position low-pass filter were used, for the sake of compactness.

Transistors.—The transistors used in the pre-amplifier should have as high a gain as possible (greater than 80 at 1mA), to ensure close agreement between the theoretical and practical operation of the circuits. Suitable types for both V_{t1} and V_{t2} are the OC44, OC75, GET874, GET113 or XA102, but this list is merely a guide, and is by no means exhaustive. Two low-gain transistors as a "super-alpha" pair might, however, be used instead of one high-gain transistor, with appropriate changes of

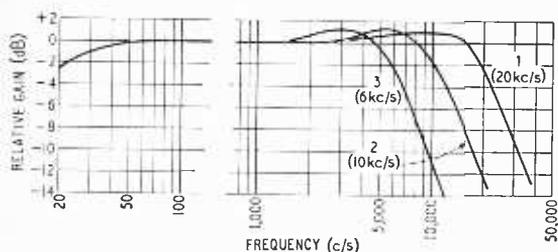


Fig. 7. Characteristics of high- and low-pass filters.

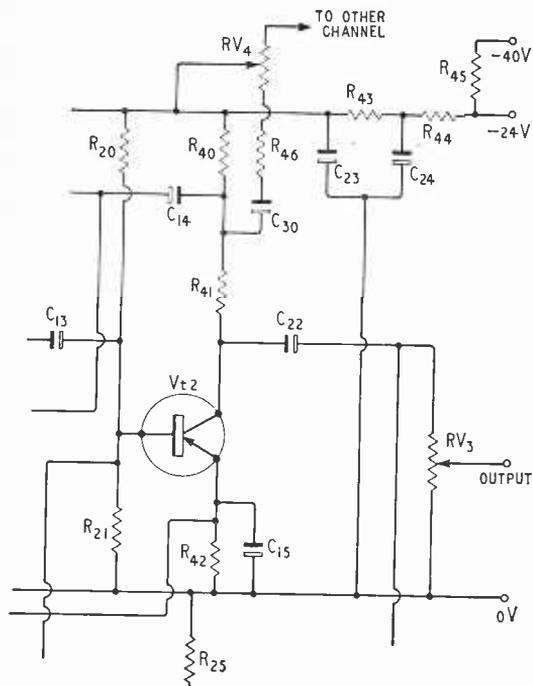
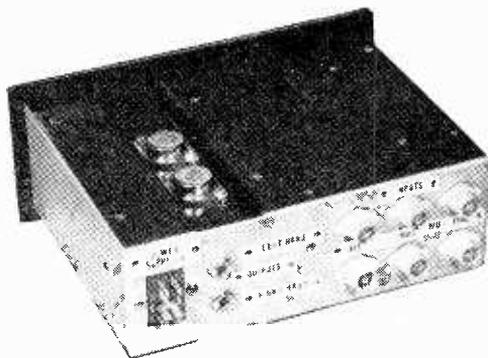
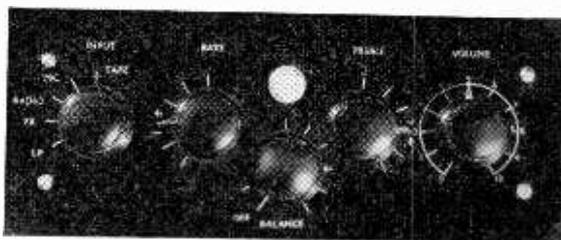


Fig. 8. Part of one half of stereophonic version of pre-amplifier.



Rear view of stereo pre-amplifier and power amplifier showing one pair of power output transistors.



Front panel of stereo power amplifier and pre-amplifier.

biasing resistors. (For a discussion of the *super-alpha* pair see, for example, p. 388 of the article by F. Butler in our Aug. 1960 issue.)

The noise factor of the first transistor determines to a large extent the noise produced by the overall equipment. Though most transistors have proved satisfactory in this application, the occasional specimen may be found which is not, since large variations of noise factor exist between different transistors even of the same type. The signal-to-noise ratio is 70dB with the tone controls level, or 60dB with maximum treble boost.

Power Supply.—The pre-amplifier is designed to work off a nominal 12-volt supply but it will tolerate supply variations between 9 and 15 volts. When the pre-amplifier is being used with a valve power amplifier, the negative voltage required by the pre-amplifier may be conveniently supplied by a dry battery, since the current drain of $2\frac{1}{2}$ mA is small enough to ensure very long battery life.

When compared with a valve pre-amplifier, the transistor pre-amplifier has less capacity to tolerate over driving, since the voltage swing which can be accommodated within the circuit is limited by the lower supply voltage. The present design will not significantly distort signals corresponding to 20dB above those needed to give full output from the power amplifier, which gives a reasonable margin of safety. However, inputs requiring a sensitivity much less than the design values (see Tables 2 and 3) should be attenuated at the input, rather than by having the volume control turned right down.

Layout.—The layout is not critical though normal commonsense precautions should be observed. When the power amplifier and pre-amplifier are mounted in close proximity, a screening plate must

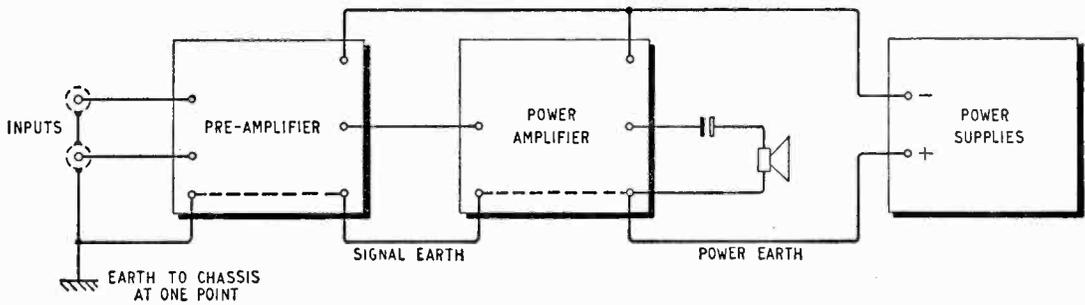


Fig. 9. Earthing diagram of pre-amplifier and associated equipment.

be used to prevent coupling between the output of the power amplifier and the input of the pre-amplifier, which may be troublesome at high frequencies, especially when treble boost is applied. The low-pass filter also helps to prevent trouble from this source.

The photographs show one channel of the pre-amplifier, and two views of the completed prototype stereo version. This was built up on a chassis 8in x 3in x 7in. The pre-amplifiers were built up on fibre-board with terminal pins. By arranging the layout of components and wiring in such a way that no wires cross each other, it is very easy to transfer the layout to a printed circuit form of

assembly. The boards for the stereophonic version were made of opposite hands to facilitate connections to the controls.

The importance of correct earthing, owing to the high currents flowing in the output stage, was stressed in the previous article (Fig. 9).

In conclusion, this article shows that in domestic high-fidelity apparatus, transistors can give just as good results as valves.

(In the article on the transistor power amplifier in last month's issue, in line 11 of the left-hand column of p. 568 R₁₀ should read R₉.)

Characteristics of Whole Stereophonic System

- Output power 10 watts per channel.
- Frequency response .. 45c/s to 20kc/s within 3dB.
- Total harmonic distortion .. 0.25% at 10 watts output.
- Signal-to-noise ratio .. 70dB (with controls level)
(at 10W output) 60dB (with max. treble boost).
- Negative feedback in power amplifier .. 60dB.
- Power requirements .. Version 1: 40 volts d.c. at 800mA (max) or 150mA (average) for 10 watts in 15 ohm speakers.
Version 2: 24 volts d.c. at 1.6A (max) or 300mA (average) for 10 watts in 3 ohm speakers and 24 volts d.c. at 500mA (max) or 100mA (average) for 3½ watts in 15 ohm speakers.
- Controls Input Selector (Microphone, Radio, Tape, l.p., 78 r.p.m.), Treble, Bass, Filter, Volume, Balance.
- Size 8in x 3in x 7in.
- Weight 3lb 2oz.
- Maximum ambient temperature 40°C.

TABLE 2
Input Data for Fig. 1

Switch Position	Function	Sensitivity (mV at 1 kc/s)	Input Impedance (kΩ)
1	Microgroove	Mag 5 Xtal 100	6 100
2	78 r.p.m.	Mag 8 Xtal 150	7.5 100
3	Auxiliary	150	100
4	Microphone	1.5	1
5	Tape replay 7½in/sec	2.5	1

TABLE 3
Input Data for Fig. 4

Switch Position	Function	Sensitivity (mV)	Input Impedance (kΩ)
1	Microgroove	Mag 25 Xtal 100	47 100
2	78 r.p.m.	Mag 30 Xtal 120	47 100
3	Auxiliary	100	100
4	Microphone	4	22
5	Tape replay 7½in/sec	30	47

"Guide to Broadcasting Stations"

NEW edition of the *Wireless World* book "Guide to Broadcasting Stations" lists 500 v.h.f. sound broadcasting stations and 250 TV stations in Europe with an e.r.p. of 5kW and over. Completely revised this 13th edition includes, as usual, details of all European long- and medium-wave broadcasting stations and over 2,000 s.w. transmitters throughout the world which are listed both geographically and in order of frequency.

Tables covering standard time, wavelength-frequency conversion and the international allocation of call signs, are included in the new Guide, which costs 3s 6d (by post 4s).

"ALL-BAND" TRANSISTOR COMMUNICATIONS RECEIVER

By C. J. SALVAGE, (G3HRO)

Design Suitable for Mobile Use

THE introduction of transistors has opened a new field to the amateur constructor and now the "drift" types have made possible the construction of an all-band all-transistor communications receiver. The set described here was designed primarily as a car radio and operates in the broadcast and six amateur bands. A b.f.o. is included for reception of s.s.b. and c.w. transmissions.

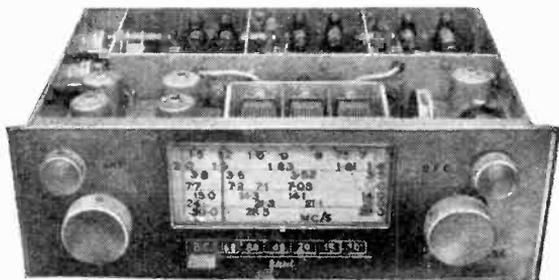
Circuit

As can be seen from the circuit diagrams (Figs. 1, 2 and 3) the line up follows closely that of a conventional communications receiver using valves.

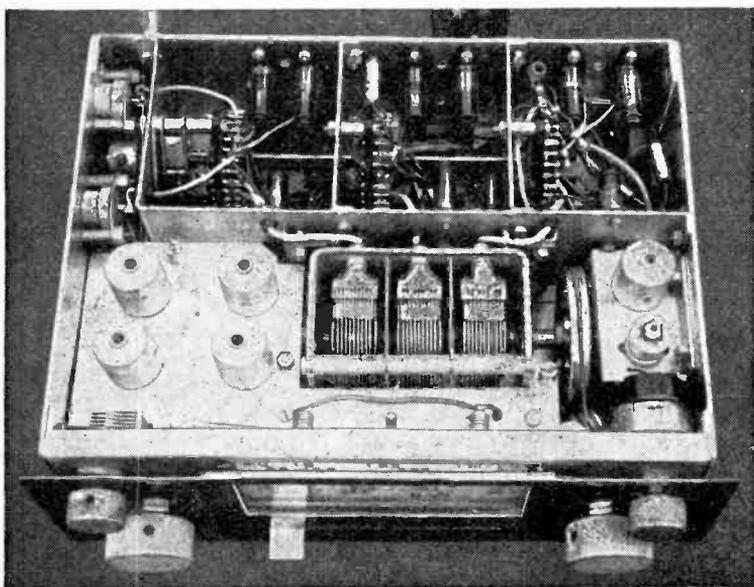
R.f., Mixer and Oscillator Stages.—The aerial circuit has seven coils, either tapped at a suitable position from earth or bearing a coupling winding to give an input impedance of approximately 50Ω , as the receiver is designed to operate from a whip aerial. The broadcast-band coils L_1 , L_8 and L_{15} in the aerial, r.f. and oscillator sections are tuned by the 310-pF three-gang capacitor C_1 , C_2 and C_3 giving a coverage of 1.5-0.7Mc/s. For the amateur bands 22-pF fixed capacitors C_4 , C_{10} and C_{11} are switched in series with the main 310-pF tuning capacitors in order to provide the necessary band-spread. The capacitive dividing circuit C_5 and C_6 provides an impedance match to the base of V1 (OC171) the r.f. amplifier. V1, V2 and V3 are supplied from the 6-V Zener-diode (Mullard

OAZ203) stabilizing circuit via the 470- Ω resistor R_{10} , thus reducing the operating voltage to 4. No useful purpose is served by raising the supply above this value which was found to be the optimum working point for all bands. High values for decoupling capacitors are necessary as all the circuits are of low impedance compared with the corresponding valve circuitry.

I.f. Amplifier.—The output from the mixer stage (V3), at a frequency of 470kc/s, passes to the i.f. amplifier (Fig. 2) which employs three stages. Two stages of amplification can provide sufficient gain if the d.c. supply is increased; but the extra stage was added in order to increase selectivity as the i.f. transformers have only one tuned winding, the secondary being untuned and providing an impedance step-down to match the base of the i.f. transi-



Above: Front view of tuner showing slider control for band switch below dial. Travel of switch "tab" is about two-and-a-half inches.



Left: Plan view of "tuner" unit. Chassis and compartments are 18s.w.g. aluminium; at top of photograph are, left to right, aerial, r.f. and oscillator compartments each containing seven coils. I.f. transformers are bottom left with b.f.o. stage to right of tuning capacitor drum.

stors V4, V5 and V6. Transformer T_4 has a secondary winding designed to match the detector diode (OA70) which supplies the a.g.c. to V5 and the demodulated signal for subsequent audio-frequency amplification. I.f. neutralizing feedback is provided by the R-C network connected to Pin 1 of each of the i.f. transformers (C_{23} and R_{16} with T_2 etc.).

First A.f. Stage.—The audio output from the $5k\Omega$ potentiometer RV_2 , which forms the volume

control, is taken to the first a.f. amplifier. The receiver up to this point is all included in the main chassis; the loudspeaker, second and final push-pull a.f. stages are all mounted on a separate panel which is conveniently placed adjacent to the main "tuner" chassis.

Beat-frequency Oscillator.—A b.f.o. stage is included for reception of s.s.b. and c.w. transmissions. Now a drawback of transistors, especially

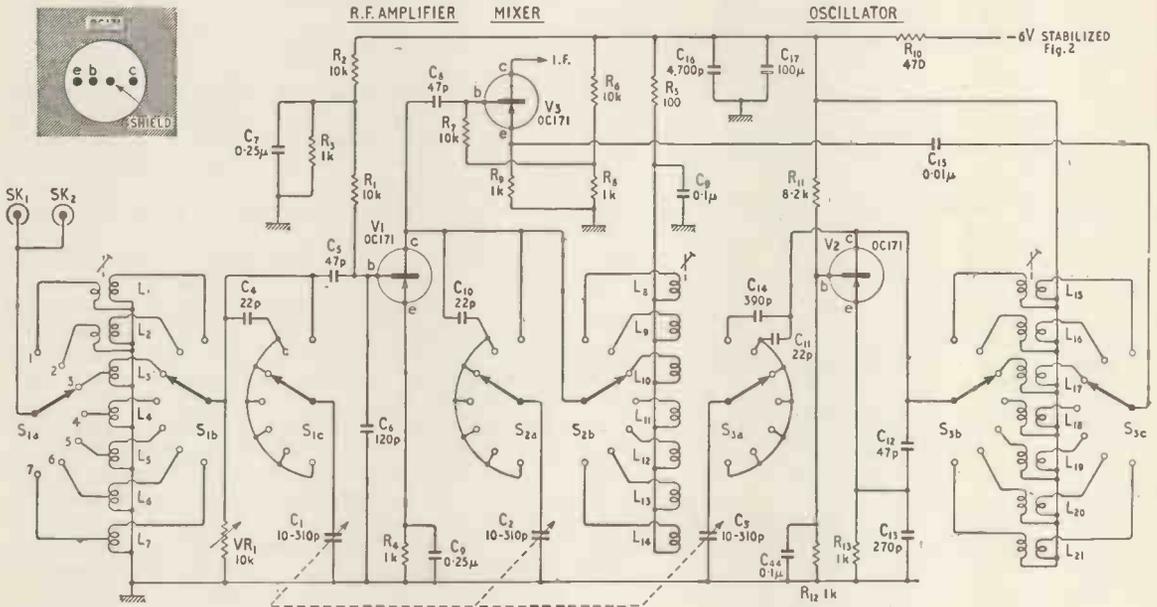
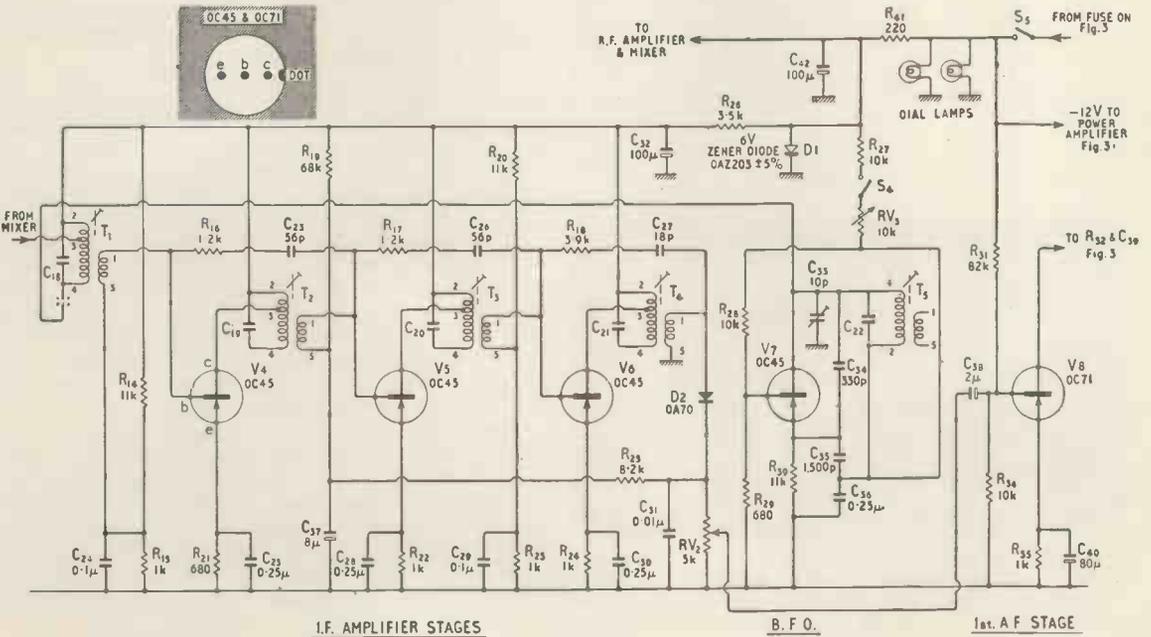


Fig. 1. R.f., mixer and local-oscillator stages. $\frac{1}{8}$ -W resistors are used.

Fig. 2. I.f., detector, b.f.o. and first a.f. stages. Note that b.f.o. coupling to Pin 4 of T_1 first i.f. transformer, is by "stray" capacitance. $\frac{1}{8}$ -W resistors are used.



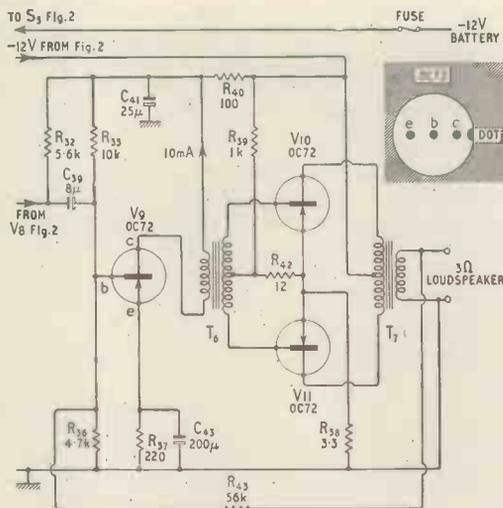


Fig. 3. Power amplifier unit.

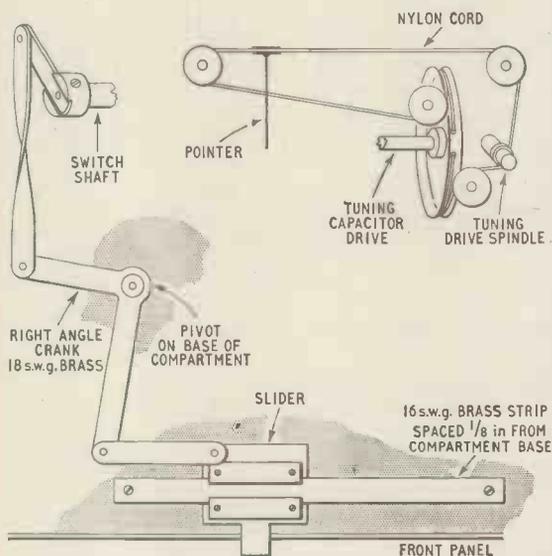
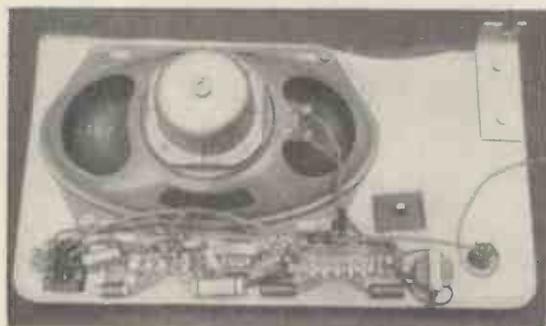


Fig. 4. Arrangement of tuning drive cord and levers actuating band switch from slide on front panel.



Back of loudspeaker and power amplifier panel. Fuse for power supply is at extreme right. First a.f. stage collector resistor and coupling capacitor to driver transistor are connected to socket at extreme left.

in oscillators, is that they are sensitive to supply-voltage variations. This, however, can be used to advantage here and adjustment of the rheostat (RV_3 , $10k\Omega$) in series with the supply to V7 can provide sufficient change of frequency for upper or lower sideband reception of s.s.b. signals or c.w. operation. C_{33} (a 10-pF trimmer) allows fine pre-setting of b.f.o. frequency. The coupling from the b.f.o. to the i.f. amplifier is provided by a lead running from the "hot" end of T_5 to a point near Pin 4 of the first i.f. transformer T_1 .

Construction & Layout

As will be seen from the photographs the set was designed for fitting into a recess that is normally provided for a broadcast receiver in a car and, as this space is different in different cars, no exact dimensions have been given. The versatility of the receiver makes it very suitable for mobile operation.

The front view of the receiver shows the general lay-out of the front panel. The large knob on the left is the a.f. gain control RV_2 , with the on-off switch S_5 incorporated, and the small knob near it is the r.f. gain control RV_1 . The tuning control is the large knob on the right and a cord drive transfers the motion to the tuning capacitor. The small knob adjacent is for control of the b.f.o. (RV_3) and is ganged to the associated b.f.o. on-off switch S_4 . The sliding band switch can be seen under the dial, which is lit by two low-consumption lamps ($12V$, 50mA).

The plan photograph shows the two aerial sockets (top left) with the three screened compartments to the right for aerial, r.f. and oscillator coils. Holes for the adjustment of the cores of coils in the second row near the tuning capacitor are located between the coils at the rear of the compartment. The eight-pole seven-way switch used for band selection is operated by the sliding control whose motion is transferred to a right-angled crank fastened to the base of the compartment. In turn the crank transfers the motion to an arm on the rotating spindle of the band-change switch.

The switch itself is a nine-position type, two positions remaining unused, of three banks of three poles each. The small space available and the need for a very smooth mechanical action indicated that something rather different from the ordinary type of wavechange switch was wanted: thus a "Winkler" type switch made by Painton was used.

The small aerial trimming capacitor, shown on the left near the i.f. transformers, has now been replaced by the $10\text{-k}\Omega$ potentiometer RV_1 and provides r.f. gain control. This control was incorporated as it was found that cross modulation occurred when receiving a very strong signal. The b.f.o. coil T_5 is to the right of the tuning capacitor and next to it is the trimmer C_{33} .

The layout of the output panel and speaker is simple, with the amplifier ranged along a tagstrip. The socket for connection to the main tuning unit is to the left of this strip. V9, the driver transistor, and its associated transformer are on the left with the two push-pull output transistors (V10 and V11) and their output transformer to the right, feeding into the $3\text{-}\Omega$ loudspeaker. Negative feedback is

(Continued on page 629)

supplied from the secondary of this output transformer via the 56-kΩ resistor R₄₃ to the base of V₉. All resistors are of ¼W rating in this section.

Performance

The set has a sensitivity of 1μV on the lower frequency and on 10 and 15 metres this falls to 5μV. The power consumption is about 150mA at 12V for normal reception, increasing to 400mA at full output. Even this current can be conserved when used with transmitter as the whole set is switched off in the transmit condition, rather than, as with a valve receiver, leaving the heaters running. A separate switch for the dial lamps would be worthwhile for dry-battery operation.

Components Specifications

Coils.—All coils are wound on "Neosid" Type 358/8BA formers 0.3in. dia., with Grade 900 cores. (Neosid Ltd., Stonehills House, Welwyn Garden City, Herts.)

Coil Band	Aerial
L1 Broadcast	180μH, wave-wound (about ⅜in wide) with 40 s.w.g. d.s.c. wire: coupling coil 15 turns close-wound adjacent to main coil, 30 s.w.g. d.s.c.
L2 160 metres	90μH, wave-wound (about ⅜in wide), 40 s.w.g. d.s.c.: coupling coil 10 turns close-wound adjacent to main coil, 30 s.w.g. d.s.c.
L3 80 metres	76 turns, close-wound, 38 s.w.g. enamelled (en.), tapped 7 turns from bottom.
L4 40 metres	28 turns, close-wound, 36 s.w.g. en., tapped 5 turns from bottom.
L5 20 metres	19 turns, close-wound, 30 s.w.g. en., tapped 5 turns from bottom.
L6 15 metres	12 turns, close-wound, 30 s.w.g. en., tapped 2 turns from bottom.
L7 10 metres	8 turns, close-wound, 30 s.w.g. en., tapped 1 turn from bottom.
	R.f. Amplifier
L8 Broadcast	200μH, wave-wound (about ⅜in wide), 40 s.w.g. d.s.c.
L9 160 metres	100μH, wave-wound (about ⅜in wide), with 40 s.w.g. d.s.c.
L10 80 metres	80 turns, close-wound, 38 s.w.g. en.
L11 40 metres	32 turns, close-wound, 36 s.w.g. en.
L12 20 metres	21 turns, close-wound, 30 s.w.g. en.
L13 15 metres	14 turns, close-wound, 30 s.w.g. en.
L14 10 metres	10 turns, close-wound, 30 s.w.g. en.
	Oscillator
L15 Broadcast	120μH, wave-wound (about ⅜in wide), 40 s.w.g. d.s.c.: coupling coil, 15 turns close-wound adjacent to main coil, 36 s.w.g. d.s.c.
L16 160 metres	80μH, wave-wound (about ⅜in wide), 40 s.w.g. d.s.c.: coupling coil close-wound adjacent to the main coil, 36 s.w.g. d.s.c.
L17 80 metres	55 turns, close-wound, 38 s.w.g. en., tapped 8 turns from bottom.
L18 40 metres	28 turns, close-wound, 36 s.w.g. en., tapped 8 turns from bottom.
L19 20 metres	14 turns, close-wound, 30 s.w.g. en., tapped 5 turns from bottom.
L20 15 metres	8 turns, close-wound, 30 s.w.g. en., tapped 4 turns from bottom.
L21 10 metres	5 turns, close-wound, with 30 s.w.g. en., tapped 2 turns from bottom.

All coils are covered with polystyrene cement to secure turns.

I.f. Transformers.—T₁, T₂, T₃ and T₅ are identical and are "Weymouth" Type P50/2CC. The detector transformer T₄ is "Weymouth" Type P50/3CC. C₁₈ to C₂₂ inclusive are supplied as part of the transformer.

(Weymouth Radio Manufacturing Co. Ltd., Regent Factory, Weymouth, Dorset.)

Band Switch.—Painton "Winkler" Type AS/3P/9/33 three-pole wafers, nine-position, make-before-break, three-bank with Type "A" spindle

(Painton & Co. Ltd., Bembridge Drive, Kingsthorpe, Northampton.)

A.f. Transformers.—Details of these are given below; but if home design and construction is not contemplated Radiospares Type T/T1, ratio 1:1, is satisfactory for T₆ and Type T/T2, ratio 6.6:1, for T₇.

(Radiospares, Ltd., 4-8, Maple Street, London, W.1.)

- T₆ Turns ratio 2:1+1
Primary inductance 1H
Primary resistance 20Ω
Secondary resistance 10Ω (each half).
- T₇ Turns ratio 3.2+3.2:1
Primary inductance 50H
Primary resistance 1.0Ω (each half).
Secondary resistance 0.2Ω.

Commercial Literature

Controller-Indicator is a moving coil meter movement, with its pointer moving between two parallel plates, one plate being divided into sections. If the two plates are compressed, a circuit is made between one plate and whichever section of the other is under the pointer. Applications are alarms, recording and control, and many variations on the basic form are available. The equipment is part of the Canadian Bach-Simpson range of instruments, including testmeters, panel meters and engine-testing equipment, now marketed by Aveley Electric, Ltd., South Ockendon, Essex.

Chopper Type D introduced by Ericsson is capable of handling signals down to 10μV. Minimum noise pick-up is achieved by terminating the coil and contact leads at opposite ends of the unit. Units are supplied to work at 40-60c/s, but can be adjusted to operate at any frequency up to 100c/s. The standard coil is for 6.3V at a resistance of 500Ω. Full details from Ericsson Telephones, Ltd., 22 Lincoln's Inn Fields, London, W.C.2.

Universal C/tan δ Bridge by Siemens and Halske offers measurement of capacitance from 10pF to 2000μF at charging currents up to 100mA (with shunts). Direct reading of capacitance and loss factor is provided and there is provision for recording readings of crest voltage, loss angle and 4C/A. Details from R. H. Cole (Overseas), Ltd., 2 Caxton Street, Westminster, London, S.W.1.

Phase-sensitive Voltmeter is described in a leaflet from Theta Instrument Corporation, 520 Victor Street, Saddle Brook, New Jersey. The instrument is panel-mounting and takes the form of a cylinder 5-in long, 3-in in diameter. Sensitivity 1mV f.s.d., frequency response 60 c/s-20 kc/s.

Position Control system—the EMICON B100—is described in a leaflet from E.M.I. Electronics Ltd., Industrial Division, Hayes, Middlesex. The system will control machines driven by electric or hydraulic motors, Ward Leonard controls or a.c. motors with clutches. Details are given of peripheral equipment for use with the system.

Components in the wide ranges made by Bulgin are listed in a new 174-page catalogue (No. 202) from A. F. Bulgin and Co. Ltd., Bye Pass Road, Barking, Essex.

Integrator Series 5300 is the subject of a leaflet from Electromethods Ltd., Coxton Way, Stevenage, Herts. The integrator, driven by the company's low-inertia integrating motor, employs a lamp and photocell with a rotating shutter to produce pulses. Motors are available to work at voltages between 1.5V and 24V.

Paralleling Transistors

AUTOMATIC DRIVE CURRENT EQUALIZATION

By F. BUTLER, O.B.E., B.Sc., M.I.E.E., M.Brit.I.R.E.

ALTHOUGH very high power transistors are now becoming available it is still quite common practice to use paralleled banks of smaller units in amplifiers and inverters designed to give a large power output. Parallel operation of small transistors has special advantages when the equipment is required to operate at high frequencies since the cut-off frequency of most high power units is unacceptably low. Matched pairs of power transistors can be supplied on demand by most manufacturers, but the provision of larger groups calls for special selection and this may delay delivery or result in increased costs. Replacements cannot be supplied to match earlier samples. When using unmatched transistors it is good practice to equalize the driving currents by the use of external resistance large enough to swamp the variations of input impedance of the individual units. The virtue of this technique is that it tends to linearize the driving currents as well as ensuring strict equality. Its drawback is that it is wasteful of driving power.

A recent paper¹ has shown how transformers of novel and unusual construction may be used to supply nearly equal currents to a number of loads of different, variable or ill-defined impedance. The author describes two distinct types of transformer which are equally effective in securing the desired equality of drive currents. In the simpler type the leakage inductance is rather larger than in a normal transformer which tends to reduce the operating bandwidth and may be objectionable on other counts, e.g. transient response. The second form of construction employs multiple cores with both individual and common windings. Good characteristics are thus assured but at the expense of increased production costs.

In power engineering it is frequently required to operate rectifiers in parallel and to provide some automatic means of load sharing between them. The usual way of doing this is to make use of small centre-tapped reactors or auto-transformers and the idea is readily adaptable for use in transistor power amplifiers or inverters.

Load Sharing by Tapped Reactors.—Fig. 1 shows an alternator of e.m.f. E supplying power to the unequal load resistances R_1 and R_2 through a centre-tapped reactor. Each half-winding has an inductance L with mutual inductance M between the windings. In practice an iron core is used and the windings are so closely coupled that M is virtually equal to L .

The action is best understood by first considering the case of equal load resistances. From the symmetry of the circuit it is clear that the input current

to the reactor centre-tap will split so that each load resistor carries half the total current. The reactor core magnetization produced by current in one half-winding is exactly cancelled by that due to the oppositely directed current in the other half-winding. The net core flux is zero and no voltage appears across the outer ends of the reactor windings. On the other hand, if the reactor currents are unbalanced due to the use of unequal load resistances, there is an incomplete cancellation of core flux and the residual flux changes result in the induction of an e.m.f. in the windings of such a polarity as to cause an increase in the current in the high impedance arm of the network.

It is not difficult to determine the exact ratio of the two currents (see Appendix). Using the notation in Fig. 1 it can be shown that:—

$$i_1/i_2 = \frac{R_2 + j\omega(L + M)}{R_1 + j\omega(L + M)} \quad \dots \dots \dots (1)$$

For close-coupled windings $L = M$ and:—

$$i_1/i_2 = \frac{R_2 + 2j\omega L}{R_1 + 2j\omega L} \quad \dots \dots \dots (2)$$

Provided the choke reactance is much larger than the load resistances it is clear that the current ratio is almost unity. In general, the two currents are out of phase but the phase difference is negligible in the case where the choke reactance is substantially larger than the load resistances.

It is instructive to look at the circuit of Fig. 1

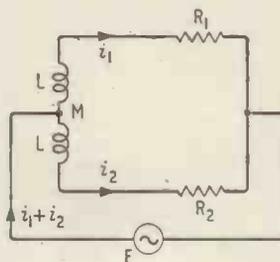
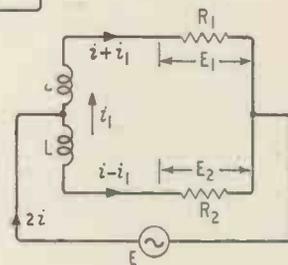


Fig. 1. Equal current division using centre-tapped reactor.

Fig. 2. Alternative treatment of Fig. 1.



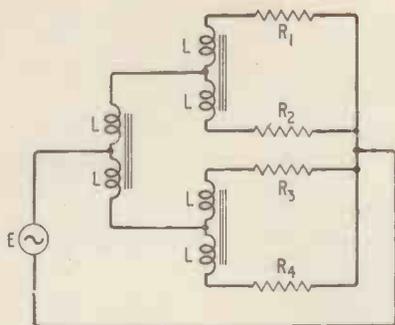


Fig. 3. Extension of current-sharing principle.

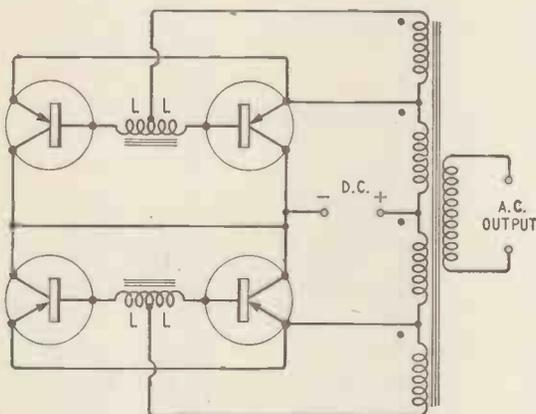


Fig. 4. Inverter using parallel push-pull circuit.

from a slightly different point of view. This has been redrawn in Fig. 2 in which a circuit current $2i$ is shown dividing equally at the reactor centre-tap. The current unbalance due to unequal load resistances is represented by a fictitious make-up current i_1 which adds to i in the low impedance arm and subtracts from i in the other. This of course calls for a reactor current i_1 flowing in the direction shown. The magnitude of this current i_1 depends on the choke reactance and on the net voltage between the outer choke terminals. In turn, this is the difference in the voltage drops across the two load resistors. If the choke is of high inductance it is clear that a large difference of voltage across the two resistances will be required to cause a significant current to flow. This is the unbalance current i_1 .

A mathematical study of the arrangement of Fig. 2 leads to exactly the same conclusion as before and to the same expression for the current ratio $(i + i_1)/(i - i_1)$.

By making use of additional centre-tapped reactors it is possible to supply nearly equal load currents to 4, 8, 16 or, in general, 2^n different load impedances. The principle is shown in Fig. 3. At each stage of division the actual current to be handled becomes smaller and smaller so that finer gauges of winding wire may be used as the working current becomes smaller.

Construction of Reactors.—In most applications the tapped reactors will only be required to equalize

the currents in moderately unbalanced loads. The working currents will seldom exceed one or two amperes and quite small magnetic cores are adequate. To provide maximum inductance with minimum physical size it is worth using cores of high grade magnetic material. Grain-oriented silicon-steel C-cores are suitable for high power 50 c/s equipment but for other applications it may be preferable to choose nickel alloy laminations of the HCR type.

As regards the windings, close magnetic coupling is best achieved by two-ply, bifilar winding, the two half-sections being connected series-aiding. To do this involves connecting the start of one winding to the finish of the other and regarding the junction as the centre-tap. The two free ends then become the outer terminals.

The wide variety of requirements makes it impossible to give useful winding specifications. In any event the design tolerances are very wide. As a rough guide it will be found that a few hundred turns of wire wound on a core with a cross-section about half an inch square will be adequate for most audio-frequency applications. For use in high frequency inverters it is sufficient to wind a few dozen turns of wire on a very small core, say about $\frac{1}{4}$ inch square section.

Practical Circuits.—Fig. 4 shows a typical d.c.-a.c. inverter circuit using four transistors in parallel push-pull. Two centre-tapped reactors serve to equalize the base drive currents. For simplicity, the normal starting-bias circuits have been omitted, but any standard arrangement can be incorporated.

The output stage of a typical Class B audio amplifier is shown in Fig. 5. Here again, the tapped reactors ensure equal base currents in the paralleled transistors. Finally, a full-wave rectifier circuit is illustrated in Fig. 6.

In all three cases two separate equalizing reactors have been shown. In the rectifier circuit both reactor windings may be placed on a single common core with suitable inter-winding insulation. With minor reservations, this technique is permissible in audio

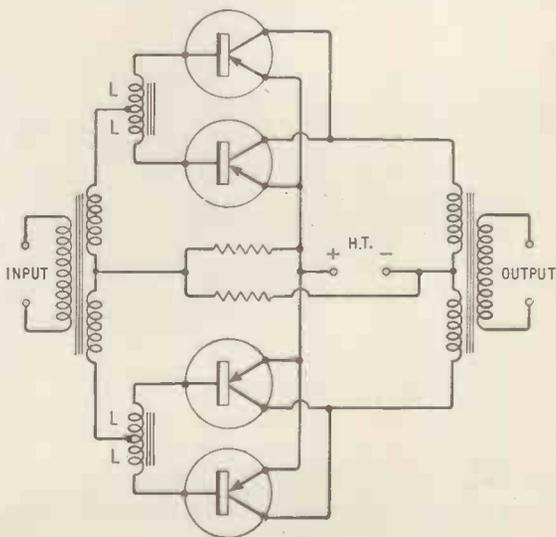


Fig. 5. High power class-B audio amplifier.

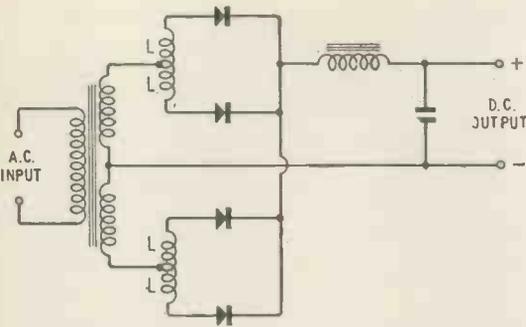


Fig. 6. Rectifier unit with current-equalizing reactors.

amplifier and inverter circuits. If a common core is used it may be found that current-sharing is imperfect near the cross-over point where the instantaneous driving currents are low. This disadvantage is not important, since the current division becomes more exact as the drive amplitude increases and the peak currents will be accurately equalized.

Conclusion.—The provision of small, simple and inexpensive reactors allows the use of unmatched transistors in paralleled groups. There is no degradation in the performance of equipment using them and few if any circuit modifications are called for. Such reactors are extensively used in high power rectifier circuits and are ideally suited for use with germanium or silicon rectifiers which can then be operated in paralleled groups without de-rating.

Reference

¹ H. G. Bassett, "Novel Transformer Suitable for the Parallel Operation of Current Driven Devices," *Radio and Electronic Components*, March, 1961, p. 129.

APPENDIX

From Fig. 1,

$$E = (R_1 + j\omega L)i_1 - j\omega M i_2$$

$$= (R_2 + j\omega L)i_2 - j\omega M i_1$$

Hence:—

$$\{R_1 + j\omega(L + M)\}i_1 = \{R_2 + j\omega(L + M)\}i_2$$

$$\therefore \frac{i_1}{i_2} = \frac{R_2 + j\omega(L + M)}{R_1 + j\omega(L + M)}$$

For a reactor with close-coupled windings $L = M$ so that:—

$$\frac{i_1}{i_2} = \frac{R_2 + 2j\omega L}{R_1 + 2j\omega L} \dots \dots \dots (1)$$

From Fig. 2, total choke inductance (end to end) is $L + L + 2M$, with $L = M$. Thus, total inductance = $4L$.

$$i_1 = \frac{E_1 - E_2}{4j\omega L}$$

where $E_1 = R_1(i + i_1)$,

$E_2 = R_2(i - i_1)$.

$$\text{Current ratio} = \frac{i + i_1}{i - i_1} = \frac{1 + \frac{i_1}{i}}{1 - \frac{i_1}{i}}$$

$$= \frac{R_2 + 2j\omega L}{R_1 + 2j\omega L}, \text{ as before.}$$

The impedance seen by the source voltage E is $Z = E/(i_1 + i_2)$. Again taking $M = L$,

$$Z = \frac{R_1 R_2 + j\omega L(R_1 + R_2)}{R_1 + R_2 + 4j\omega L} \dots \dots \dots (2)$$

Some special cases are:—

(a) $L = 0$ so that $Z = \frac{R_1 R_2}{R_1 + R_2} = \frac{R}{2}$ if $R_1 = R_2 = R$.

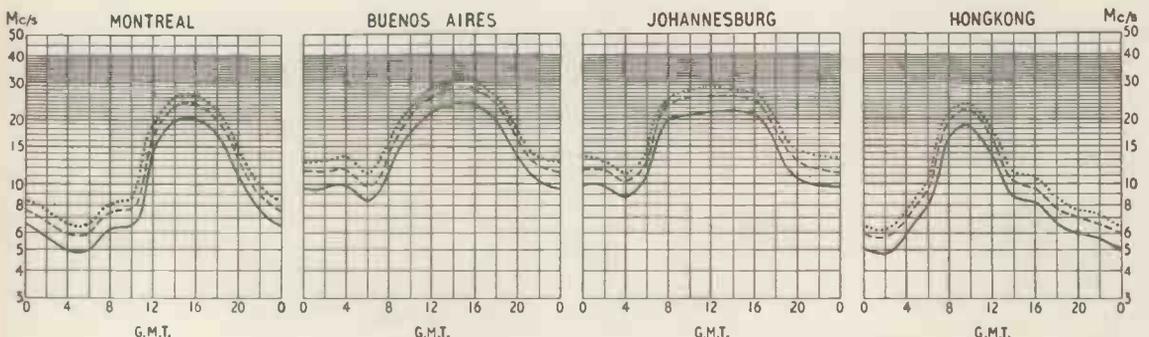
The load impedance is simply R_1 and R_2 in parallel.

(b) $L = \infty$, $Z = \frac{R_1 + R_2}{4}$,

(c) $R_1 = R_2$, $Z = R/2$ and is independent of L .

SHORT-WAVE CONDITIONS

Prediction for December



THE full-line curves indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during December.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

- FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME
- PREDICTED MEDIAN STANDARD MAXIMUM USABLE FREQUENCY
- FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

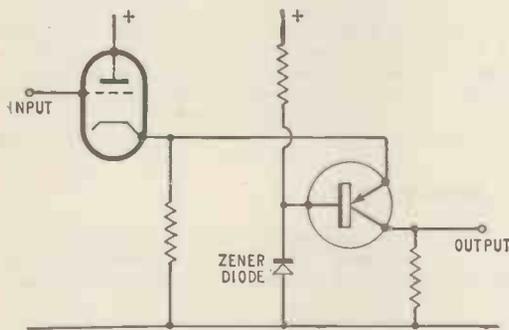
LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Hybrid Amplifiers

THE accompanying circuit which appeared in the *Hewlett-Packard Journal* for April, 1961, is interesting. This hybrid is used in the X and Y amplifiers of an oscilloscope to provide high gain with a bandwidth of 22 Mc/s. The designers point out that the circuit is useful in a direct-coupled amplifier, since the difference in the steady voltage levels at the input and output is only 3 volts, compared with 60 volts for an all-valve circuit. As a result, the power supply can be simplified, and heater-cathode potentials can be kept low.

My article on hybrid amplifiers was written in January, and since then the cost of transistors has dropped



considerably. For example, the Texas Instruments 2G301, an r.f. transistor with a cut-off frequency of 6 Mc/s and a current gain of 60, is listed at under five shillings. This is less than the price of a triode valve, so hybrid circuits should now be a more attractive economic proposition. The intrusion of transistors into mains television receivers reported in *W.W.'s Radio Show Review* seems to confirm this.

Croydon.

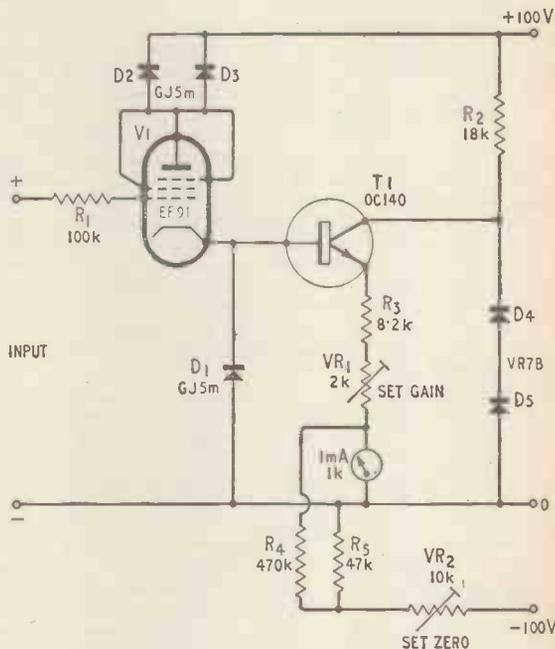
G. W. SHORT.

IN your October issue, G. W. Short has analysed two of the many connections possible with a valve-transistor combination. In my work, a requirement arose for a high-impedance amplifier with good linearity for measuring the voltage stored on a 0.1 μ F capacitor, without discharging the capacitor unduly. The voltage range was 0-10V, and the amplifier was required to drive a 1000-ohm load at up to 1mA. A hybrid amplifier has proved ideal for this, using the common-anode plus common-collector combination.

In a simple cathode-follower circuit, low grid current can be obtained by operating the valve at low anode voltage and low cathode current. This results in poor linearity, but this can be improved by operating the valve with a constant cathode current. A germanium junction diode, operating in its reverse current direction, is a suitable cathode load, and the circuit is completed by an emitter follower driving the output load.

The accompanying diagram shows the practical circuit. The only additions necessary to the basic circuit are zero setting arrangements and the use of components R₁, D₂ and D₃ to protect the transistor in the event of the input voltage exceeding about 12V. Diodes D₂ and D₃ are operating on the reverse part of their characteristic and limit the valve anode current under abnormal operating conditions.

The linearity obtained with the circuit was $\pm 0.1\%$ of



maximum input and the input current was less than 10^{-10} amps over the range 0-10 V.

No attempt was made to compensate the circuit for temperature changes and the voltage drift referred to the input is therefore rather large. This has not proved troublesome for the 0-10 V range chosen.

The work described in this letter is published by permission of the Director, Central Electricity Research Laboratories.

Leatherhead.

A. E. T. NYE.

Safety of Life at Sea

THE Ministry of Transport announced in August that as from 1st September, 1961, direction-finding facilities from British coast radio stations would be suspended. While these services offered by the coast stations have not been patronized to any appreciable extent, the ability of a wireless station to take the bearing of a transmission is a facility that should not readily be withdrawn.

That it is not the desired intention of the Post Office, who staff and operate the stations, to curtail this facility seems apparent from the reservation of a four-acre site for direction-finding aerials at the new Ilfracombe radio station and also from their action in resiting the aerials at Humber Radio within the past few years.

At a coast station the M/F watch, on 500 kc/s, is conducted by the Post Office for the Ministry of Transport, who pay for the service. This is considered to be a non-commercial activity. The direction-finding equipment consists, the present tense is used, of large triangular loop aerials erected at a site about half a mile away from the station. The loops are unscreened and are centrally supported from a wooden pole. The site for the direction-finder aerials has to be on suitable elevated ground well clear of buildings, trees, wire fences and overhead lines. Long term preservation of

the site is usually secured by the Post Office becoming the landowner of surrounding territory that then may be leased for agricultural use. At the operating position, which is manned by the operator listening on 500 kc/s, there is a radiogoniometer and a receiver that can be switched at will to either the radiogoniometer or a receiving aerial. A.g.c. is automatically removed from the receiver when it is connected to the radiogoniometer. At frequent and regular periods throughout the day bearings are taken on other coast stations and by this means the operational efficiency of the system is checked.

The prime purpose of radio apparatus on board ship and of the coast radio stations is the safety of life at sea. In the past it has always been the automatic action of an operator at a coast station to take a bearing of a distress signal on 500 kc/s; most often this information is unnecessary but occasionally it has proved of great value and assistance in guiding rescue craft to the location of the distress. Information of this kind is generally only required when weather conditions are foul and only one transmission is made from the vessel in distress. The Ministry of Transport notice, issued from St. Christopher House, states "... there is not sufficient demand for navigational purposes to justify the retention of the service, and the needs of ships in distress are met by other methods." What these methods are is not stipulated.

What could they be? Bearings taken by other vessels? This is unlikely to happen if only one call is made from the station in distress because ships at sea do not normally keep watch on a D/F receiver and circumstances can arise, as was the case in the rescue operations subsequent to the foundering of the *Princess Victoria* in January 1953, when the search vessel is unable to take a reliable bearing owing to the extreme yawing of the vessel. Additionally, transmission of the distress message may occur when the ships' operators are not on watch, or the direction finder may be in the chartroom. Bearings provided by naval stations? These stations have not contributed directly in such operations in the past and it does seem unlikely that the D/F facilities would be transferred to the Service at this stage. The use of other modern aids to navigation? If a ship runs aground it would appear that these aids had failed and that it is uncertain of its position. How, then, is assistance to be directed to it promptly?

It seems that the cost of maintenance of these installations, compared with the revenue for the particular service rendered, is considered to be out of proportion. Another factor of influence will be that, in recent years, other countries have abandoned this service; not, however, countries with strong maritime interests. That the facility is not required for navigational purposes is not disputed; but it should be retained for distress purposes and even extended.

The D/F system just abandoned worked in the band 410 to 500 kc/s. This was, perhaps, its greatest disadvantage because the majority of ships using the coastal waters about the United Kingdom, fishing and home-trade vessels, are fitted with radiotelephone equipment that operates in the band 1,625 to 2,850 kc/s. D/F coverage in this band would be difficult to provide over the entire coastal area unless the facilities of the Coastguard Service were linked into the scheme. The segregation of marine communication into two bands without ready means of contact from one band to the other has, in the past, hampered rescue work; the most recent instance of this nature occurred after the collision involving the *Crystal Jewel* in the English Channel. It is peculiar that a modern ocean-going vessel cannot communicate directly with a lifeboat or coastal vessel that is coming to its assistance. The Merchant Shipping (Radio) Rules, 1952, make no provision for circumstances like these. Would it be unfair to hint that there seems to be a lack of complete assessment of practical conditions?

If the measures taken by the Ministry are unable to prevent accidents taking place, at least all facilities

should be provided for rescue operations; and while it is not anticipated that they will in any way rescind their decision, the usefulness of permanent D/F installations, capable of reception over a wide frequency range, should not be overlooked. Who could help the crew of an aircraft in a rubber dinghy in the North Sea at 0130 G.M.T.? German coast stations, Dutch coast stations and, we are told, "other methods," but not British coast stations.

South Shields.

A. T. FERGUSON.

Hearing High Frequencies

MR. MAWSON'S conclusion (November issue), that the most acceptable type of radio receiver for the elderly is one which has plenty of built-in top cut, would indicate that at high frequencies not only does the absolute level of hearing threshold increase with age but that also the absolute level of the threshold of pain reduces with age.

This would account for the often observed phenomena that such persons are the first to reach for the top cut and/or filter controls in reproduced music.

Many eminent elderly musicians, however, although ardent top-cut fans at home, make no complaint about the top from a live orchestra, even sitting in the middle of it. Can it be that with the experience of advancing years one becomes more discerning and thus less prepared to accept the imperfections which most transducers exhibit at high frequencies?

Huntingdon.

P. J. WALKER.

Telemetry

I WAS pained to read in your November issue of the abuse of the word "Telemeter." A magazine with as much influence as yours should realize that some confusion will arise from its use.

Unless action is taken, followers of the noble science of measurement at a distance will become identical in the public image with gas company inspectors, and will have to coin a new word to cover their activities. I leave suggestions to Mr. F. Grid. I can only think of "Slotelly" for them.

One group will have to change. We have got classical justification and we got there first.

Cambridge.

S. H. SALTER.

[While we sympathize with our correspondent's point of view, we think that "abuse" is perhaps too strong a word. After all the coins are measured, and at a distance from the company's headquarters.—ED.]

Degrees of Definition

THE suggestion in your November editorial, to use the word "Mark" in distinguishing different degrees of television, is astonishing.

Present day use of "Mark . . .", by individuals or commercial firms, suggests adherence to a style which became familiar to many in war time, or alternatively a snobbish attempt to suggest that the items referred to have a large "official" backing.

In the early days of multiple production, mainly in the gun industry I believe, when designs were modified for improvements or economies, it was found convenient to put on a distinguishing number, letter or other mark. When referring, in writing, to such distinctions, to avoid referring to "Gun II" or "Tank II," the reference became Gun or Tank "MARK II," sometimes abbreviated to "Mk. II." For consistency the word "Mark" or its abbreviation was then added on the articles themselves. Incidentally not all Armament and Government work makes use of the "Mark" system. I met it first as a curiosity of another branch when connected with Naval work in the early 1930's.

For a system to distinguish different standards of

television definition, I suggest "Definition I," etc., for it will always be necessary to note that definition is referred to and the word "Mark" is superfluous. Subsequently in a single article, abbreviation to "I," "II," etc., would be reasonable. It is interesting for comparison to note that there seems no tendency to further abbreviate "Band I," etc., no matter how often repeated.

As the editorial also refers to "hair-splitting" about "service," it might not be wise for me to go on and list some of the ways in which "service" is used portmanteau fashion, like "thingamajig" to cover careless lack of discrimination.

However, as an engineer I like to avoid quibbling which is liable to waste time, like redundant reference symbols.

London, N.W.6.

W. G. EALY.

Electronic Music

SINCE it is not possible in a short article to outline fully the artistic or manipulative techniques necessary to extract real value from electronic music, I append some references which readers will find useful. Mr.

Judd, in his article in September, did not give sufficient credit to the father of *musique concrète*, Pierre Schaeffer, or his colleagues Olivier and Pierre Messian, whose musical knowledge enabled the art to be launched.

The same applies to the monumental work of Prof. W. Meyer-Eppler and his colleagues Herbert Eimert, Fritz Enkel and Karlheinz Stockhausen, at Cologne. The immense amount of research into musical notation, composition, and apparatus for electronic music research cannot be fully appreciated without reference to the literature cited below.

Radcliffe-on-Trent.

ALAN DOUGLAS.

Schaeffer, P. "A la Recherche d'une Musique Concrète." Edition du Seuil, 1952.

Poullin, J. "Son et Espace." Editions Richard Masse, 1954.

Moles, A. "Les Machines à Musique." Editions Richard Masse.

Moles, A. "Studium und Darstellung des Complexen Tones in der Musikalischen Akustik." *Funk und Ton*, 1953.

Bernhart, J. "Deux Applications de la Notion de Distorsion Spatiale." *L'Onde Electrique*, No. 304, July, 1952.

Articles in the special number "Elektronische Musik," Vol. 6, No. 1/2, 1954, of *Technische Hausmitteilungen des Nordwestdeutsche Rundfunks*.

TUNED COUPLED CIRCUITS

USE OF MAXIMUM POWER TRANSFER THEOREM By B. J. AUSTIN

THE theory of tuned coupled circuits is a straightforward example of elementary circuit analysis and is adequately treated as such in many text books. However, in view of the importance of such circuits, it seems worth while to review the situation in a way which focuses attention on the underlying physics, not on the algebraic manipulations.

The purpose of the article is not, then, to carry out a complete analysis of the circuit of Fig. 1. This would be unrewarding and without much interest. Instead, let us try to see just why tuned coupled circuits behave as they do. In particular, let us attempt to explain, from basic physical principles, the observation that the secondary current I_2 can never be made to exceed $V/2R$, however large the coupling M may be. Familiarity with this fact may detract from its striking character, but could we, on a first acquaintance with the problem, merely write off such strange behaviour as accidental? Would we not contrast the docile increase of I_2 with M , up to the critical value $V/2R$, with its stubborn refusal to increase beyond this point, and begin to suspect the workings of a hidden law? Of course we would, and this article is intended to show how well-founded our suspicions would have been. Any of our readers who have read the subtitle will know that the law involved is one about maximum power transfer.

First of all, we must know what the Maximum Power Transfer theorem states. Imagine that we have a voltage generator V with internal resistance R . We connect, in turn, load resistances of various values and measure, in each case, the power which is dissipated in the load. The theorem then simply states that this power is greatest when the load resistance is equal to R , the internal resistance of

the generator. The reader will be able to show that the maximum power available for dissipation in the load is then $V^2/4R$, corresponding to a current of $V/2R$. The theorem applies to steady or alternating voltage generators and, if necessary, it could be extended to include generators having complex internal impedances. We will not require this extension.

The theorem is still valid when the load is separated from the generator by a tangle of L 's and C 's. Indeed, in this situation, it is more flexible since it is possible to "match" any value of load resistance to the generator by means of a suitable lossless coupling network. The network must be chosen so that the generator "sees" a load equal to R , while the real load thinks that the generator has an internal resistance equal to itself. Fortunately, the second half follows from the first, so that we can forget about it. A well-known example of this technique is the matching of a loudspeaker coil

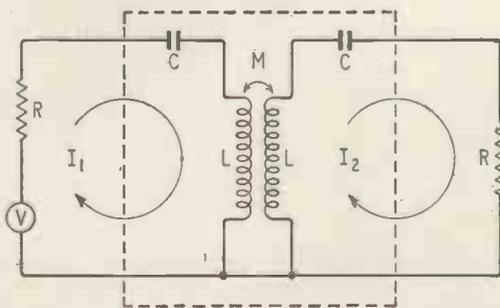


Fig. 1. Basic tuned coupled circuit. The dotted box contains a network which couples a "load" to a "generator".

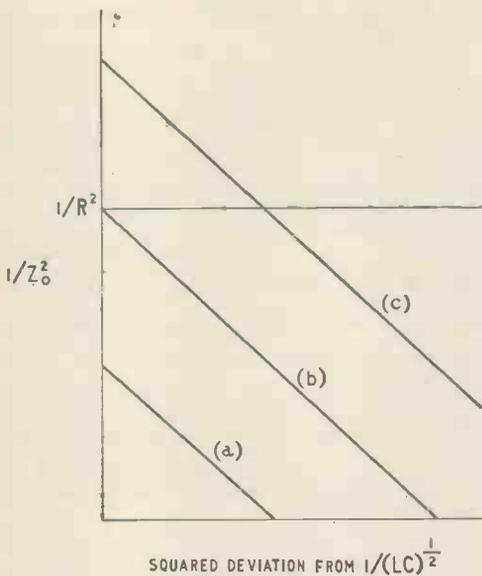


Fig. 2. Squared deviation from $1/(LC)^{1/2}$ plotted against $1/Z_o^2$ (for high-Q circuits). Graph (a) is for small M , when $1/Z_o^2$ never reaches $1/R^2$ (undercoupling), (b) is when $1/Z_o^2$ just reaches $1/R^2$ (critical coupling) and (c) is for large M (over coupling).

(resistance 15 ohms, say) to a power output valve (internal resistance 5000 ohms, say) by a transformer with a suitable turns ratio.

To see the application to tuned coupled circuits, let us view the circuit of Fig. 1 in an unusual way. Let us think of the resistance R in the primary as the internal resistance of the generator, and the secondary resistance as a load. Of course, this is an artificial dodge because the R 's are inseparably bound up with the transformer, and, anyway, we are not using the tuned circuits merely to dissipate power in the secondary. These objections are not fundamental however, so we may lay them aside. Our problem is to find the condition for greatest secondary current, which amounts to finding the condition for maximum power dissipation in the "load". The properties of the coupling network are in this case frequency dependent, and we are seeking the frequencies at which a load R connected to the output terminals gives rise to a resistance R at the input terminals. (The point here is that the resistance "seen" at the input must be the same as the internal resistance of the generator, i.e. also R .)

At first sight, this problem may seem quite impossible to solve, but actually it can be done. At least, it is always possible to find an impedance (called Z_o) which, when connected to the output terminals of a symmetrical four-terminal network, causes the input impedance to be Z_o as well. Z_o is called, among other things, the iterative impedance, and it is a concept much used in some branches of circuit theory (e.g. the theory of filters). We need not worry about this, but merely remark that our problem is to find the frequencies at which the iterative impedance of the coupling network is equal to R .

It can be shown (and this stock phrase hides quite a lot of algebra) that in our case Z_o is given by:— $1/Z_o^2 = -[\omega C - 1/\omega(L+M)][\omega C - 1/\omega(L-M)]$ (1) Hence, the frequencies at which the secondary

current is a maximum are the solutions of:—

$$1/R^2 = 1/Z_o^2 = -[\omega C - 1/\omega(L+M)][\omega C - 1/\omega(L-M)] \quad (2)$$

The reader may be tempted to feel that this is the end. After all, we have only to find what frequencies satisfy equation (2) for any given values of the parameters (M in particular), and we have the frequencies at which the load power is a maximum, and hence the secondary current is greatest. Disappointingly enough, we have not quite finished, since it is not always possible to satisfy equation (2). This is most easily seen by reference to Fig. 2. A word of explanation about this figure is in order here. The abscissa is plotted in terms of the squared frequency deviation from the centre frequency i.e. from $1/(LC)^{1/2}$. Thus each point to the right of the origin represents two frequencies, one above and one below the centre frequency. Negative points have no meaning. When plotted against this variable, for high Q circuits, the graph of $1/Z_o^2$ is practically a straight line in the region which concerns us.

For a given value of M , $1/Z_o^2$ is greatest at the centre frequency (remember that negative values of the abscissa are not allowed). If the highest value attained is less than $1/R^2$, as will happen if we make M sufficiently small, we will not be able to find a solution of equation (2). This is, of course, the situation known as "undercoupling". The secondary current has a single maximum at the centre frequency (i.e. where matching is most nearly achieved). The current is always less than $V/2R$ since we can never have the theoretical maximum power transfer.

If we make M large enough, we arrive at the situation called "overcoupling". We now have the line representing $1/Z_o^2$ rising above $1/R^2$ at some real (positive) abscissa value. Hence we will have two solutions of equation (2) and thus two frequencies at which I_2 is a maximum. We can now see that the value of these maxima will be $V/2R$, for all values of M greater than the critical value. Thus, the obstinate refusal of I_2 to exceed $V/2R$ can be seen to be a consequence of the maximum power transfer theorem.

At last we have reached the end of the road. It may seem that an undue amount of effort has been expended to arrive at rather meagre scraps of information, especially as the method cannot be extended to include the case of unequal primary and secondary resistances. We could, however, have worked out one more detail, namely the critical value of M , but this is left as an exercise for the reader.

CLUB NEWS

Bexleyheath.—W. J. Green (G3FBA) will give a talk entitled "Bandspreading HRO Coils" at the meeting of the North Kent Radio Society (G3ENT) on December 14th at 8.0 at the Congregational Hall, Clock Tower, Bexleyheath, Kent.

Birmingham.—The subject for discussion at the December 1st meeting of the Slade Radio Society (G3JBN) is d.f. developments. Meetings are held on alternate Fridays at 7.45 at Church House, High Street, Erdington, Birmingham, 23.

Bradford.—"The development of time measurement" is the title of the talk to be given by W. Barton at the December 12th meeting of the Bradford Radio Society. The club headquarters are at Cambridge House, 66, Little Horton Lane, Bradford, 5, where meetings are held at 7.30. Instruction for junior members is given at 7.0.

The D.C. Feedback Pair

A USEFUL TRANSISTOR AMPLIFIER CIRCUIT

By G. W. SHORT

THE circuit shown in Fig. 1 has several virtues. Not the least is economy: it gives good temperature stability with fewer components than the conventional one (Fig. 2(b)). It is useful in low-level audio stages, and it lends itself to negative feedback arrangements.

It has been called the transistor d.c. feedback pair,

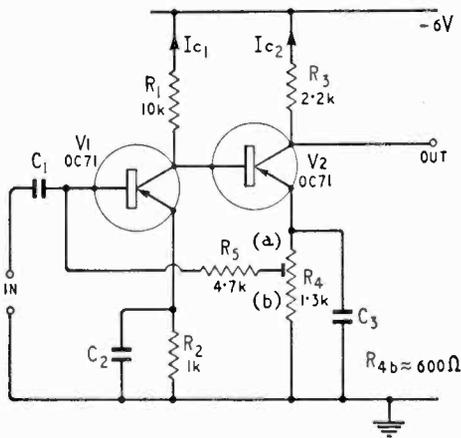


Fig. 1. Transistor d.c. feedback pair.

because it contains two transistors in a d.c. feedback circuit. The operation is complicated. Interested readers can look up reference (2) which contains a full circuit analysis. But they are warned that the formulæ are so complex that they mean very little to ordinary mortals.

A rough qualitative picture of what happens can be arrived at without any mathematics. Suppose that, as the result of a temperature change, there is a change in the base current of V1. The increment of base current is amplified by V1, which causes phase inversion as well. Part of the amplified increment is passed to V2, where it is further amplified, and finally a portion is fed back to V1 via R5. Since there is no phase reversal in V2, which is a common-collector circuit as far as this feedback is concerned, the overall feedback is negative.

What about the temperature drift of V2? Assuming that ambient temperature, not the heat of internal power dissipation, is the controlling factor, then both transistors will be subject to the same temperature fluctuations. Their collector-base leakage currents (I_{cbo}) will drift in the same direction. Since there is phase inversion in V1, its amplified drift current appears at the base of V2 in opposite polarity to V2's own drift current. Thus some cancellation of V2's drift takes place. In practice, with two

similar transistors, the drift in V2 is overcompensated by V1. As the temperature increases, the collector current of V2 decreases.

The behaviour of a practical circuit is shown in Fig. 3. This compares the performance of the d.c. feedback pair with the more conventional arrangements of Fig. 2. The same transistor was used for V1 and for the two conventional arrangements, and the operating current at room temperature was arranged to be the same in each case. A water bath was used to control the temperature: the transistor envelopes were immersed for about three-quarters of their length.

Simplified Circuits:—The d.c. feedback pair can be simplified by connecting the emitter of V1 straight to "earth", and increasing R5. This has

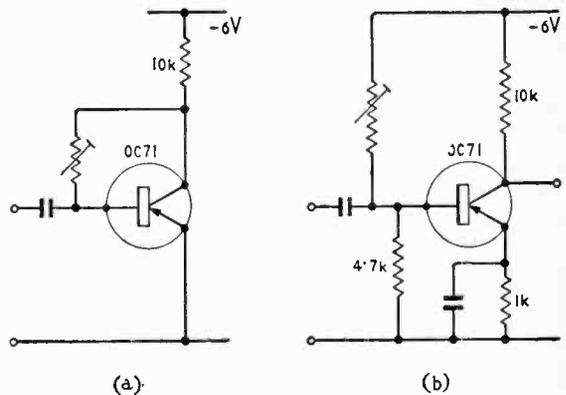


Fig. 2. Conventional temperature-compensated circuits; (a) with shunt feedback, (b) with emitter resistor and base bias potentiometer.

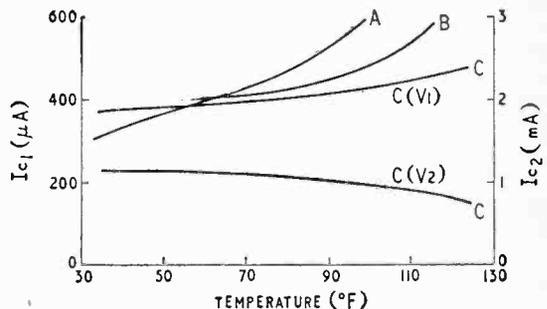


Fig. 3. Variation of collector current with temperature. Curve A refers to the circuit of Fig. 2(a), Curve B to that of Fig. 2(b), and Curve C to the d.c. feedback pair of Fig. 1.

the advantage of getting rid of R_2 and C_2 . (It also increases the input impedance of V1 slightly, but this is hardly important, since R_3 can usually be made at least twice as big as the input impedance of the transistor V1 itself.)

Two simplified circuits are shown in Fig. 4. The first one (Fig. 4(a)) is applicable when the input is connected through a capacitor. The second (Fig. 4(b)) has too low an input resistance for this (in the particular set-up investigated by the writer, $R_{4(b)}$ was only about 30Ω) but it can be used with transformer input-coupling, as indicated.

The temperature responses of these circuits are compared with that of full circuit in Fig. 5. The immediate conclusion is that the Fig. 4(a) type of circuit is no good: in this particular instance it is worse than the simple circuit of Fig. 2(a). In fact the trouble with this particular circuit was caused by an over-large R_4 , which in turn made necessary an over-large R_5 . For good stability, R_5 should be as small as possible.

Measurements taken on the circuit of Fig. 6, in which R_5 is reduced to $4.7k\Omega$, are shown in Fig. 7, along with those of the full circuit for comparison. The simpler circuit gives quite a good performance. ($R_{4(b)}$ was 37Ω .)

In general, then, all the variants of the d.c. feedback pair can be made to provide good enough temperature stability for use in domestic equipment, at any rate in a temperate climate. We shall now review some specific applications of the circuit.

Low-Level Input Stages.—Transistor noise can be serious in audio work. In order to minimize it, the transistor should be operated at a low current. In addition, the collector voltage (V_{ce}) should be kept small, though this is not so important as low current.

The temperature-stability curves show that the feedback-pair circuit is a good one for this application. The current in V1 is low and fairly constant, so that the transistor can be operated at a low voltage without the risk of "bottoming" at the higher temperatures. The OC71 is not conspicuously good from the point of view of noise. A special low-noise transistor such as the Mullard AC107 should give less noise, and also less temperature drift: its base leakage current is an order of magnitude less than that of the OC71. It would be reasonable to use an OC71 in the second stage, where noise and I_{co} are less important.

Negative Feedback.—The d.c. feedback pair behaves also as an a.c. feedback circuit at frequencies at which the capacitor which decouples the emitter of V2 has an appreciable impedance. The effect of this feedback is twofold. It reduces the input impedance of the amplifier as a whole, and it increases the input impedance of V2. Both effects

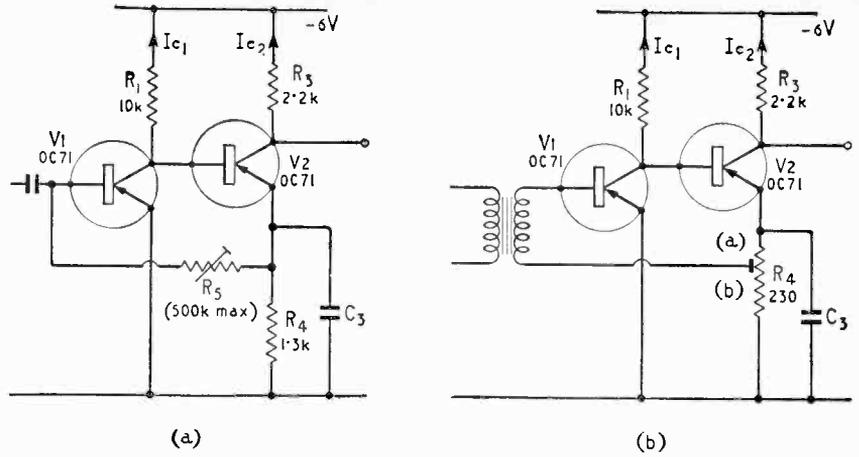


Fig. 4. Simplified feedback-pair circuits.

can cause a reduction of gain as the frequency decreases. The magnitude of this "bottom cut" depends on the signal-source impedance and on the size of the collector load of V1. If the signal source has a very high impedance (constant-current drive) then the input current divides between the base of V1 and the feedback resistor R_5 . Under these conditions the maximum amount of bottom cut is obtained. Note, however, that the process does not go on for ever. As the frequency is reduced, a stage is reached at which the reactance of the V2 emitter-decoupling capacitor becomes so great compared with the emitter resistance (R_4) that the feedback is virtually independent of frequency. The response then levels out again.

If the amplifier is driven from a low-impedance source (constant-voltage drive) the overall feedback has no effect. There is still the local feedback, however. The input impedance of V2 increases as the frequency is reduced. If V2 were driven from a source with a very high impedance, its base current would be unaffected, and there would be no bottom cut. In fact, the source impedance is the collector load of the first stage in parallel with the output impedance of V1, and it is unlikely to be very high compared with the input impedance of V2. The latter becomes approximately βR_5 at very low frequencies.

As in all transistor circuits, the two effects can-

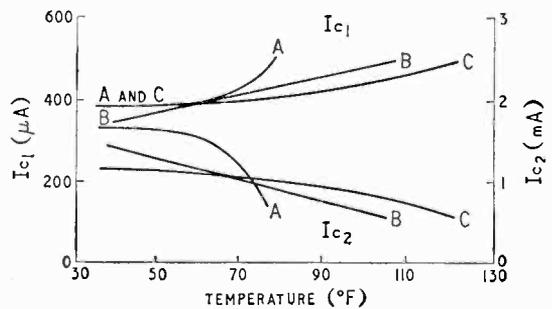


Fig. 5. Temperature performance of various feedback-pair circuits. Curve A refers to the circuit of Fig. 4(a), Curve B to Fig. 4(b), Curve C to one like Fig. 1, but with $R_5=10k\Omega$.

not be completely separated. The output impedance of V1 is influenced by the signal-source impedance, for instance. But in typical audio circuits the signal-source impedance has only a small effect on the output impedance of V2. One can then get an idea of the effect of the second type of feedback by taking frequency response using a constant-voltage source.

Measurements on a practical circuit showed a low-frequency fall-off of about 5dB per octave with constant-voltage drive, and 8dB per octave with constant-current drive. These values were obtained when the capacitance C_3 was big enough to bypass the second emitter more or less completely above about 10 kc/s. If, on the other hand, C_3 is so small that it only begins to bypass the second emitter at frequencies near the upper cut-off frequency of a normal amplifier, a compensation effect occurs, and the frequency response is improved. In a particular instance, a $0.005\mu\text{F}$ capacitor doubled the bandwidth of the amplifier compared to that when no

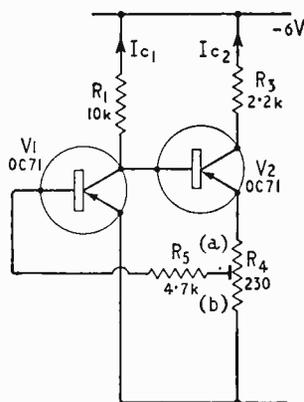


Fig. 6. Improved version of Fig. 4(a). By fixing R_6 and adjusting R_4 to obtain the right operating conditions the resistance in the base circuit of V1 is kept fairly low.

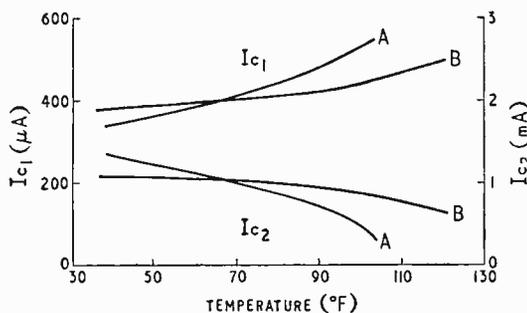


Fig. 7. Temperature performance of Fig. 6 (curve A) compared with full feedback-pair circuit with $R_5 = 10 \text{ k}\Omega$.

capacitor was used, the gain remaining almost the same.

Tape Recorder Equalization.—Readers may remember an article in the December, 1958, issue in which P. F. Ridler³ showed that the circuit of Fig. 8 produced playback equalization for a tape recorder. In this case the inductance was that of the playback head, which was 500 mH.

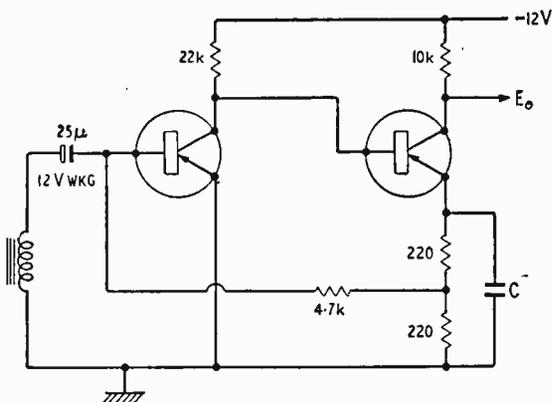


Fig. 8. Ridler's tape-recorder playback equalization circuit.

In tape-recording, two effects occur which modify the frequency response—a bass cut and a top cut. The bass cut arises simply because, as the frequency is reduced, the rate-of-change of flux at the playback head is reduced. The result is a bass cut of 6dB/octave. The top cut arises from more than one cause.

If the response of the recording amplifier is flat, and the recording current is constant, then, because of the low-frequency effect, the voltage induced in the playback head by the moving tape is proportional to the frequency. The lower the frequency, the lower the voltage, other things being equal. If, as is usual, the playback head is worked into a high-resistance load, so that it acts as a voltage generator, i.f. boost is necessary somewhere in the system.

If, however, the playback head is connected to a load with such a low resistance that it can be considered a short circuit, the output current does not fall off as the frequency is reduced. It remains constant. The reason is simple. The voltage induced in the head falls with frequency, as before. But the impedance of the head also falls, since the head is an inductor. These two effects cancel one another, and the output current is not a function of frequency.

Thus, in principle, the need for i.f. equalization can be avoided. The system fails if there is an appreciable amount of resistance in the circuit, either in the winding of the playback head or in the load. While a common-emitter transistor has a lowish input resistance (say $1 \text{ k}\Omega$), this is by no means a short-circuit. The i.f. current response is 3dB down when the total resistance is equal to the reactance of the head. Assuming a 1 H head, then for a loss of no more than 3dB at 30 c/s the total resistance of winding and load must not exceed about 200Ω . While the winding resistance of the head may be less than 200Ω , the input resistance of a common-emitter transistor is much greater. One must either use a common-base transistor, or artificially reduce the input resistance of a common-emitter circuit. Since the feedback pair does this for us if we omit C_3 , and since negative feedback brings other advantages, it is reasonable to use the feedback pair in equalization circuits.

The mechanism by which the equalization works is then as follows. The input resistance of V1 is unaffected by the feedback. What the feedback

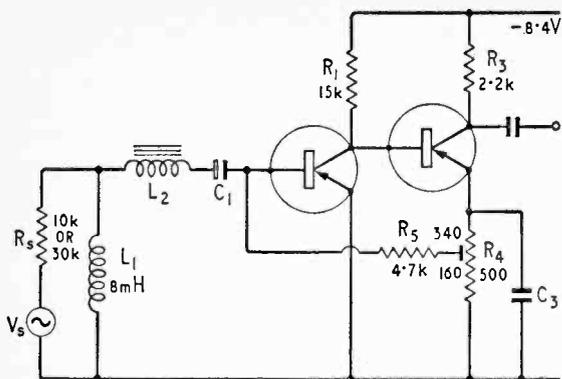


Fig. 9. Test circuit for playback equalization.

does is to make R_5 look smaller to the signal source, so that the input current mostly flows through R_5 . If the amount of feedback is the same at all frequencies, the ratio in which the input current is shared by V1 and R_5 remains constant. (By reducing the feedback at high frequencies, one can produce top lift. With reduced feedback, R_5 looks more like its real value, and V1 gets more current from the source.)

The Mullard OC71 transistors used by the writer had a higher current gain than the transistors used by Ridler (about 50, compared with 30). In addition, the supply voltage available was less than Ridler's (8.4 V compared with 12 V). These factors prevented the use of an exact copy of Ridler's circuit. The one actually used is shown in Fig. 9. No test tape was available, so instead of using a tape recorder to generate an input voltage proportional to frequency, the effect was simulated by the method suggested by Murray.¹ This is to force a constant signal current through a small inductance (L_1 in Fig. 9). At low frequencies, R_s was 10 k Ω , and above about 1 kc/s it was 30 k Ω . In each case the condition $R_s \gg \omega L_1$, which is necessary if the current is to approach constancy, is satisfied, since L_1 is only 8 mH. (It might be mentioned that hum pick-up by L_1 and L_2 was somewhat troublesome at first, but was eliminated by carefully orienting the two chokes.)

Measurements were made using two different components for L_2 . One was a choke of 800 mH, with a zero-frequency resistance of 70 Ω , and the other was an actual tape head of 200 mH inductance with a resistance of 100 Ω . The results are shown in Figs. 10 and 11. To begin with, the frequency response of the amplifier itself was measured;

i.e., without any chokes at all. This is shown by the curve in Fig. 10 labelled $L_1 = L_2 = 0, C_3 = 0$. In theory, exact l.f. equalization is obtained using the full circuit with $C_3 = 0$, and this is borne out by the measurement. Note, however, that when the tape head has an appreciable resistance compared with its reactance, the system fails at really low frequencies (Fig. 11, 200 mH, 0.4 F).

Referring again to Fig. 10, it can be seen that, by including C_3 , and so reducing negative feedback at high frequencies, a rising response is obtained. This is used by Ridler to compensate the h.f. losses of the head. With his particular circuit, he found a distinct peak at the h.f. end. Such a peak is beginning to appear in the Fig. 10 curves. If the gain of the amplifier is much higher, it can oscillate at the peak frequency. Ridler's remedy for the peak of inserting a low resistance in series with C_3 stops this and gives the designer additional control over the h.f. response.

The effect of changing C_3 is to shift the response curves bodily. The slope remains nearly the same (about 6dB per octave). This suggests that, simply by switching in different capacitors, one might change the equalization to suit different tape speeds. The amount of equalization is sufficient to compensate

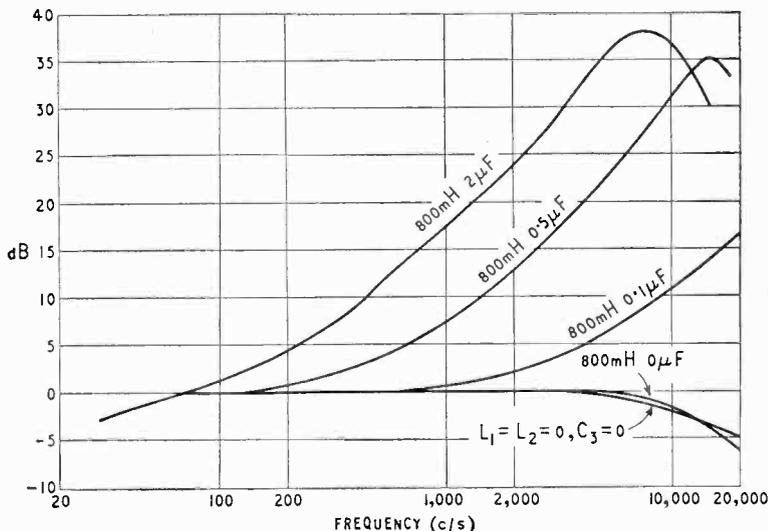


Fig. 10. Response of test circuit with simulated high-impedance playback head (800 mH). The capacitance values refer to C_3 .

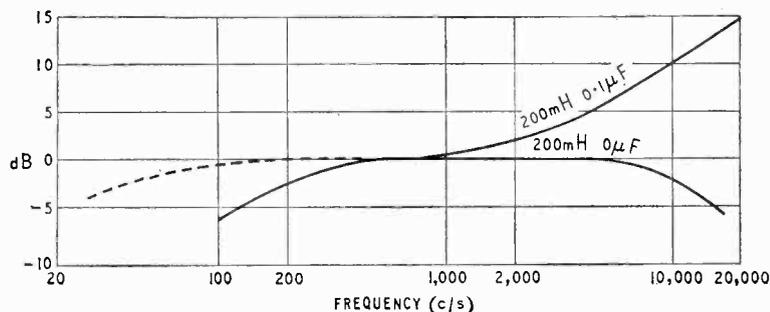


Fig. 11. Response of test circuit with low inductance head (200 mH, 100 Ω d.c. resistance). The dotted curve shows how the l.f. response was restored by connecting 2k Ω in series with 0.5 μ F across the collector load of the first transistor.

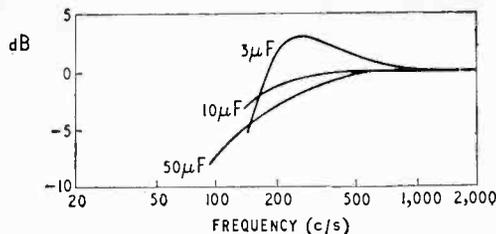


Fig. 12. Effect of C_1 on the low-frequency response of the test circuit, using the low-impedance tape head.

the l.f. tape loss completely. No pre-emphasis of low frequencies should be required when recording. If, as is probable, the same amplifier has to be used for recording and playback, one might wish to take advantage of the full gain for recording purposes. All one needs to do to get it is to switch a large capacitor across the second emitter resistor—say $10\mu\text{F}$. This will remove negative feedback at all significant frequencies. On the other hand, one might not need the full gain. The opportunity then presents itself of using some high-frequency pre-emphasis by leaving a small capacitor across the second emitter resistor. By suitable choice of values it should be possible to use the same capacitor during recording and playback and end up with a flat overall response.

The bass loss due to the head winding-resistance can be compensated, at the expense of gain, by connecting a series RC network across R_1 . The effect of $2\text{k}\Omega$ and $0.5\mu\text{F}$ is shown by the dotted curve in Fig. 11. With $C_3 = 0$, the shape of the h.f. response was unaffected, but with $C_3 = 0.1\mu\text{F}$ the h.f. lift at 10 kc/s was reduced by about 4dB. Partial l.f. compensation can be obtained by selecting a value for C_1 which resonates with L_2 near the l.f. end of the response curve. The effect is shown in Fig. 12. As the resonant frequency is reduced, the circuit Q falls, and there is no peak in the response.

High-Impedance Input.—If the feedback loop is broken, the impedance looking into the break is high. This can be useful if one has a high-impedance signal source which must not be loaded appreciably by the amplifier. One then connects the signal source in place of R_5 .

The input impedance can be measured by means of the circuit of Fig. 13. In this, there is no d.c. feedback, because to measure the impedance it is necessary to alter R , and this would upset the static conditions if R were carrying the base current of V_1 . With $R = 0$, apply an input signal big enough to produce a sizeable meter reading. Then adjust R so that this reading is halved. R is now the same as the input impedance. It can easily be a few hundred kilohms. An a.c. feedback pair along the lines of Fig. 13, but preferably with proper temperature stabilization of V_1 , may be useful when the signal source is a crystal pickup or crystal microphone. It is, of course, arguable that it may be just as good to use a straightforward amplifier without a.c. feedback and connect the crystal device to the input in the ordinary way, but with a series resistance big enough to provide an adequate load. For all the writer knows, this arrangement may be satisfactory. There is, however, one apparent virtue in doing it the other way. If the signal source is in the feedback path, the amount of feedback is controlled by the

source impedance. As the latter decreases, the frequency response improves. This appears to work out the right way for crystal transducers, since their impedance falls as the frequency is raised.

Some evidence is provided by the following test results. The circuit used was like Fig. 9, but without the inductors, R_5 , or C_3 . V_1 was biased by a resistor from base to the collector supply, and set up with $V_{ce} = 1\text{V}$. The input was applied between the emitter of V_2 and the free end of C_1 . The input resistance was over $500\text{ k}\Omega$. When the input signal was applied from a low-impedance source in series with 1000pF (this simulates a crystal device) the output was 3dB down at 250 c/s and 16 kc/s .

Conclusion.—Now that the writer has shown, to his own satisfaction, at least, that the d.c. feedback pair is a useful circuit, he will attempt to parry the inevitable question. If a feedback pair is good, why not a feedback triple, or quadruple? Let me say right away that circuits with d.c. feedback over three stages exist (Fig. 14). Readers can look up details in Reference 4. But there are a couple of snags. One

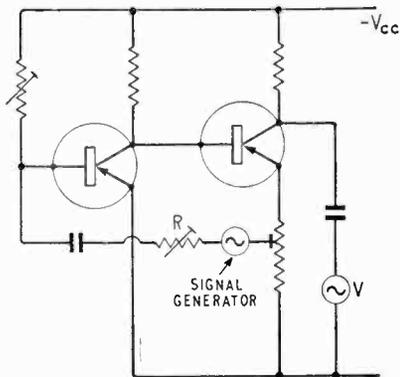


Fig. 13. Circuit for measuring input impedance, looking into the feedback loop.

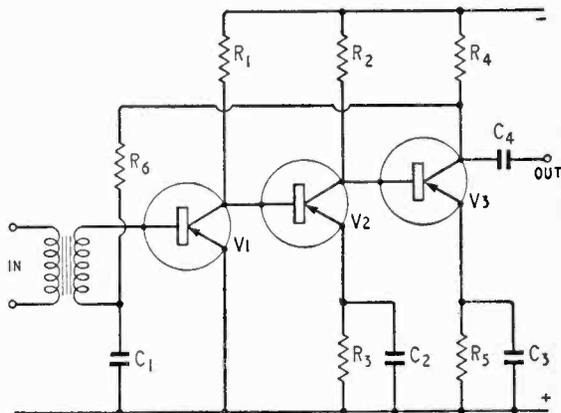


Fig. 14. D.C. Feedback Triple. In one variant, all the emitters are returned to earth directly.

is that, with germanium transistors, the temperature drift may be so great that the third transistor bottoms as the temperature rises. The point is that, with three stages, the drift of the first transistor gets amplified rather a lot before it reaches the third transistor, and may overload it. It's all right with

silicon, but hardly with germanium transistors. Before readers who are familiar with Reference 4 rush to get pen and paper to write me rude letters, let me say that two of the germanium transistors in the three-transistor direct-coupled hearing aid described in it are not operated on the linear part of the V_e-I_e characteristics, but below the knee.

The other snag is that negative feedback over three stages isn't always practicable. If audio transistors are used, internal phase shifts may turn the amplifier into an oscillator if one attempts to apply a substantial amount of feedback. However, this objection is less valid if transistors with cut-off

frequencies in the r.f. region are used, as for example in the amplifier described by R. C. Bowes in the July issue.

References

¹ J. S. Murray, "Transistors Bias Stabilization," *Electronic and Radio Engineer*, May, 1957.

² S. D. Berry, "Transistor Amplifiers for Sound Broadcasting," *B.B.C. Engineering Monograph No. 26*, Aug., 1959.

³ P. F. Ridler, "Transistors Tape Pre-amplifier," *Wireless World*, Dec., 1958 (correspondence, March, 1959).

⁴ "Mullard Reference Manual of Transistor Circuits," pp. 165-6 and pp. 268-270.

BOOKS RECEIVED

Audio Biographies, by G. A. Briggs. With the collaboration of 64 of his contemporaries and friends the author has penetrated the façade of "hi fi" and explored the background, the upbringing and the motives which drive and sustain those who practise the art of sound recording and reproduction, either as professionals or amateurs. Quite apart from the human interest and the entertaining wit of the author/editor there is a wealth of technical information which should be invaluable to present and future historians. Pp. 343; Fig. 113. Wharfedale Wireless Works Ltd., Idle, Bradford. Price 19s 6d.

Printed Circuits, by J. M. C. Dukes. The book provides the background knowledge necessary for the engineer to undertake the electrical and mechanical design of printed-circuit assemblies at all frequencies up to the microwave region. A useful chapter contains design information for printed inductors, capacitors and resistors, and the bibliography is extensive. Pp. 228; Figs. 91. Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 40s.

Two-Way Radio, by Allan Lytel. A comprehensive, practical book on the theory and installation of voice-modulated radio-communication systems. The two main types of modulation, f.m. and a.m., are compared, and the later methods of amplitude-modulation such as single-sideband working are described. Information is given on power supplies, test equipment and servicing, and a chapter on selective-calling is included. Pp. 291; Figs. 277. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 74s.

Brimar Valve and Teletube Manual No. 9 is the latest in the series of manuals published by the Brimar Commercial Division of Thorn-A.E.I. Valves and Tubes, Ltd., Rochester, Kent (formerly Brimar Division of S.T.C.). Costing 6s, the new edition incorporates data on many new devices (including bonded-faceplate television c.r.t.s) and has a tabular section listing characteristics of obsolete and obsolescent valves. Circuits included in this edition encompass a.f. amplifiers from 1.5 to 75W output, a crystal-controlled f.m. receiver and an R-C a.f. oscillator.

The Advance Science Master's Handbook, compiled by Ivan L. Muter. Intended to help the science teacher concerned with electricity and electronics. The first part of the book contains reference material and basic theory, while the second section is a set of nearly fifty experiments and demonstrations ranging from elementary a.c. theory to pulse circuits. Experiments to illustrate the nature of sound and wave motion are also included. Pp. 124; illustrated. Advance Components Ltd., Roeback Road, Hainault, Ilford, Essex. Free to science teachers; otherwise available at 12s 6d.

Dictionary of Electronics, by Harley Carter. A cross-indexed, illustrated dictionary. Appendices contain lists of graphical symbols, colour codes and other tabulated data. Pp. 337; illustrated. George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 35s.

Elsevier's Telecommunication Dictionary, compiled by A. Visser. Nearly ten thousand words and expressions are arranged in alphabetical order, using English as the base, with translations in five languages set out underneath. Following the main table, alphabetical lists of the terms in each language are given, and each term is linked to the main table by a reference number. The languages given are German, Spanish, French, Italian and Dutch. Pp. 1011. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price £7 7s.

The Mobile Manual For Radio Amateurs. Selected articles on mobile radio equipment, taken from past issues of "QST." Articles on s.s.b. equipment are included, and there is a complete section on portable and emergency units. Pp. 282. Profusely illustrated. American Radio Relay League, Inc., West Hartford 7, Connecticut, U.S.A. Price \$2 (in U.S.A.), \$3 (elsewhere).

Communications (Progress of Science Series), by Charles A. Marshall. Affords the younger reader an overall view, in non-technical language, of the field of telecommunications, including radar and television. A chapter on careers is included. Pp. 64; Figs. 19; plates 28. Phoenix House, Ltd., 38, William IV Street, Charing Cross, London, W.C.2. Price 9s 6d.

Sensitometric Control in Film Making, by L. J. Wheeler. Describes the system of sensitometry used to control the continuous processing of films used in B.B.C. Television news programmes. Pp. 22; Figs. 14. A B.B.C. Engineering Monograph. B.B.C. Publications, 35, Marylebone High Street, London, W.1. Price 5s.

Shortwave Propagation, by Stanley Leinwoll. Directed at both the amateur and the engineer, the book presents the basic principles of propagation on short waves, with chapters on circuit analysis and the preparation of m.u.f. curves. Mathematics are avoided wherever possible. Pp. 151; Figs. 75. John F. Rider (Publisher) Inc. Available from Chapman and Hall, 37, Essex Street, London, W.C.2. Price 36s.

Sound Recording Works Like This, by Clement Brown. An introduction to the subject for the layman, which describes in an unselfconscious way the working of all types of equipment, both domestic and professional. Pp. 62; Figs. 60. Phoenix House, 10-13, Bedford Street, Strand, London, W.C.2. Price 9s 6d.

Radio-Frequency Measurements

2.—LISSAJOUS FIGURES AND COUNTING TECHNIQUES

By R. BROWN

THE low difference frequency which is the output from some of the comparison systems has to be measured. A quick check through some of the standard textbooks reveals an almost bewildering number of ways in which such a measurement can be made. Many of the techniques described, however, seem now to be of only historical interest, and there seems to be only one or two of these methods of measurement in current use.

Lissajous Figures

By far the most common method is the one based on the use of Lissajous figures. This is an extremely accurate method, and it is one which calls for no other test equipment than the oscilloscope and a low frequency oscillator. It is a comparison method, the basic set up of which is shown in Fig. 9a.

The frequency to be measured (f_2) is fed to the "Y" plates of the oscilloscope, the "X" plates of which are fed from a reference oscillator (f_1). A figure will be traced on the oscilloscope, and the shape of this figure will depend upon the ratio of the frequency of f_1 to f_2 .

The simplest case is where $f_1 = f_2$, and the shape the figure will take can be found with the aid of Fig. 9b. Here f_1 is represented by the equation

$$X = A \sin \theta \quad \dots \quad (7)$$

and f_2 is represented by the equation

$$Y = B \sin (\theta + \alpha) \quad \dots \quad (8)$$

where α is the phase difference between f_1 and f_2 .

The two vectors in Fig. 9b, being of the same frequency will rotate at the same speed, and the figure is constructed by marking off the projection of the rotating vector B on the vertical axis—this represents Y in equation (8)—and marking off the projection of the rotating vector A on the horizontal axis—this represents X in equation (7).

The shape will vary with the phase difference α . In Fig. 9b this is 45° : when the two signals are in phase the ellipse of 9b closes to a straight line, broadening out again to an ellipse, and then to a full circle as the phase angle increases through 45° to 90° . This is shown in Fig. 10a.

The procedure when measuring the frequency of f_2 is simply to adjust the frequency of the reference oscillator (f_1), until a stationary figure is obtained on the oscilloscope screen. f_1 and f_2 are then equal, and their frequency can be read off the reference oscillator tuning dial. This should be known with sufficient accuracy, for most commercial oscillators are accurate to within about 1%, and if the frequency being used is, say, 100 c/s the error will only be one cycle, and this is one cycle error in the measurement of the high frequency signal. So if the high fre-

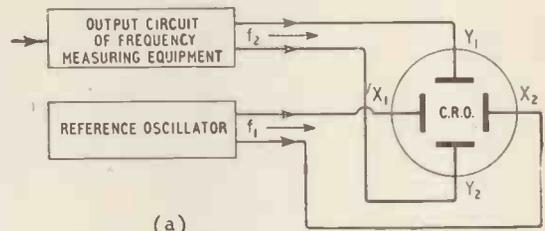


Fig. 9(a) Frequency measurement by Lissajous figures; (b) Construction of Lissajous figure.

quency signal were say, 10 Mc/s this one cycle would amount to one part in 10^7 .

Where the two frequencies f_1 and f_2 are fixed, and differ by only a fraction of a cycle, as is usually the case when checking fixed frequency oscillators against a standard oscillator for example, a stationary pattern will not be obtained. The phase angle between the two frequencies will slowly change, the rate of change depending upon their frequency difference. The figure on the oscilloscope screen will thus be of the form shown in Fig. 10, but it will change from a straight line, to an ellipse, then a circle and so on as the phase difference changes. If Fig. 9b is redrawn with vector Y say, rotating slightly faster than vector X and the results repeated as the phase difference increases from 0° to 360° it will be seen that the rate of rotation of the figure is equal to the frequency difference between f_1 and f_2 . Frequency difference of as small as a cycle every few minutes can be measured in this way. It is not necessary to use an oscilloscope to time these slow rotations of the Lissajous figures; some quite simple device such as a magic eye tuning indicator can be used.

So far we have only considered the case where f_1

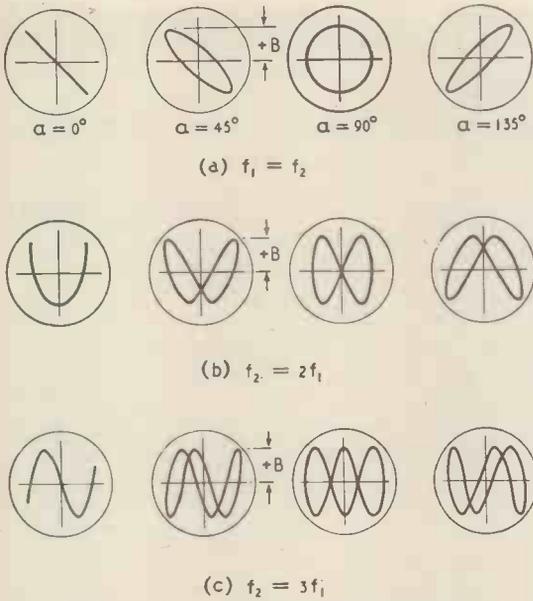
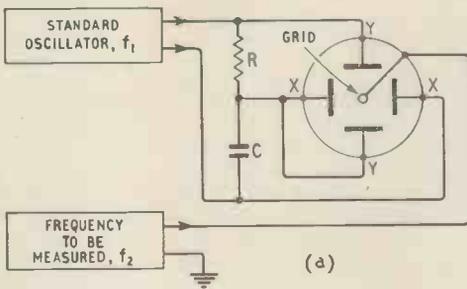


Fig. 10a, b, c. Some standard Lissajous figures.

is equal to, or very nearly equal to f_2 . It is often more convenient, however, to have f_1 a sub-multiple, or a multiple of f_2 . Stationary figures will be obtained when the ratio of f_1 to f_2 is 2 : 1, 1 : 2, 3 : 1, 1 : 3 etc. Examples of some of these figures are shown in Fig. 10b and 10c. They are all constructed in a similar manner to which Fig. 9b was constructed. Frequency ratios of four, five, six and higher can also be displayed; the figure becomes very complex with high ratios, however, and a ratio of six is about the highest that can be easily distinguished.



An important rule for determining the ratio of f_2 to f_1 can be found from these figures. Examining the three left-hand figures of each frequency ratio, that is the figures in which the go and return traces are separate, it can be seen that the number of times the curve intersects with the line $+B$ is the same as the frequency ratio. That this must be so may be seen from the following:—

Let f_1 be represented by
 $X = A \sin \theta$ (9)
 as before, and let f_2 be represented by
 $Y = B \sin (p\theta + \alpha)$ (10)
 where p is the frequency ratio f_2/f_1

From Fig. 9b these intersections can only occur when $Y = +B$, i.e. from (10) when

$$\sin (p\theta + \alpha) = 1 \quad \dots \dots \dots (11)$$

i.e. when $p\theta + \alpha = \pi/2, 3\pi/2$ etc. (12)

Now the figure has a period of 2π . That is, the figure will be traced out once as θ goes through 360° (one revolution of the vector X). When $p=1$ there will be only one value of $p\theta + \alpha$ lying between 0° and 360° , and so the curve will intersect with the line $+B$ only once. When $p=2$ there will be two values of $p\theta + \alpha$ lying between 0° and 360° , and the curve

intersects with the line $+B$ when $\theta = \frac{\pi - \alpha}{4}$ and when

$$\theta = \frac{5\pi - \alpha}{4}$$

In the same way when $p=3$ there will be three values of $p\theta + \alpha$ lying between 0° and 360° , and the curve will intersect with the line $+B$ when

$$\theta = \frac{\pi - \alpha}{6}, \text{ when } \theta = \frac{5\pi - \alpha}{6} \text{ and when } \theta = \frac{9\pi - \alpha}{6}$$

And so on for high values of p .

As has been said the highest frequency ratio p that can be easily distinguished, at least by people who don't spend the whole of their lives looking at Lissajous figures, is about six to one. One way of viewing high frequency ratios is by connecting the lowest frequency to both the 'X' and 'Y' plates, and the higher frequency to the grid or cathode of the cathode ray tube so that it intensity modulates the beam. The lower frequency signal is connected to the tube via a resistance-capacitance phase shifting network as shown in Fig. 11a. The 'X' and 'Y' plates will thus have connected to them signals of the same frequency, but which have a large phase difference, approaching 90° . Hence an ellipse, which is very nearly a circle, will be displayed on the oscilloscope. The time taken to

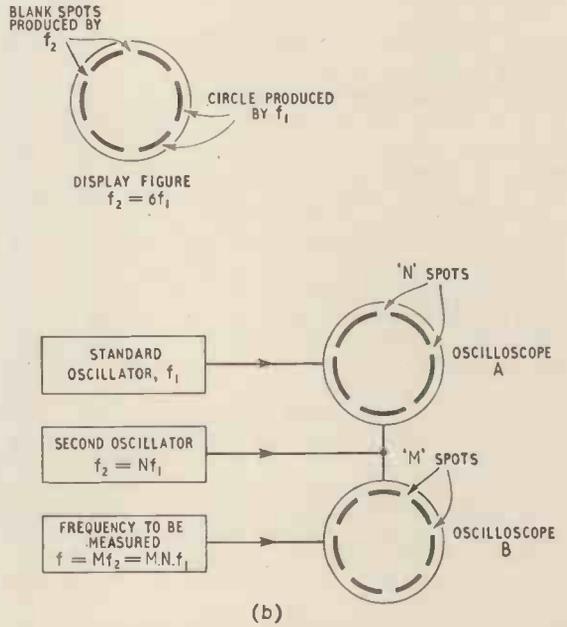


Fig. 11 (a). Determining frequency ratios up to 50:1. (b) Determination of frequency ratios greater than 50:1.

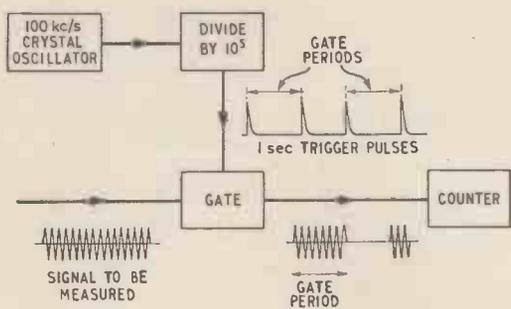


Fig. 12. Digital frequency meter—the counter displays frequency directly.

display the figures once will, as before, be the period of one cycle of the low frequency. The high frequency signal, which is being used to intensity-modulate the tube will shut off the beam on the peaks of the positive or negative half cycle (depending upon how it is connected). The result will be to produce a figure of the form shown in Fig. 11b, a broken circle. Since the circle is being displayed once for every cycle of the low frequency the number of blank spots must be equal to the ratio between the two frequencies.

As with Lissajous figures a stationary figure will only be obtained when one frequency is an exact multiple of the other. When the frequency is close to, but not an exact multiple the pattern will rotate slowly. Using this method frequency ratios of up to 50 : 1 can be determined. Much higher ratios can be determined by using a second oscillator, whose frequency need not be accurately known, and a second oscilloscope. This is shown in Fig. 11c.

A number of other similar comparison techniques use an oscilloscope,¹⁸ and stroboscopes are also used to measure low frequencies.

Counter-type Frequency Meters

Frequency measuring techniques based on counters are being increasingly used. Where the accuracy required lies between about one part in 10^4 and one part in 10^6 the use of counters is becoming almost universal. This is largely because of the extreme simplicity of operation of the counter-type frequency meter.

A simple arrangement is shown in Fig. 12. The signal to be measured is connected to the input of the counter via a gate. When the measurement is to be made a trigger pulse is used to open the gate. The counter starts to count the individual cycles of the signal being measured; after one second a second trigger pulse closes the gate, and the counter stops counting. There will thus be displayed on the counter the number of cycles in one second of the signal being measured—that is its frequency. This count is usually repeated automatically. One small snag with this arrangement is that while the count is being made no information is presented to the operator, and conversely when the count is being displayed no information can enter the counter. This can be avoided if the counting and display sections are separate and if a memory device is included.¹⁹ The memory system holds a count and displays it continuously while the new count is being accumulated. At the end of each counting

interval the new count is transferred to the display in a very brief time— $100\mu\text{s}$ in a commercial instrument. Thus the frequency is displayed practically continuously and the counter is collecting information on the frequency also almost continuously.

The trigger pulses, since they determine the width of the gate, must occur at accurately known intervals of time. A 100 kc/s crystal oscillator is usually the basic standard for determining this, the one per second trigger pulses being obtained by successive division of the 100 kc/s signal.

The highest frequency that can be measured is limited by the speed of the counter. In commercial instruments it is usually one megacycle or ten megacycles.^{20, 21}

Any frequency within the range of the counter can, however, be measured simply by connecting it to the input of the counter, no adjustments being required.

To measure frequencies above the top limit of the counter, heterodyne techniques can be used. A suitable arrangement is shown in Fig. 13. The

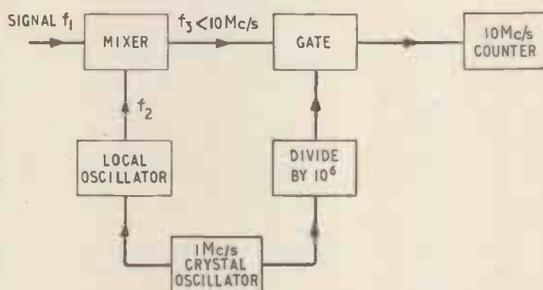


Fig. 13. Measuring frequencies above the upper limit of the counter by means of a heterodyne unit.

local oscillator can be locked, at 10 Mc/s intervals in the case of a 10 Mc/s counter, to the harmonics of the crystal oscillator. If the frequency to be measured was, say, 26 Mc/s, the local oscillator would be tuned to 20 Mc/s and locked to one of the crystal harmonics. The local oscillator output is then mixed with the signal in the mixer, and the difference frequency, $26\text{ Mc/s} - 20\text{ Mc/s} = 6\text{ Mc/s}$, is passed on to the counter and displayed.

With this sort of arrangement the signal frequency is given by the sum of the local oscillator frequency, and the frequency displayed on the counter. Some adjustment is now necessary when making measurements, but once the local oscillator has been set up any frequency over a 10 Mc/s band can be measured without any further adjustment.

This type of frequency meter suffers from two types of error. There is first of all the effects of an error in the standard 100 kc/s frequency which produces errors in the gate period. When using a heterodyne system, however, the local oscillator frequency will also be in error, and this error will add to the error in the gate period. If the 100 kc/s signal was for example slightly high, the gate period would be shorter than it should be. The local oscillator frequency would then be higher than it should be, causing the difference frequency to be low. The error in the standard frequency would thus result in low difference frequency and a short gate period. It is shown in the appendix, however,

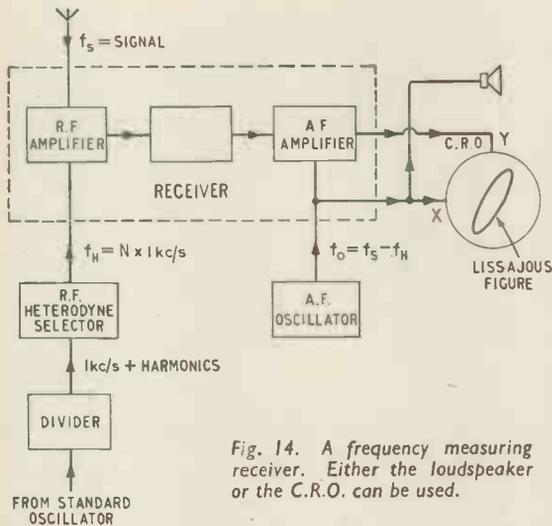


Fig. 14. A frequency measuring receiver. Either the loudspeaker or the C.R.O. can be used.

that the total error can never be greater than the error in the local standard.

The second source of error, and this is peculiar to counters, is what is called gate error. There is no direct relationship between the signal being measured and the trigger pulses that open the gate; the point in time when the trigger pulses arrive can be at any point on the signal waveform. Whether or not the first cycle is counted will depend upon what point on the waveform the gate opens, and an error of ± 1 digit is possible.

This error is the same, one digit, whatever the length of the gate period, so its effect can be consider-

ably reduced by lengthening the gate period. A ten second gate can be used, for instance, and if the frequency being measured was, say, 10 Mc/s, then 10^8 cycles would be counted in the gate period and the gate error of one digit would then be equivalent to only 1 in 10^8 . The displayed count must then be divided by ten, of course, and this does rather increase the possibility of errors due to misreading.

Counters with much higher counting rates seem to be just around the corner, and counter-type frequency measuring systems using computer techniques have also been described.²²

Frequency Measuring Receivers

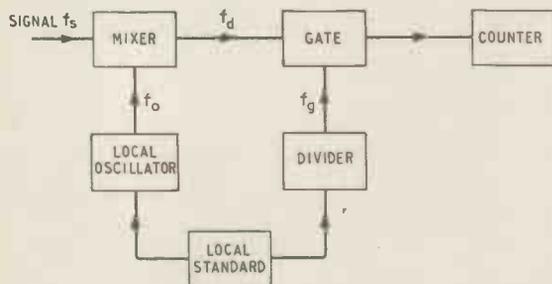
Errors due to misreading are always a possibility with frequency measuring systems, particularly the more sophisticated ones. Where readings have to be taken over a long period this can become a serious problem, and special care has to be taken with the design of the operating controls and read-out sections.

A technique which while covering a wide frequency range is almost free of misreading errors is the frequency measuring receiver. A simple type is shown in Fig. 14. The receiver, a conventional one, is tuned accurately to the signal to be measured. The heterodyne oscillator is then tuned until it is set to a frequency corresponding to the nearest whole number of kilocycles below the frequency to be measured, the accuracy of the oscillator setting being checked against the harmonics from the 1 kc/s multivibrator.

The heterodyne note produced in the receiver output will thus be below 1 kc/s. The output from (Continued on page 647)

APPENDIX

That the total error can never be proportionately greater than the error in the local standard when using a counter in a heterodyne set-up can be seen in the following way. Any error in the local standard will cause the frequency of the local oscillator to



be in error and the gate interval to be in error. Suppose this error is a small fraction e , and the nominal local oscillator frequency is f_o , then the possible limits of the local oscillator frequency will be

$$f_o' = f_o (1 \pm e) \quad \dots \quad (1)$$

The difference frequency f_d between the local oscillator frequency and the signal frequency f_s will, therefore, be somewhere between the limits

$$f_d = f_s - f_o (1 \pm e) \quad \dots \quad (2)$$

Next consider the effect of the error in the local standard on the gate interval. If f_g is the nominal gate frequency then the actual gate frequency will vary between the limits

$$f_g' = f_g (1 \pm e) \quad \dots \quad (3)$$

But the gate time interval t_g' is given by $1/f_g'$.

Hence

$$t_g' = \frac{1}{f_g (1 \pm e)} \quad \dots \quad (4)$$

For a frequency f_d counted for a time interval t_g the counter display will be N where N is given by $f_d \times t_g$, and the actual indicated count will vary between the limits

$$N = f_d t_g (1 \mp e) \quad \dots \quad (5)$$

The indicated frequency N/t_g will thus vary between the limits

$$f = N/t_g = f_d (1 \mp e) \quad \dots \quad (6)$$

The actual indicated value of the signal frequency f_s can now be found by adding the nominal value of the local oscillator frequency to this, or

$$f_s = f_o' + f_d (1 \mp e)$$

Substituting for f_d in equation (2) we get

$$f_s = f_o + [f_s - f_o (1 \pm e)] (1 \mp e) = f_s \mp e f_s + e^2 f_o$$

If we ignore the second order terms, which we can do since e is normally a very small fraction, then the limits of error in the measurement are given by $\mp e f_s$.

an audio oscillator is then mixed with the heterodyne note, and the audio oscillator tuned until it zero beats with the heterodyne note. The reading of the audio oscillator tuning plus the reading of the heterodyne oscillator tuning then gives the signal frequency.²³

A counter can be included in the receiver to further increase the simplicity of operation, and one such arrangement is shown in Fig. 15. A receiver covering the desired range in 1 Mc/s bands is used. If the frequency to be measured was, say, 6.3 Mc/s, the receiver would be switched to the 6 Mc/s band, and tuned to 6.3 Mc/s. The range switch will have caused the first local oscillator to be locked to the 50th harmonic of the standard, that is to 5 Mc/s. The signal is mixed with this to give a difference frequency of 1.3 Mc/s. The output from a variable frequency oscillator, covering 900 kc/s to 1.9 Mc/s, is mixed with this, and the oscillator tuning is set to give an accurate difference frequency of 100 kc/s. This tuning is checked by comparing the 100 kc/s difference frequency with the standard 100 kc/s using Lissajous figures. The variable oscillator output at 1.2 Mc/s is now mixed with the 9th harmonic of the 100 kc/s standard to produce a 300 kc/s difference frequency which is displayed on the counter. The frequency of the signal is thus given by the frequency range in use, 6 Mc/s, and the counter reading, 300 kc/s, as 6.3 Mc/s.

Practical counter type frequency measuring receivers are usually more complicated than this; but despite the high inherent accuracy of such a system frequency measurement is no more difficult

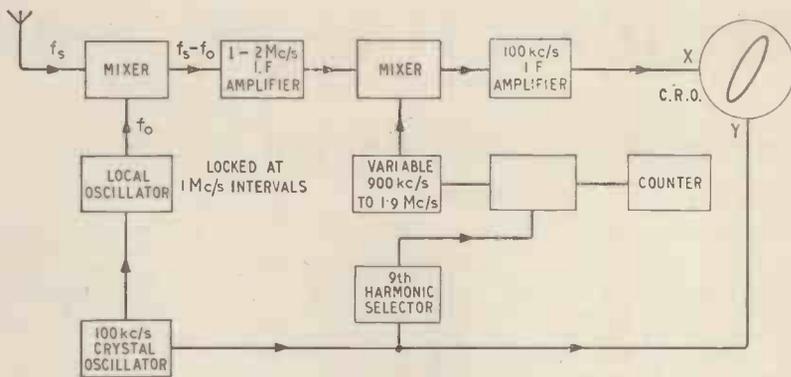


Fig. 15. A frequency measuring receiver using a counter.

than tuning the receiver to the signal to be measured. Quite an improvement on some of the earlier high accuracy systems where a training period of anything from three to six months was usually required.

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HORN RADIATOR

ON a 1,000-acre site near Rumford, Maine, U.S.A., Bell Telephone Laboratories is installing what is said to be the world's largest horn aerial as part of a new experimental space communications station. The 250-ton steel and aluminium structure will be a rotating aerial—177ft long, 94ft high, and will be protected from the weather by an inflated spherical cover, or radome, 210ft wide, 161ft high.

The huge horn will rotate on two concentric circular tracks on the ground. It will also "roll" about its horizontal axis so that it can follow a satellite from low to high angles of elevation.

Carried around on the structure with the horn will be two "houses" for equipment including a travelling-wave maser.

The radome will be supported by air pressure of one tenth of a pound per square inch greater than the outside atmospheric pressure. It will be anchored to the top of a 14-foot wall that will encircle the base of the aerial. Double doors provide an "air lock" to avoid losing pressure.

Cut-away drawing of the Bell horn radiator inside its radome. Eventually five such structures may be built on the Rumford site.



MANUFACTURERS' PRODUCTS

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Capacitance-Type Moisture Meter

SIMPLICITY of operation is afforded by the single knob control of the "Varsity" moisture meter, in which the capacitance method of measurement is employed at a frequency of 100 Mc/s. Readings are obtained by noting the combined readings of a 10-turn calibrated control and a moving coil meter. The meter reading can be converted to moisture content by means of a graph or a transparent scale placed over the meter. The



Shaw "Varsity" moisture meter. Material sample is placed in 2,000cm³ container on top of the instrument.

instrument is fully stabilized for mains variations of 190V-260V. Details are obtainable from Shaw Moisture Meters Ltd., Rawson Road, Westgate, Bradford.

Direct Writing Recorder

A SINGLE-CHANNEL recorder, the R.1, with a choice of two writing systems, is announced by Devices Ltd. Either a hot stylus on heat-sensitive paper using rectilinear co-ordinates, or an ink pen on curvilinear co-ordinates may be used, and any of six paper speeds can be selected. The sensitivity is 0.5V/cm or with pre-amplifier 0.5 mV/cm, giving a linear excursion of 5 cm.



Devices R.1. recorder, with hot stylus unit in use. This may quickly be interchanged with an ink pen system.

A differential feedback amplifier is employed, and the frequency response of the complete instrument is 0-65 c/s (-3dB). Full details of the instrument, which uses transistors throughout, may be obtained from Devices Sales Ltd., 13-15 Broadwater Road, Welwyn Garden City, Herts.

Polar Recording Turntable

IN conjunction with level recorder Type 2305, the Brüel and Kjaer turntable Type 3921 enables directional measurements to be made on aerials, microphones, loudspeakers, etc., and the results automatically recorded on polar co-ordinate graph paper. The item under test may be either bolted to the table by means of the threaded holes provided, or may be mounted centrally in the chuck. The specimen can be provided



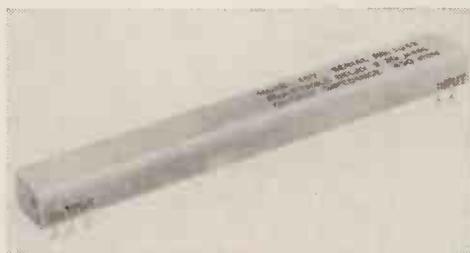
Brüel and Kjaer polar recording turntable.

with power or signals via a slip-ring arrangement below the table. Full details are obtainable from B. and K. Laboratories, Ltd., 4 Tilney Street, Park Lane, London, W.1.

Adjustable Delay Line

VARIABLE magnetostrictive delay lines with delays between 2 μ sec and 20 μ sec are announced by Seaelectro. The unit is contained in a hermetically sealed steel case, and adjustment of the delay is by means of a single screw. The maximum pulse repetition rate is 500 kc/s, with a pulse width of 1 μ sec. Input and output impe-

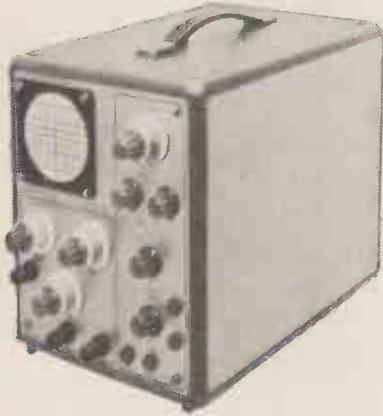
Seaelectro Deltime Type 157 variable delay line. Adjustment screw is at left-hand end.



dances are 400 ohms and insertion loss is 45 dB. A complete description can be obtained from Sealectro Corporation, Hershams Factory Estate, Walton-on-Thames, Surrey.

Inexpensive Oscilloscope

ALTHOUGH marketed at the very low price of £36, the Model 381 general-purpose oscilloscope is capable of a high performance. The Y-amplifier has a band-



Dartronic Model 381 oscilloscope.

width of 0.9 Mc/s, a rise time of 40 nsec. and a sensitivity of 100 mV r.m.s./cm. Input impedance is 1 M and 20 pF. The timebase speed is from 0.55 μ sec/cm to 0.15 sec/cm and the waveform is made available at the front panel. Accessibility for servicing is assured by the sensible construction; the top, bottom and side panels are removable, and most of the circuitry is mounted on two vertical panels. The instrument is made by Dartronic Ltd., 3, 5 and 7 Windmill Lane, London, E.15.

Sensitive Millivoltmeter

ALTERNATING voltages from 300 μ V in the range 100c/s to 900Mc/s may be measured by means of the Airmec Type 301. Measurement of direct voltages may be made in the range 100 μ V to 10V.



Airmec millivoltmeter Type 301.

The amplifier is direct-coupled throughout, stability being achieved by the use of chopper. A semiconductor rectifying probe allows the use of a simplified attenuator

which needs no frequency-compensation. The input impedance is 5M Ω on d.v. ranges and when measuring alternating voltage varies from 120k Ω +2pf at 100kc/s to 3k Ω +2pf at 200Mc/s and above. Fluctuation of reading with \pm 10% mains variation is less than \pm 1.5% on all ranges. Full details are obtainable from Airmec Ltd., High Wycombe, Bucks.

Wobbulator Attachment

TO extend the coverage of currently-available sweep-frequency generators to the Bands IV and V region, Grundig have introduced their VS-2 u.h.f. converter. The output of the existing generator is set to 55Mc/s and applied to the converter, where it is mixed with



Grundig VS-2 u.h.f. converter for wobbulators.

the output of a u.h.f. oscillator. The resultant signal covers the range 460-795Mc/s and the level is -13dB on the output of the sweep frequency generator. Input and output impedances are 60 Ω unbalanced. The converter costs £30, and is available from the British distributors, Wolsey Electronics, Ltd., Cray Avenue, St. Mary Cray, Orpington, Kent.

Cable Identifier

DESIGNED for application without tools, the Helagrip is a flexible p.v.c. sleeve supplied in sizes to fit cables of $\frac{1}{8}$ -in to $\frac{7}{8}$ -in dia. The indented edge of the sleeve prevents adjacent pieces twisting relative to each other, and the special section prevents sliding. The sleeving is supplied partially cut in lengths of identical coding (A-Z, 0-9).

Further details may be obtained from Hellermann, Ltd., Gatwick Road, Crawley, Sussex.

"Helagrip" cable identifier.



DECEMBER MEETINGS

Tickets are required for some meetings; readers are advised, therefore, to communicate with the secretary of the society concerned.

LONDON

4th. I.E.E.—Discussion on "Backward waves in waveguides" opened by Dr. P. J. B. Clarricoats, R. A. Waldron and G. H. B. Thompson at 5.30 at Savoy Place, W.C.2.

6th. Brit.I.R.E.—Discussion on "Possible uses of computers in medical diagnosis" opened by Dr. A. D. Booth at 6.0 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

8th. Institute of Physics and Physical Society.—"Electron microscopy in Japan" by T. Mulvey and Dr. M. Whelan at 2.30 at 47 Belgrave Square, S.W.1.

8th. Television Society.—"Remote control operation of television cameras" by H. C. Nickels at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

11th. I.E.E. Graduate and Student Section.—"The professional engineer and an expanding industry" by G. S. C. Lucas at 6.45 at Savoy Place, W.C.2.

12th. I.E.E.—"Diversity reception and automatic phase reception" by L. Lewin at 5.30 at Savoy Place, W.C.2.

12th. Institute of Physics and Physical Society.—"Integrated electronics" by Dr. W. J. Granville at 5.30 at 47 Belgrave Square, S.W.1.

14th. Brit.I.R.E.—Symposium on "Constant luminance colour television" including papers by I. J. P. James and W. A. Karwowski, W. N. Sproson, A. V. Lord, K. Hacking and G. F. Newell at 6.0 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

14th. Radar & Electronics Association.—"Loudspeaker enclosures" by J. Gough and Prof. F. Landgrebe at 7.0 at the Royal Society of Arts, John Adam Street, W.C.2.

15th. Television Society.—"The 'Nev-Eye' vidicon camera" by N. S. Rutherford at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

15th. B.S.R.A.—"Problems in telephone transmission" by D. L. Richards at 7.15 at the Royal Society of Arts, John Adam Street, W.C.2.

18th. I.E.E.—"Large microwave steerable aerials for communication with artificial earth satellites and space probes" by F. J. D. Taylor at 5.30 at Savoy Place, W.C.2.

20th. I.E.E.—"Satellite instrumentation" by Dr. R. L. F. Boyd at 5.30 at Savoy Place, W.C.2.

ARBORFIELD

11th. I.E.E. Graduate & Student Section.—"Design of service equipment" by B. W. Norman at 7.0 at the Unit Cinema, 3(Tels.) Training Bn., R.E.M.E.

BIRMINGHAM

4th. I.E.E.—"The banana-tube display system—a new approach to the display of colour-television pictures" by Dr. P. Schagen at 6.30 at the College of Technology. (Joint meeting with the Institution of Post Office Electrical Engineers.)

8th. Society of Instrument Technology.—"Instruments in clinical chemistry" by N. Crawford and "Electronics in surgery" by R. Lightwood at 7.0 at the College of Technology, Aston Street.

12th. Institute of Physics and Physical Society.—"The observation of radio stars" by Dr. P. F. Scott at 6.30 at the Midland Institute.

14th. Brit.I.R.E.—"The R.R.E. radio-telescope interferometer" by H. Gent at 6.15 at the Electrical Engineering Department, The University.

BRADFORD

5th. I.E.E.—"The potentialities of artificial earth satellites for radiocommunication" by W. J. Bray at 6.30 at the Institute of Technology.

BRISTOL

14th. Society of Instrument Technology.—"The atomic clock" by Dr. L. Essen at 7.30 at the Department of Physics, the University.

20th. Brit.I.R.E.—Annual general meeting of the South-Western Section followed by "Transistors in transmitters and communications receivers" by D. C. Carey at 6.0 at the School of Management Studies, Unity Street.

CAMBRIDGE

12th. I.E.E.—"The banana-tube display system—a new approach to the display of colour television pictures" by Dr. P. Schagen at 8.0 at the Cavendish Laboratory, Free School Lane.

CARDIFF

6th. Brit.I.R.E.—"Microwave valves" by R. W. White at 6.30 at the Welsh College of Advanced Technology.

CHELTENHAM

1st. Brit.I.R.E.—"Electronic telephone exchanges" by J. F. Hesketh at 7.0 at the North Gloucestershire Technical College.

EDINBURGH

5th. I.E.E.—"Precision Measurement" by G. H. Rayner and A. Felton at 7.0 at the Carlton Hotel.

13th. Brit.I.R.E.—"Jodrell Bank" by J. B. Wilson at 7.0 at the Department of Natural Philosophy, The University, Drummond Street.

FARNBOROUGH

7th. I.E.E. Graduate and Student Section.—"The synthesis of speech for communication purposes" by H. L. Chesters at 6.30 at the Technical College.

FAWLEY

1st. Society of Instrument Technology.—"Applications of transistors and diodes" by D. Osborne at 5.45 in Room 4a, Administration Building, Esso Petroleum Co.

GLASGOW

4th. I.E.E.—"Precision measurement" by G. H. Rayner and A. Felton at 6.0 at the Royal College of Science and Technology.

14th. Brit.I.R.E.—"Jodrell Bank" by J. B. Wilson at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

GRANGEMOUTH

21st. Society of Instrument Technology.—"Instrumentation of space vehicles" by Dr. A. E. Roy at 7.0 at the Leapark Hotel, Bo'ness Road.

LEICESTER

6th. Brit.I.R.E.—"Transistors in computers and control equipment" by P. James at 6.45 at the University.

12th. I.E.E.—"Altitude control of earth satellites" by B. Stewart at 6.30 at the Lecture Theatre, E.M.G.B. Showrooms, Charles Street.

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LIVERPOOL

4th. I.E.E.—“Simulation of intelligence” by Prof. D. M. MacKay at 6.30 at the Royal Institution.

13th. Brit.I.R.E.—“Nuclear power station instrumentation” by M. W. Jervis at 7.30 at the Walker Art Gallery.

14th. Society of Instrument Technology.—“The versatility of the electronic potentiometer” by F. W. J. Howard at 7.0 at the Merseyside and North Wales Electricity Board Industrial Centre, Paradise Street.

18th. I.E.E.—“Education of an electrical engineer” by Prof. M. R. Gavin and “The place of formal study in the post-graduate training of an electrical engineer” at 6.30 at the Royal Institution.

MAIDSTONE

7th. I.E.E.—“Electronics in the postal mail services” by G. P. Copping at 7.0 at the “Wig and Gown.”

MANCHESTER

6th. I.E.E.—“Generation and amplification in the millimetre wave field” by W. E. Willshaw at 6.25 at the Engineers' Club, Albert Square.

7th. Brit.I.R.E.—“Radar for civil aviation purposes” by K. F. Slater at 7.0 at the Reynolds Hall, College of Technology.

NEWCASTLE-UPON-TYNE

4th. I.E.E.—“Planning and installation of the sound broadcasting headquarters for the B.B.C.'s Overseas and European Services” by F. Axon and O. H. Barron at 6.15 at the Rutherford College of Technology, Northumberland Road.

13th. Brit.I.R.E.—“Masers and parametric amplifiers” by Dr. T. H. Wilmhurst at 6.0 at the Institute of Mining and Mechanical Engineers, Neville Hall, Westgate Road.

18th. I.E.E.—“Heavyside—his life and work” by Prof. R. L. Russell at 6.15 at the Rutherford College of Technology, Northumberland Road.

PORTSMOUTH

13th. I.E.E.—Discussion on “Silicon controlled rectifiers” opened by R. J. Alexander, J. P. Birchenough and R. Thompson at 6.30 at the C.E.G.B. Offices, 111 High Street.

SHEFFIELD

13th. I.E.E.—“Millimetre waves” by Dr. J. Allison at 6.30 at the University.

SOUTHAMPTON

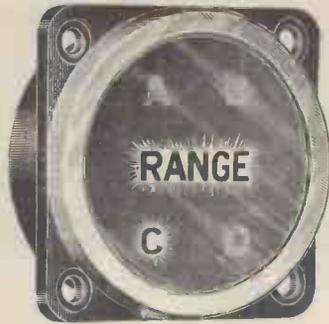
12th. I.E.E.—Discussion on “High speed measuring techniques in the nano-second region” opened by B. H. Venning and D. Grollet at 6.30 at the University.

WEYMOUTH

1st. I.E.E.—“The banana tube” by Dr. P. Schagen at 6.30 at the South Dorset Technical College.

WOLVERHAMPTON

6th. Brit.I.R.E.—Symposium on “New electronic techniques in non-destructive testing” at 10.0 at the Wolverhampton and Staffordshire College of Technology.



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In Old Bohemia

AMERICANS often claim to be far ahead of us Europeans—and in particular of us Limeys—in the various activities of life, and in many cases they are, of course, quite justified in their claims. For instance, in some of their big cities, their buildings and their crime statistics are much higher than anything we can boast of.

However, it is mostly in matters of applied science that the Americans claim to be so far ahead of us, and here again they are fully justified. What European state, for instance, can boast of having had, since 1890, an electric chair for the administration of what they call "electrocution" but which we old-fashioned grammarians prefer to call "electrocussion"? I believe that American doctors are as out of date as we are when they speak of "concussion," rather than of "concution."

But there is one instance of applied science where the U.S.A. is twenty years behind Europe, as Mr. Kenneth Greenberg, writing to me from the city of sudden and violent death, has made quite clear by sending me a cutting from the October 1957 issue of the American journal *Popular Mechanics*.

This cutting has an illustration of an American ambulance fitted with a radio transmitter which turns all traffic lights red for a few seconds to give it a clear passage as it speeds on its way.

Mr. Greenberg quite rightly sends this cutting to me to refute the statement I made in the September issue of *W.W.* that the idea had never been put into use. But my statement was all wrong, and it is all the

more blameworthy in that I had forgotten that in the issue of Dec. 2nd, 1937—nigh on a quarter of a century ago—I myself reported in these columns that I had seen this idea in use in a European city. I can only hang my debowled head in shame at forgetting my own words, and thus misleading my readers.

I did not mention the name of the city but unless my memory has let me down again it was in the city of Good King Wenceslas that I saw this sight.

If any of you are so ignorant that you don't know the name of the land over which Good King Wenceslas ruled, and the name of his capital city—still unchanged today—in which he did his looking out on St. Stephen's Day, I do not consider it my duty to enlighten you. Ask any of the children who sing carols on your doorstep this Christmas.

Diary Data and Dates

I AM very gratified to see in the "W.W. Diary" for 1962 that the pages in which we record our daily doings have been kept as free from printed matter as possible. Thus the Editor has kept his hagiographical information to a minimum, only including saints' days and other ecclesiastical information where they coincide with quarter days and half-quarter days.

In the non-diary pages I was a little surprised to see that the terminating sigma (σ) had been omitted from the Greek alphabet, but I suppose the reason is that it has no symbolic significance. I suppose, too, that a similar reason, namely lack of usefulness, causes the omission on the page of abbreviations of r.d.f., to denote what we now call radar. I think it is a pity that this was ever allowed to be superseded by the American name of "radar," but it is too late to alter it now.

I was very pleased to see the page of some historic wireless dates. I notice that the adjective "some" is used in the title, but even so I wonder why some dates were omitted. The omission which dismayed me most was the date when the cavity magnetron was invented.*

It is made quite clear in the Diary that G.M.T. is used throughout but I think it is carrying accuracy a bit too far when the time of the Titanic

* An almost impossible task. It was developed over a period of many months, but on outstanding date was February 21st, 1940, when, to quote Sir Robert Watson-Watt, "the new device was successfully operated."—Ed.

disaster is reduced to G.M.T. from local meridian time, thus causing what I regard as the wrong date of 15th April, 1912, to be given for the event which I, and all others who personally remember the disaster have always regarded as occurring on 14th April. It occurred at 11.40 p.m. local meridian time on Sunday, 14th April, but as the ship's longitude was 50° 14' W it would be just after 3 a.m. G.M.T. on 15th April.

Forty Years On

ALTHOUGH it is only three months since the British National Radio Show closed its doors, preliminary plans for the 1962 show are already being discussed. I think, therefore, I had better remind the organizers that next autumn we shall be celebrating not only the fortieth anniversary of the first radio show, held in the old Horticultural Hall in 1922, but also the fortieth anniversary of the beginning of broadcasting itself; at any rate of regular broadcasting in this country from 2LO.

I hope these anniversaries will be celebrated in some way at the show next August but we don't want merely a static museum showing a few sets that were on sale in 1922. Of course a museum section could form a part of the exhibition; there is, at any rate, plenty of room for it in the vast open spaces of which I complained in 1960 and which were again in evidence at the last show.

In order to celebrate these two anniversaries I think it would be a good idea for the B.B.C. to combine with receiver manufacturers to bring home to people how excellent is the quality of 1962 compared with that of 1922, not only on the technical side but on the entertainment side also. I am not trying to decry the pioneers of 1922, but, of necessity, they were venturing into a new field of entertainment altogether, and their efforts were naturally somewhat amateurish compared with today's polished standards.

Could not the B.B.C. arrange to give a programme or two of the type we used to get in 1922. I wonder if there are any recordings available. If such programmes were fed through 1922 sets, present day listeners—including youngsters of 40—would know what we had to put up with in those far off days.

Senescent Senescence

I MUST accept with becoming grace the rebuke administered to me by Mr. K. W. Mawson of the Royal Eye & Ear Hospital, Bradford (Nov. issue), concerning remedial measures necessary to combat the hearing defects of the ageing. It is quite clear to me that I have advanced further along the road of senescence than I had supposed, without a corresponding increase in my senescence.



"I can only hang my debowled head in shame."

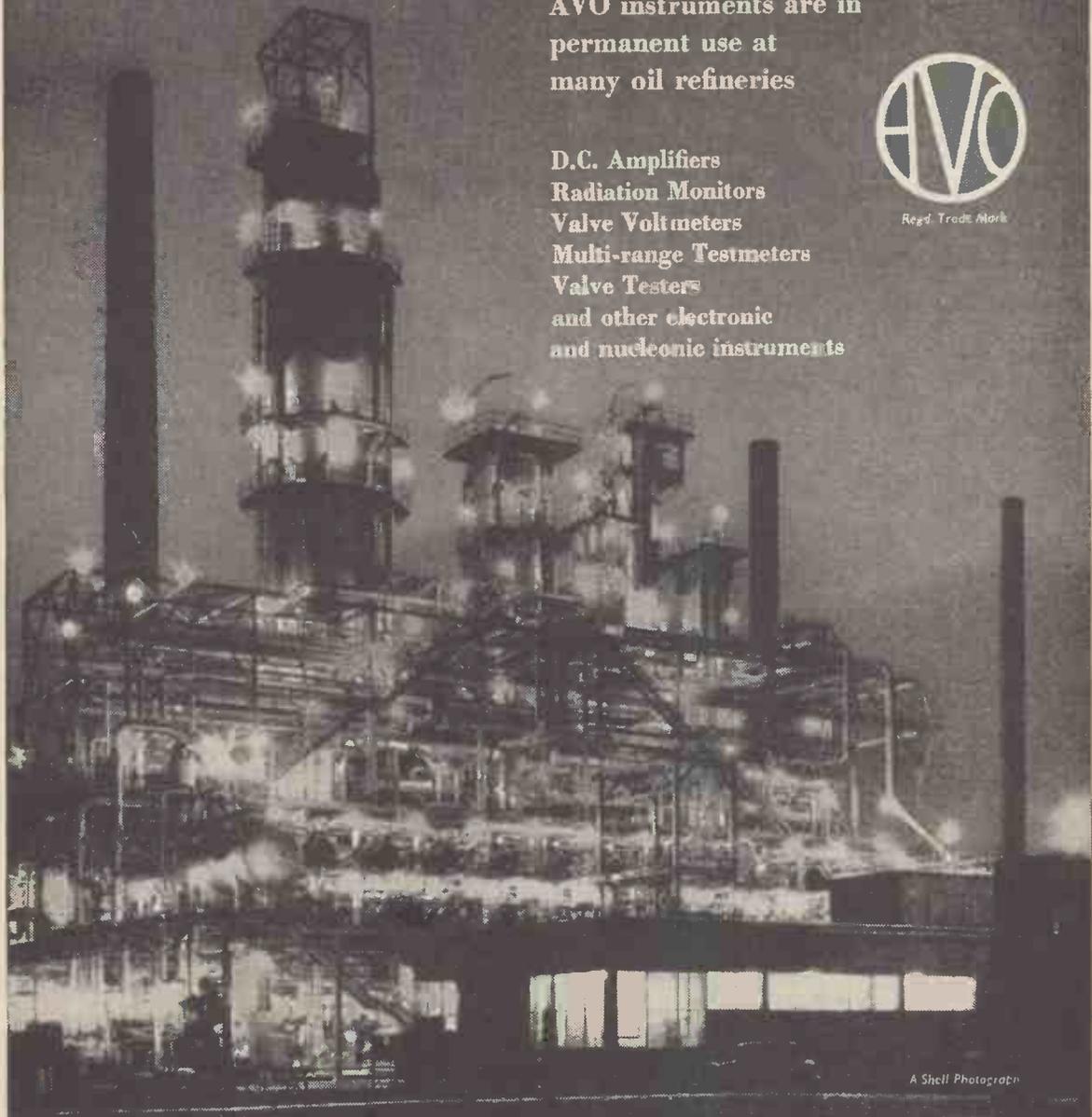
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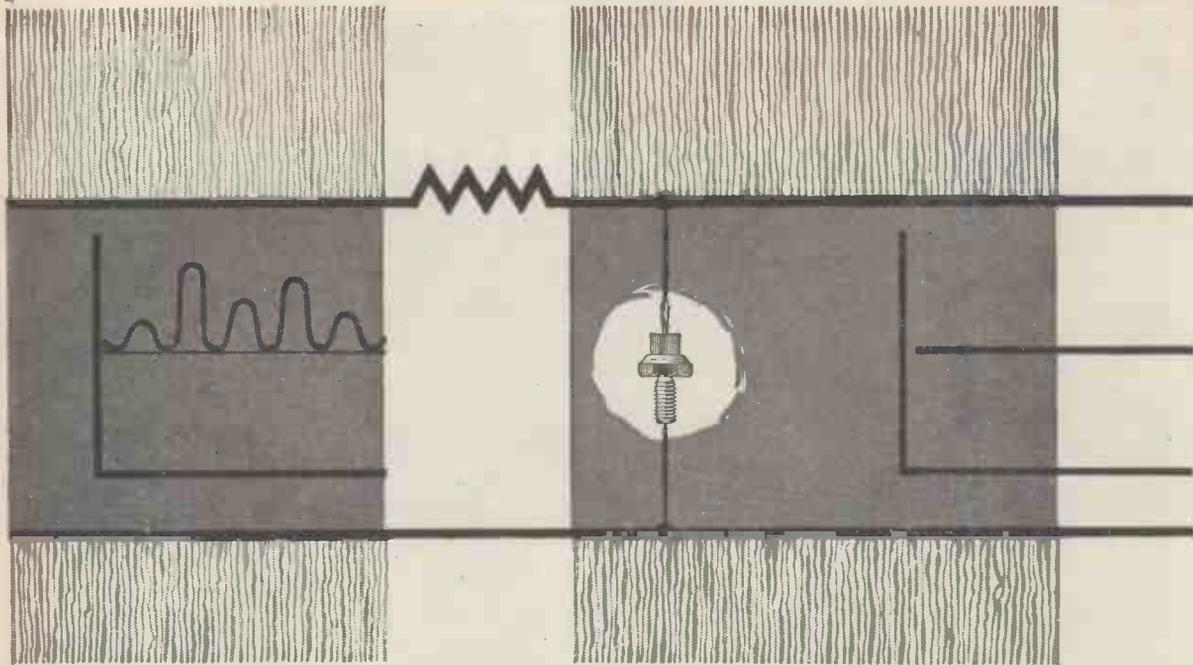
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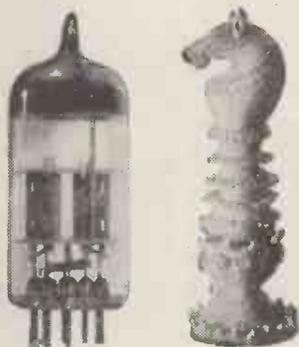
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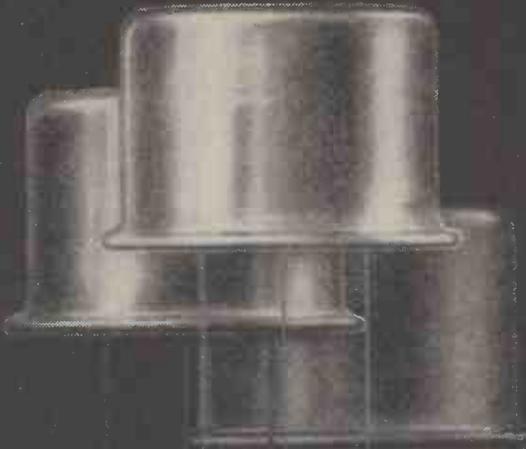
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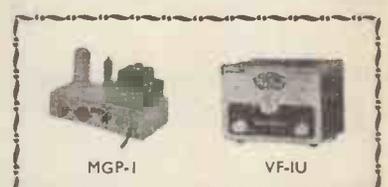
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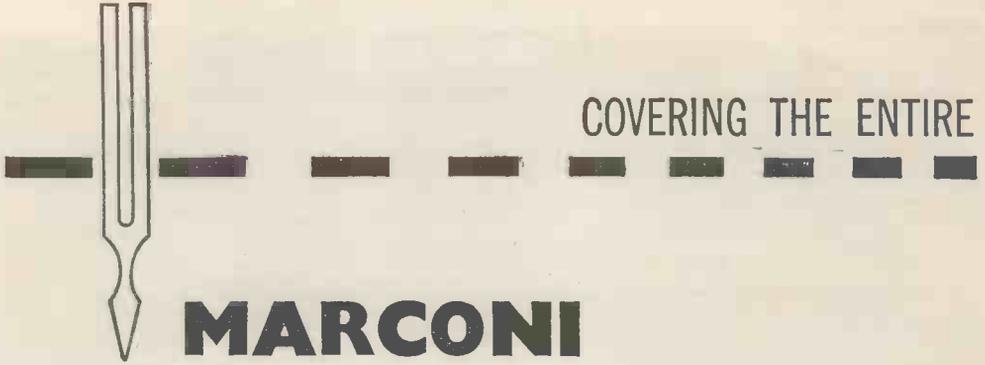
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TF 867	15 kc/s to 30 Mc/s	0.4 μ V to 0.4 V 13 Ω 4 μ V to 4 V 75 Ω	A.M. up to 100%. Crystal check facilities
TF 995A/2M	1.5 to 220 Mc/s	0.1 μ V to 0.1 V 52 Ω 0.1 μ V to 0.2 V 75 Ω	F.M. up to 75 kc/s deviation. A.M. up to 50%. Crystal check facilities. The TF 995A/5 is a narrow-deviation model for mobile radio testing.
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TF 801D/1	10 to 470 Mc/s	0.1 μ V to 1 V 50 Ω	Sine a.m. up to 90%; also pulse mod. Crystal check facilities.
TF 1064B	68 to 108, 118 to 185, and 450 to 470 Mc/s	0.5 μ V to 10 mV 50 Ω	F.M.: 3.5 and 10 kc/s fixed deviation.
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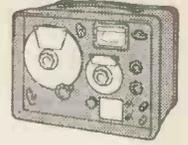
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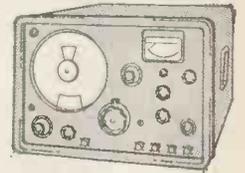
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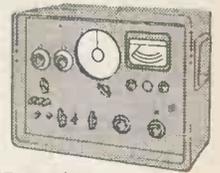
TF 144H



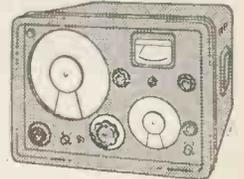
TF 1064B



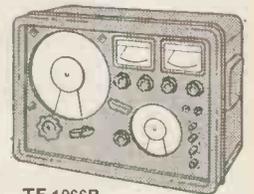
TF 1061



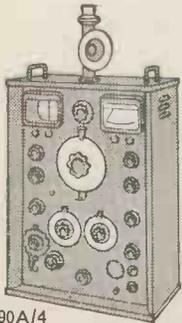
TF 955A/2M



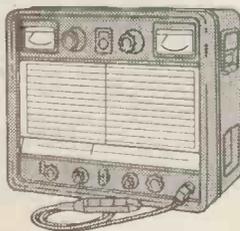
TF 1060



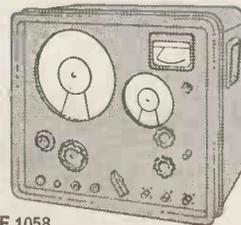
TF 1066B



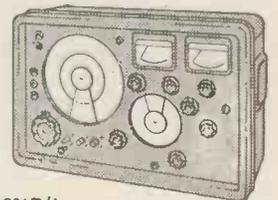
TF 890A/4



TF 867



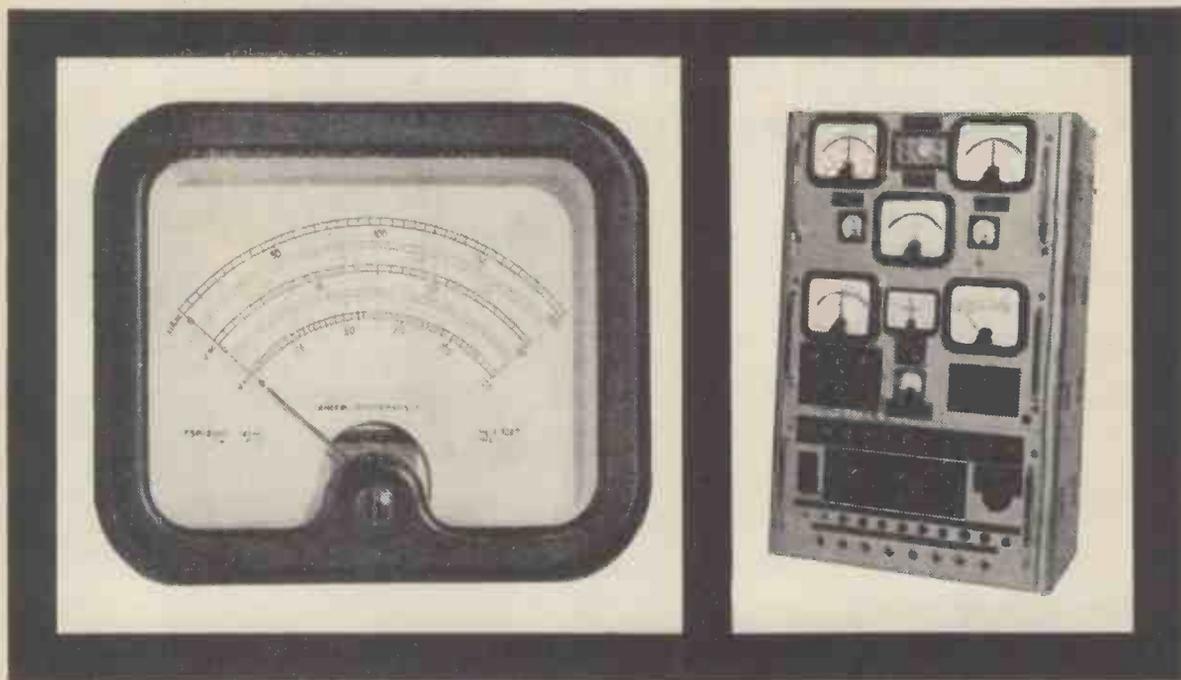
TF 1058



TF 801D/1

TC 200

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seven-range meter, including V, mV, μ A, made for Elliott's at short notice

This seven-range meter, using Ernest Turner Model 605 was calibrated with special ranges by Anders at short notice for Elliott Brothers Ltd for the special-purpose test gear shown above. All the meters in this complex installation were supplied by Anders, who have the pleasure of carrying out similar work for a number of famous manufacturers. Anders are indebted to Elliott Brothers for kind permission to illustrate this equipment.

The Anders Instrument Centre commands the largest stocks of meters in the country, unique calibrating facilities, and detailed knowledge of metering problems. Most standard meters are supplied immediately. Non-standard meters of all kinds, shapes and sizes, for special voltage and current ranges, are accurately calibrated, tested and normally ready within 10-14 days. Makes include Avo, Crompton Parkinson, EAC, Elliott, Pullin, Taylor, Turner, Weir, Weston. Types include moving coil, moving iron, thermocouples, electrostatic, dynamometers, from 1½" to large switchboard instruments, and complete range of accessories. Please write or 'phone for details of the Anders meter service.

ANDERS

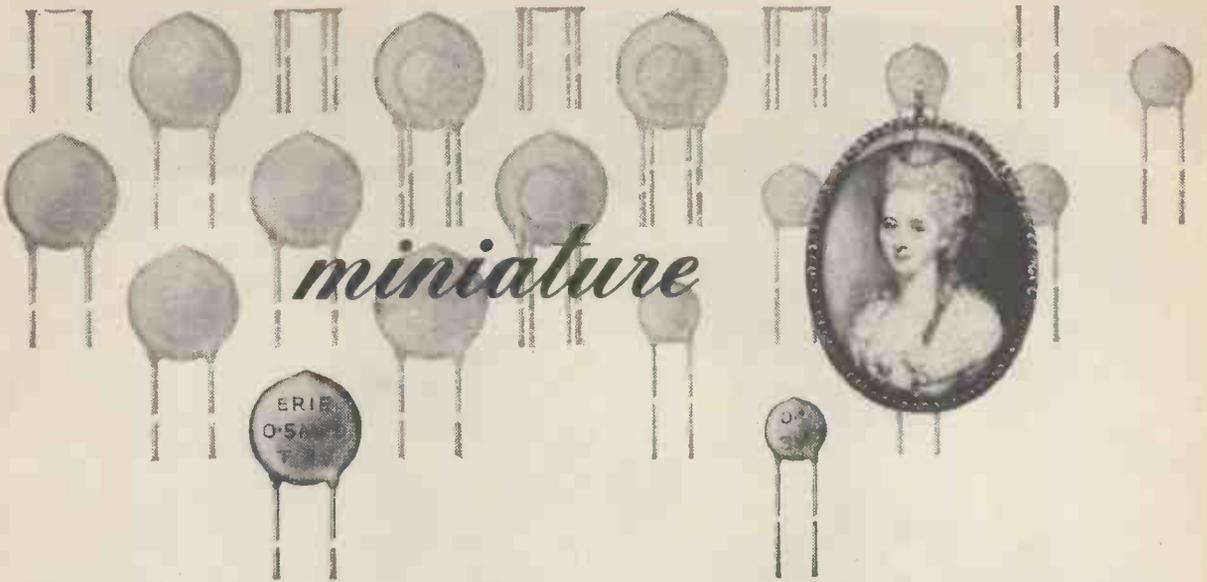
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SPECIFICATION

	811T	831T
CAPACITANCE :	0.5μF	0.1μF
TOLERANCE :	-20% +50%	-20% +50%
DIAMETER :	0.594" max.	0.312" max.
THICKNESS :	0.156" max.	0.156" max.
WORKING VOLTS :	3 d.c.	3 d.c.

In line with the Erie policy of anticipating the component requirements of the future, the Erie Transcap capacitor is now added to our ever-increasing range of components for use with transistors.

Designed specifically as a small, reliable, high capacitance, low voltage, coupling, and by-pass capacitor, the Erie developed Transcap is manufactured entirely at our Great Yarmouth factory.

Styles 811T and 831T shown here in their actual physical sizes are only forerunners of the wide range in differing values and voltages which will ultimately emerge.

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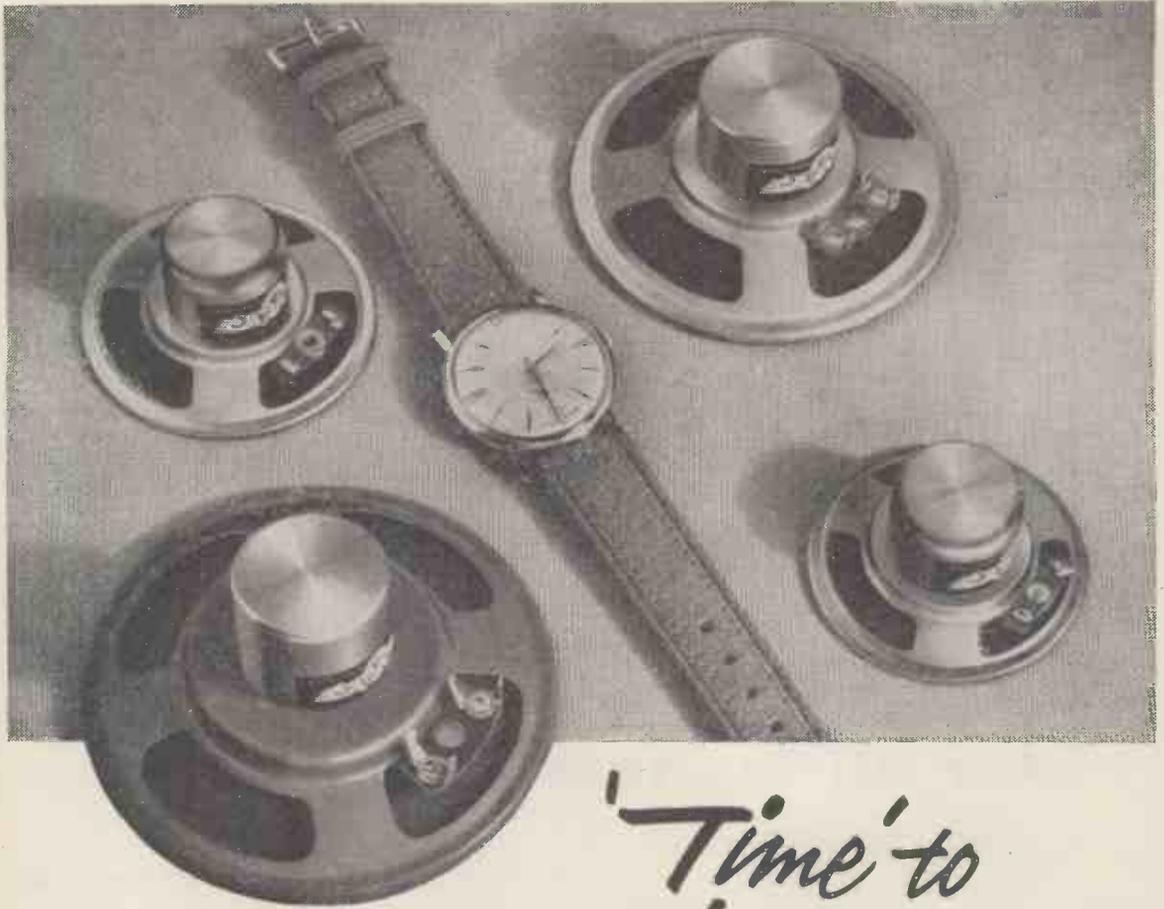
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2½" (5.7 CM) „ 2SS

3" (7.6 CM) „ 3SL

3½" (8.6 CM) „ 33SL

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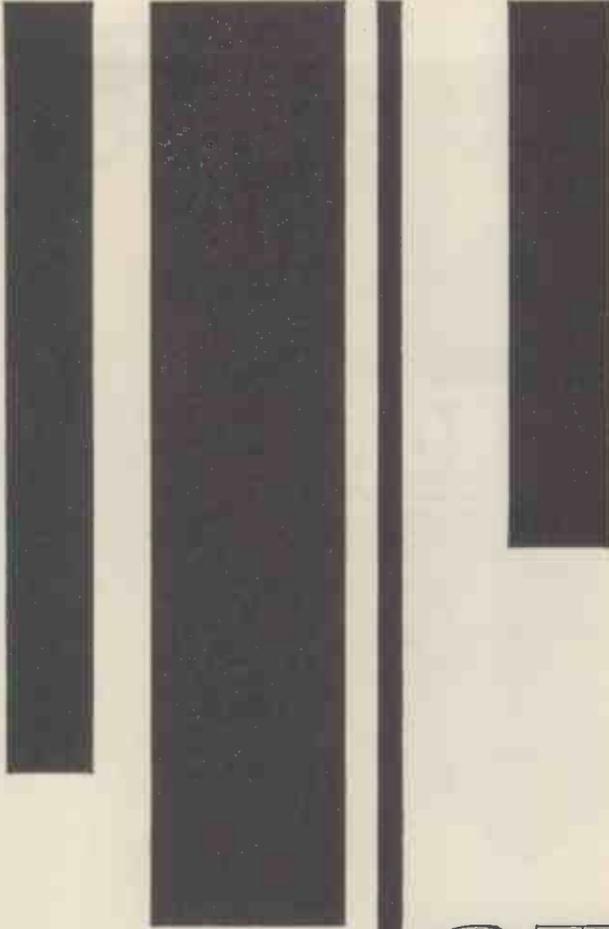
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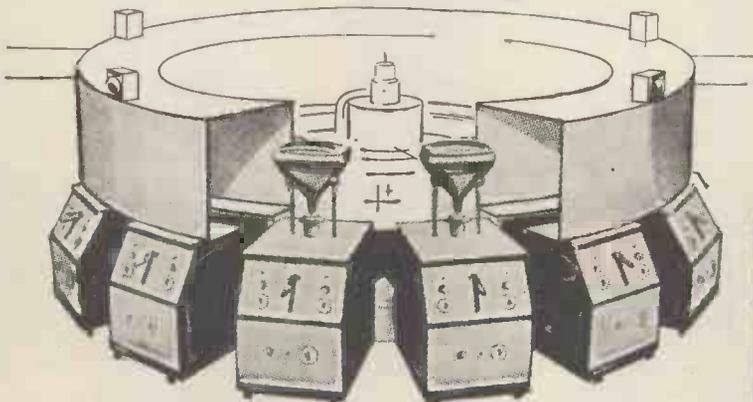
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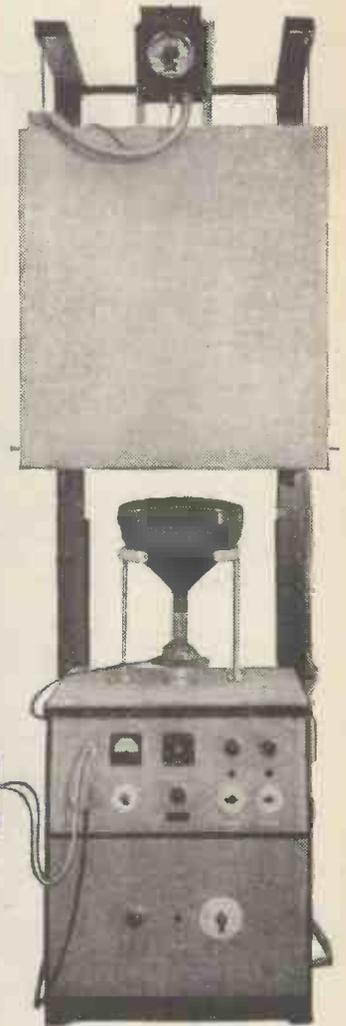


Vacuum Oven with
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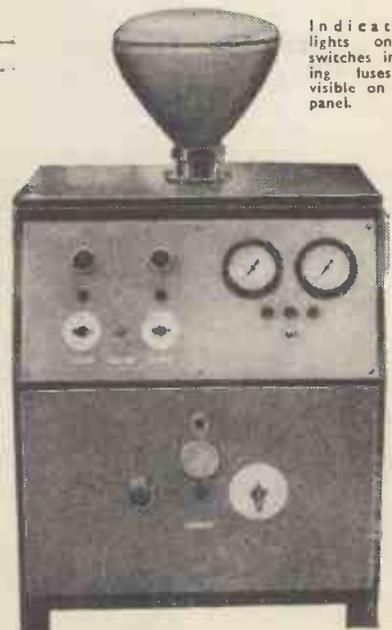
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This versatile instrument has four main outputs generating true +ve or -ve going pulses with a rise time of less than 10 μ sec at an output of 5V in 75 Ω . Variable amplitude, width and delay are provided and the instrument is capable of either single or double pulse modes of operation.

The four main outputs of the generator are (1) a pre-pulse of fixed amplitude and width. (2) A single or double main pulse of variable width and amplitude. (3) A single or double negative going sawtooth (sweep) pulse coinciding with the main pulse. (4) A single or double cable pulse derived from the main pulse.

APPLICATIONS of this instrument can be made in many fields of research and measurement. Its comprehensive specification makes it particularly suitable for use in radio navigation, radar, television, electronics, nucleonics, computers, telemetering and physiological research. Other uses will be apparent and the more common applications are listed in a comprehensive leaflet available on written request.

BRIEF SPECIFICATION

PERIOD: Continuously variable from 0.9 μ sec to 1.05sec corresponding with a frequency range 0.95c/s to 1.1Mc/s. Accuracy is within $\pm 5\%$.

PRE-PULSE: Fixed amplitude 8V peak in 75 Ω positive going. Fixed width 60 μ sec.

DELAY: The time between the peak of the pre-pulse and the advent of the main pulse is variable from 0.9 μ sec to 105msec. Accuracy is within $\pm 5\%$.

MAIN OUTPUT PULSE: Continuously variable in width from 0.09 μ sec to 105msec with a calibration accuracy of $\pm 5\%$. The amplitude and impedance is controlled by a four position switch and a fine control giving a 4:1 attenuation of each maximum as follows

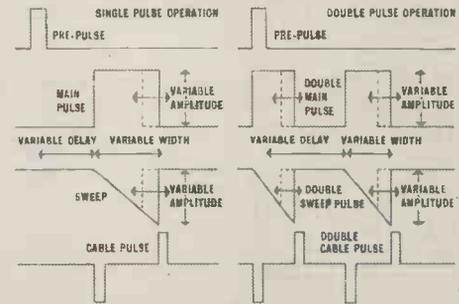
AMPLITUDE	IMPEDANCE	RISE TIME
5V max	75 Ω	<10 μ sec
10V max	150 Ω	\approx 25 μ sec
25V max	600 Ω	\approx 40 μ sec
50V max	1000 Ω	\approx 50 μ sec

POLARITY of the output pulse can be positive or negative going with respect to earth as required. Accuracy of calibration is within $\pm 2\%$ on all ranges except the 50V range where it is within $\pm 5\%$.

THE SWEEP waveform is a direct coupled negative going sawtooth with the same width and delay as the main pulse. The amplitude of this waveform is 15V peak at maximum width. Linearity is maintained to within $\pm 2\%$. Output impedance approximately 300 Ω .

CABLE PULSE is obtained from a short circuited pure line. Two narrow output pulses are obtained, one positive and one negative going, coincident with the leading and trailing edges of the main pulse. The width of both pulses is 25 μ sec. The maximum amplitude is 3V peak in 75 Ω and rise time 8 μ sec.

DOUBLE PULSE operation can be obtained by a setting on the front panel. Two pulses are produced, the first coincident with the pre-pulse and the second delayed on it by a selected amount.



SYNC/TRIGGER The generator can be synchronised or triggered by almost any externally applied waveform. The minimum amplitude levels for a sine wave being: SYNC operation 0.5V peak to peak 2Mc/s max., and TRIGGER operation 1.0V peak to peak 2Mc/s max.

SINGLE SHOT operation obtained by a push-button switch

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POWER CONSUMPTION 200W

DIMENSIONS 22 $\frac{1}{2}$ " wide x 15" deep x 21" high (57 x 38 x 53 cm.)

WEIGHT 90 lbs. (41 kilos).



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The New SERVISCOPE*



The introduction of the first Serviscope S31 set a new standard in small portable oscilloscopes. Now with the model S32 replacing the S31, the Serviscope again reaches far out beyond all competition. This successor to the S31 retains all the features of the earlier model including the same compact dimensions, calibrated attenuator and time base and unique triggering facilities, but has five immense improvements :

- PDA tube operating at 3.5 KV
- Maximum sensitivity now 10mV/cm
- Bandwidth increased to 7.5 Mc/s
- Complete suppression of re-trace
- 110v or 200/250v operation

- 3" Flat Faced PDA Tube designed especially for the Serviscope. Full 5 cms. X and Y deflection.
- New High Gain D.C. Coupled Amplifier Dual Range 1. D.C. — 7.5 Mc/s 100mV/cm. 2. D.C. — 200 Kc/s 10mV/cm. The amplifier is completely free from drift and has equal D.C. and A.C. gain.
- New D.C. Coupled Flyback Blanking System.

Accurate Calibrated Input Attenuator gives direct reading of A.C. or D.C. input voltages from 10mV/cm, D.C.—200 Kc/s, 100mV/cm to 50V/cm D.C.—7.5 Mc/s.

Wide Range Calibrated Time Base has 18 pre-set sweep speeds from 1 usec/cm to ½ sec/cm (or slower if necessary).

X Expansion Control gives over 10 diameters expansion equivalent of a trace length of over 50 cm.

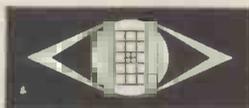
Versatile Triggering Circuit gives two modes of triggering:

1 Automatic Synchronisation. For most applications simply switch to Auto. and the Time Base locks automatically to any frequency between a few cycles and 1 Mc/s at any input level.

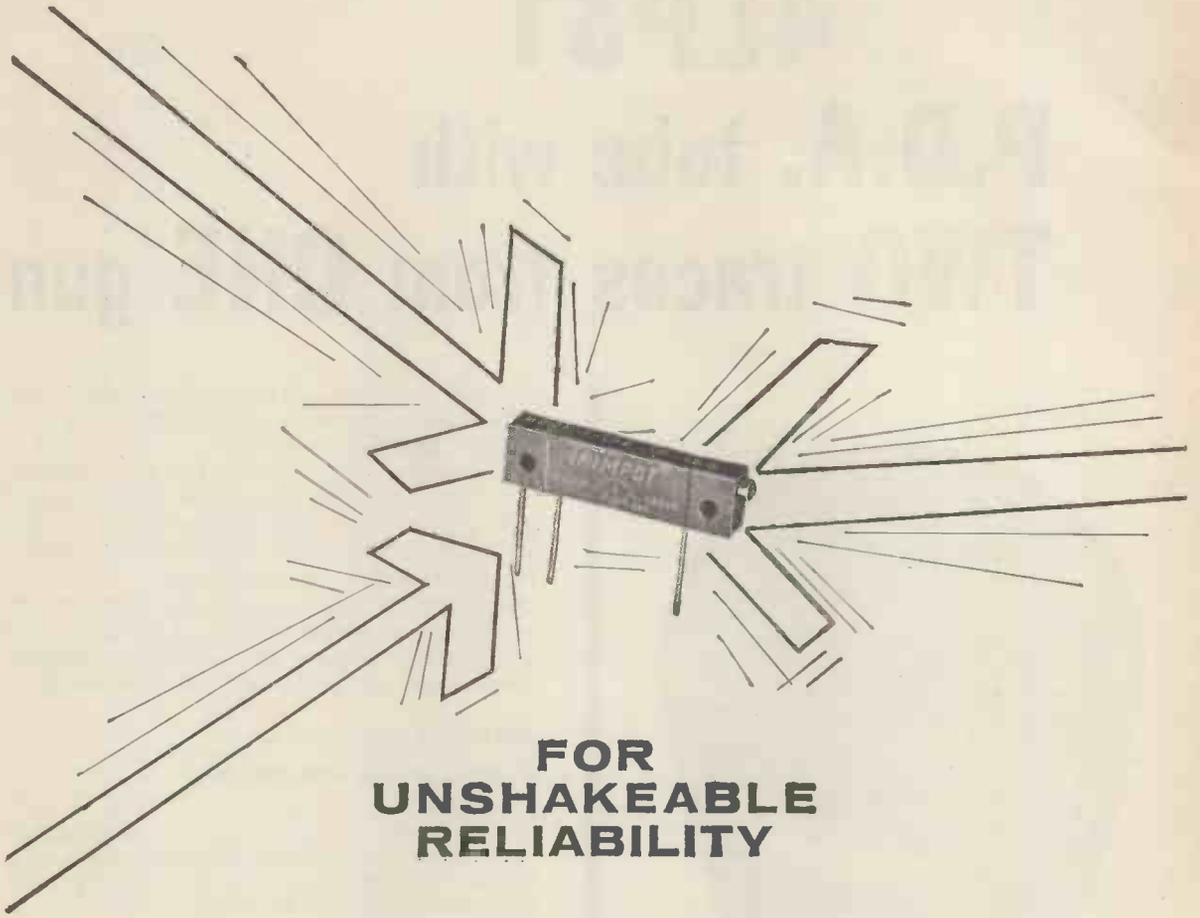
2 Selective Triggering. Enables the Time Base to be triggered from any selected point on the input waveform.

Built-in T.V. Sync. Separator

selects Line or Frame pulses from Positive or Negative Video Signals.



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THE PAINTON BOURNS TRIMPOT TYPE 224 Wirewound Potentiometer is a high performance component, widely specified where extreme reliability is of prime importance.

Excellent shock, vibration and acceleration stability are achieved by the self-locking adjustment screw. The component is sealed against humidity, liquids and potting compounds and operates at a temperature of 175°C. Three different terminal configurations are available (Stranded insulated leads, solder-lugs or printed circuit pins).

Stringent quality control and inspection are enforced for each individual component to ensure that the tight limits of the manufacturing specification are rigidly adhered to.

Technical details available on request in Publication PB1/1.



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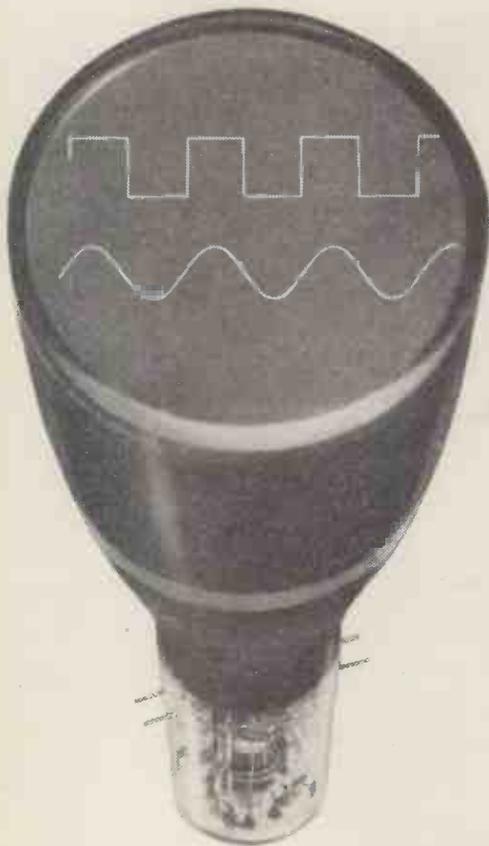
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4LP31

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The 'ETEL' four-inch instrument tube 4LP31 is the most economical high performance tube for dual trace oscillography.

Two traces are provided in the simplest and most economical manner—by means of a single gun with a beam-dividing electrode. Sensitivity of 27 V/cm at 3kV is attained by employing a post-deflection accelerator.

The 4LP31 is recommended for high quality general purpose applications. It has a flat face and side connections to the deflector plates. Write for full information to the address below.

ABRIDGED DATA

4LP31 single gun dual trace tube.

SCREEN TYPE	...	...	...	*P31
DEFLECTION	...	...	...	electrostatic
POST-DEFLECTION ACCELERATOR	...	...	...	single stage
SCREEN DIAMETER	...	...	...	4 inches
MAXIMUM OVERALL LENGTH	...	...	...	15½ inches

* (The green medium persistence phosphor used by E.T.L. has now been designated P31. It is exactly the same as the E.T.L. phosphor previously called P1.)

Capacitances

$C_{x'-x''}$	...	...	...	1.4 to 2.0 pF
$C_{x'-all}$ (x' earthed)	...	...	...	2.7 to 3.8 pF
$C_{x''-all}$ (x'' earthed)	...	...	...	2.7 to 3.8 pF
$C_{y'-all}$	...	...	...	2.5 to 3.8 pF
$C_{y''-all}$	...	...	...	2.5 to 3.8 pF
$C_{y'-y''}$	...	...	...	<0.1 pF

Typical Operating Conditions

V_{a1}	...	...	...	1.5 kV
V_{a2}	320 to 420 V
V_{a3}	1.5 kV
V_{a4}	3.0 kV
V_g (for cut-off)	-40 to -95V
S_x	27 V/cm
$S_{y'}$	27 V/cm
$S_{y''}$	27 V/cm

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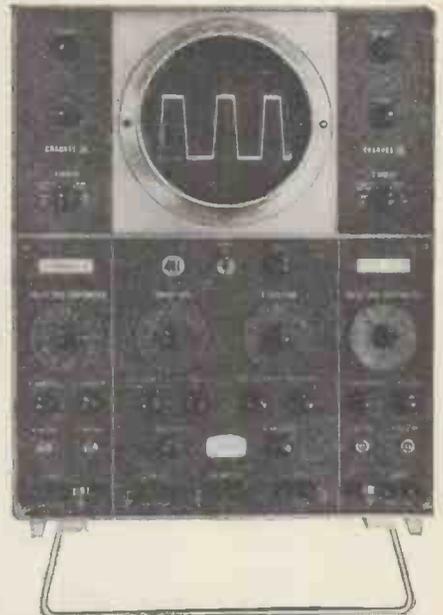
The 425 is a modularized, 35 megacycle, highly versatile general-purpose oscilloscope. The READ OUT SWITCH FEATURE and the unique "Two Dot" dialled method of wave-form measurement make this the most accurate instrument available today. Innumerable types of accurately repeatable measurements can be made and the applications are limitless.



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DUMONT TYPE 411 DUAL-BEAM OSCILLOSCOPE

The 411 is an ultra-high sensitivity instrument of very low frequency and is particularly valuable in the measurement of vibrations in the medical field. It is a true dual-beam oscilloscope employing a multi-gun cathode-ray tube and provides an unusually varied selection of displays. DUMONT cameras are available for all types of 5in. Tube high grade oscilloscopes. Bezel adaptors used for all makes other than DUMONT. Demonstrations and Full Servicing Facilities available.



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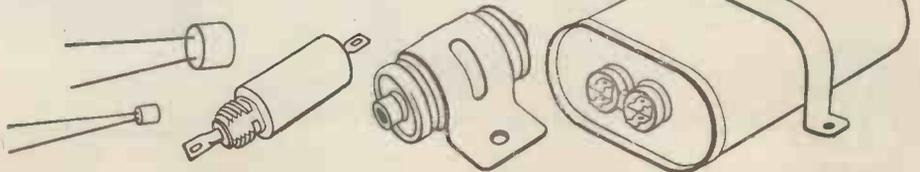
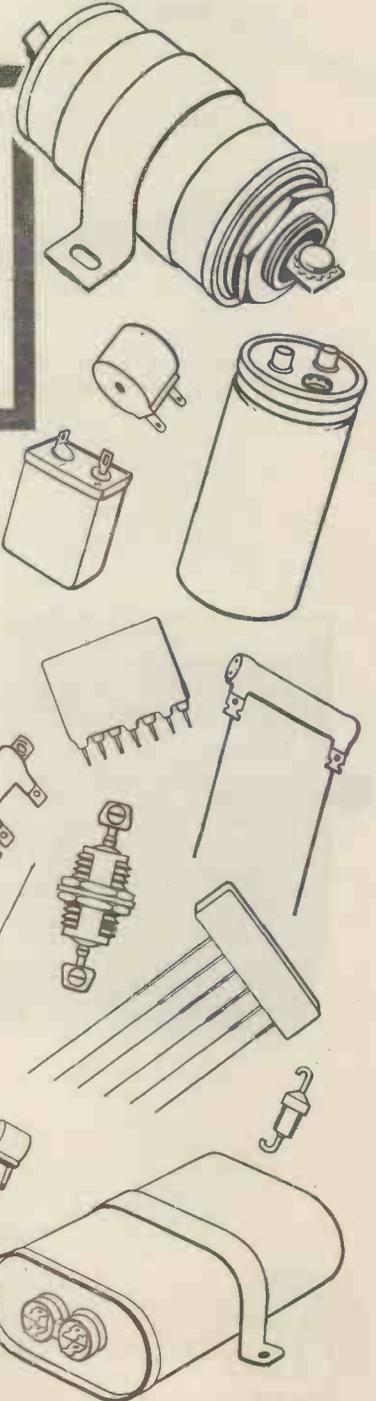
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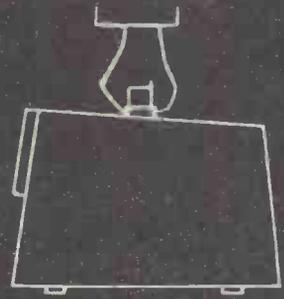
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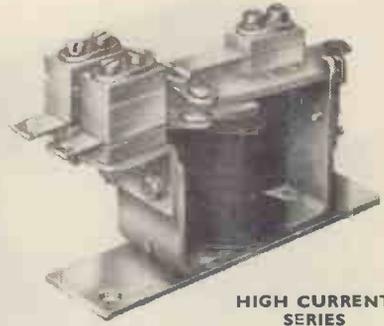
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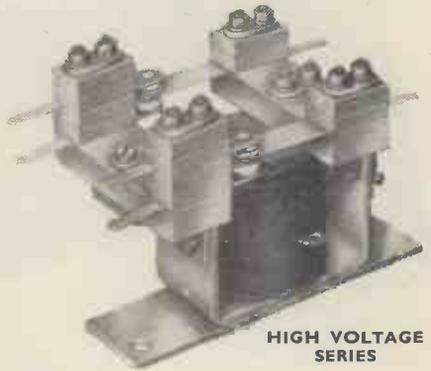
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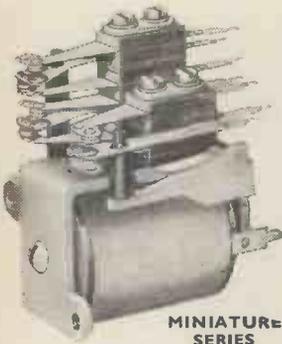
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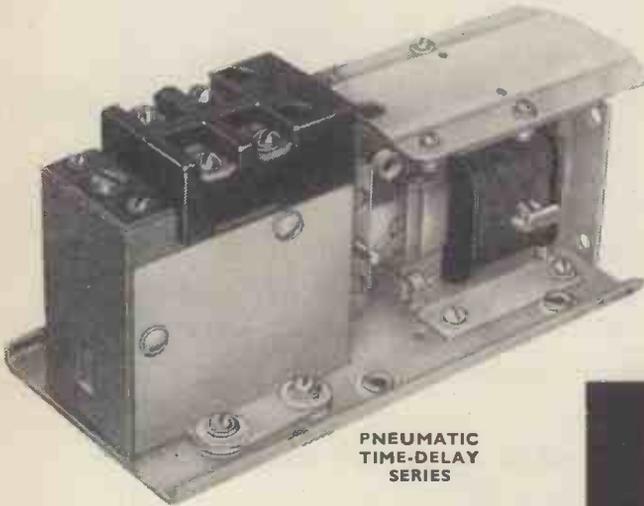
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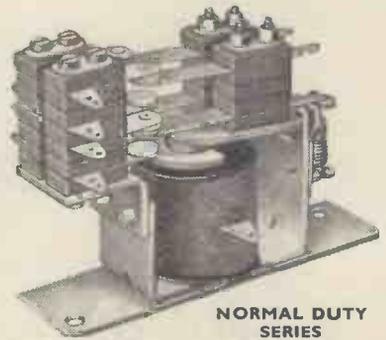
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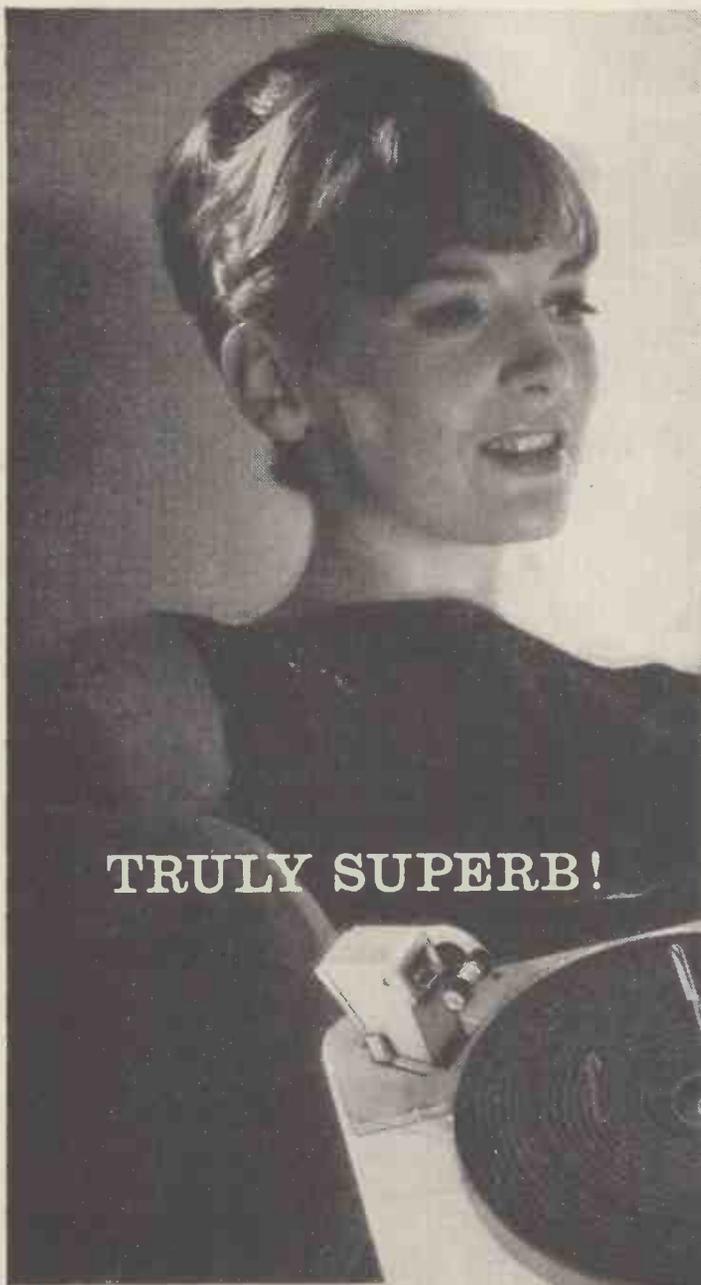
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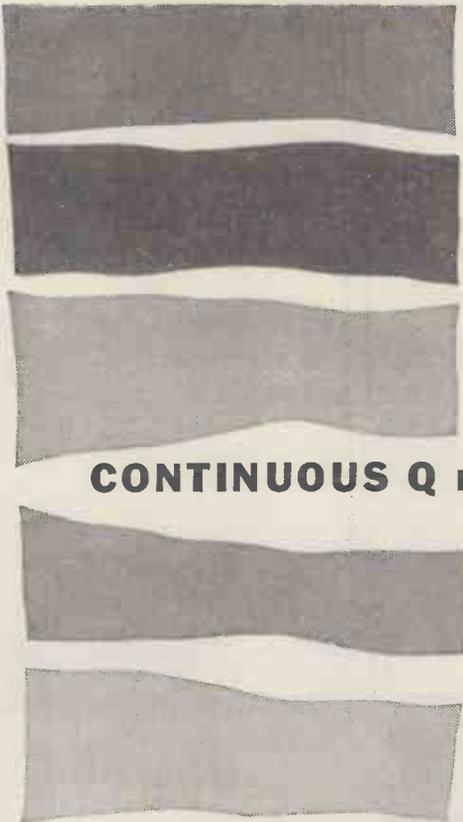
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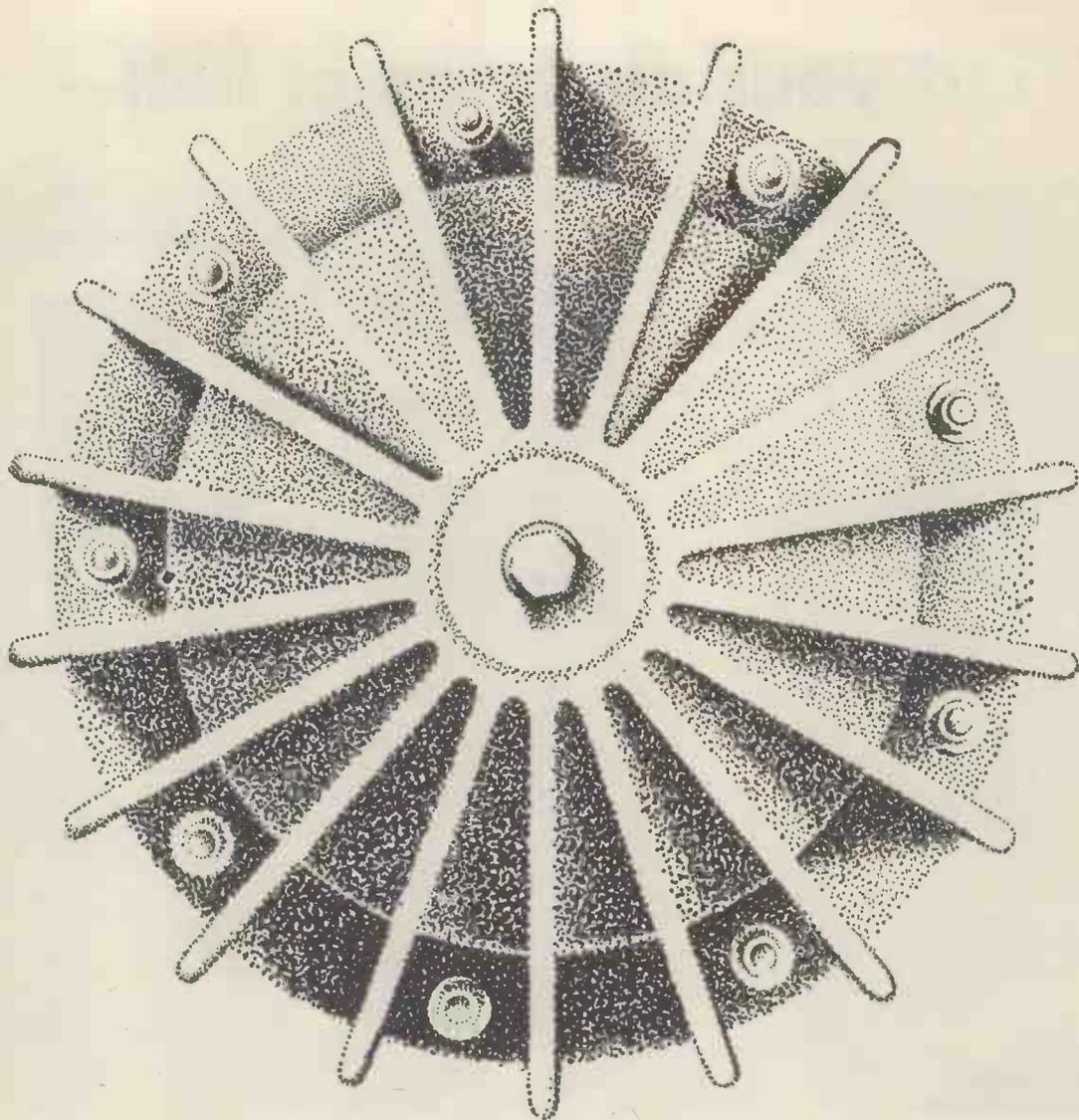
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 - 1dB at 0.1 Mc/s
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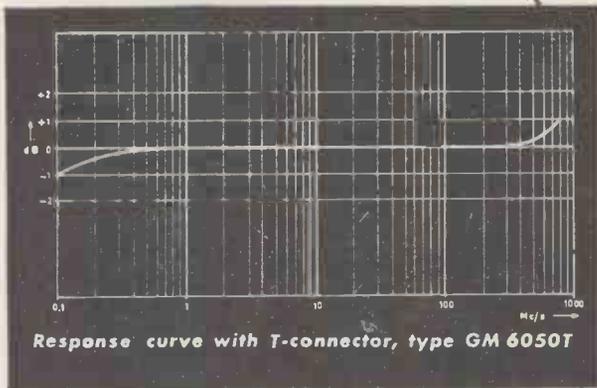
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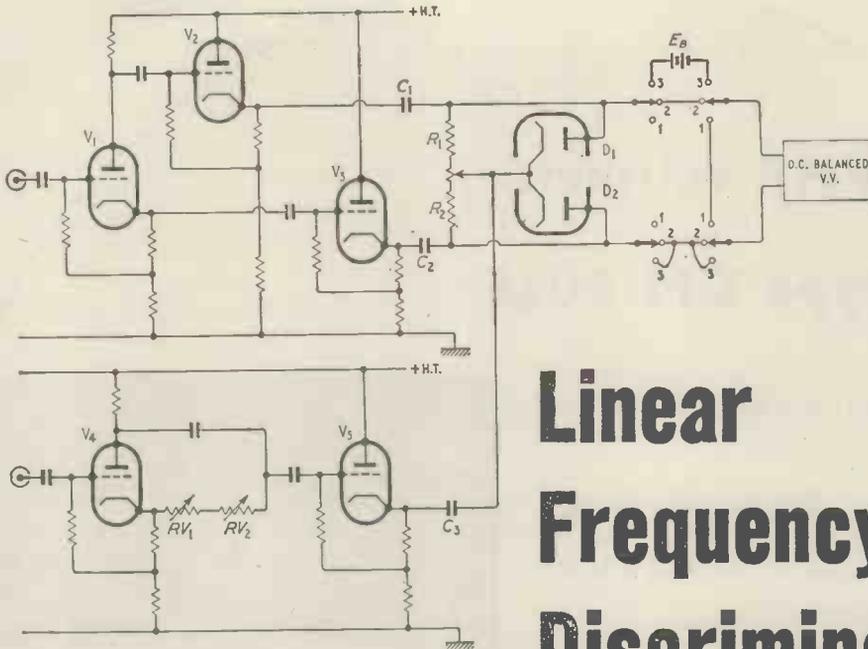
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Linear Frequency Discriminator

The current November issue includes this article in which a simple method is described for distortionless demodulation of low-frequency f.m. signals with large deviations, as used in multichannel communication systems utilizing the so-called f.m.-f.m. method of frequency multiplexing. Initially a simple theoretical analysis, to determine the conditions for maximum linearity, of a practical discriminator is given. Following this a complete practical circuit is presented and it is shown that the theoretical analysis is confirmed experimentally.

ARTICLES

IN THE DECEMBER ISSUE INCLUDE:

FERRITE CORES AS LOGICAL ELEMENTS

In this article the properties of ferrite cores are explained and some of the ways in which they can be arranged to provide logical functions are then described. The operation of a typical core logical circuit is analysed and the implications of the analysis in design is discussed.

SILICON P-N-P-N SWITCH—2

The newly-developed four-layer semiconductor device which is known as a p-n-p-n switch can be used in many interesting ways to perform a number of functions. This article primarily deals with the practical applications of the p-n-p-n switch. It gives a number of circuits using this new device and briefly describes the operation of each circuit.



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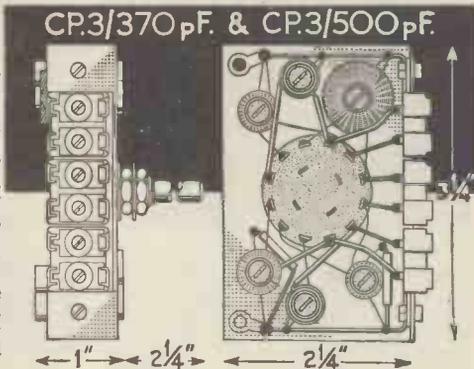
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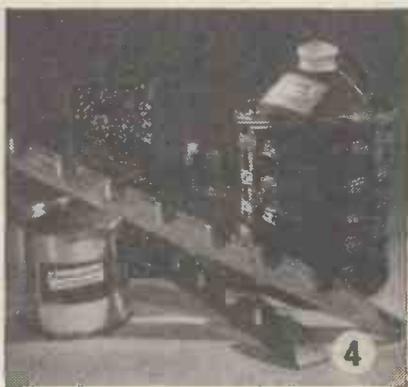
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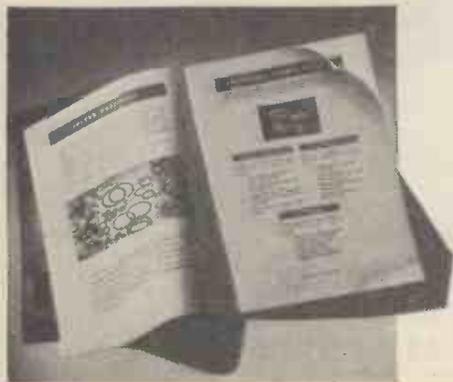
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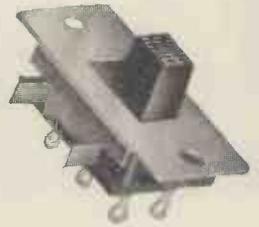
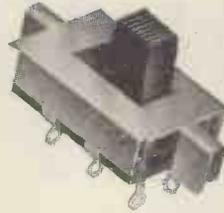
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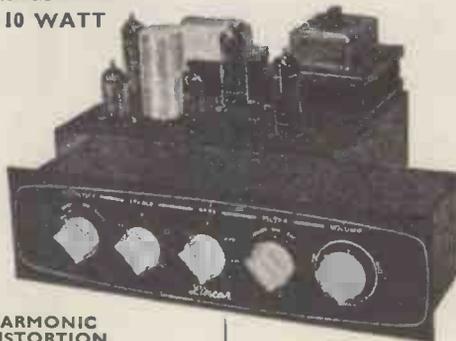
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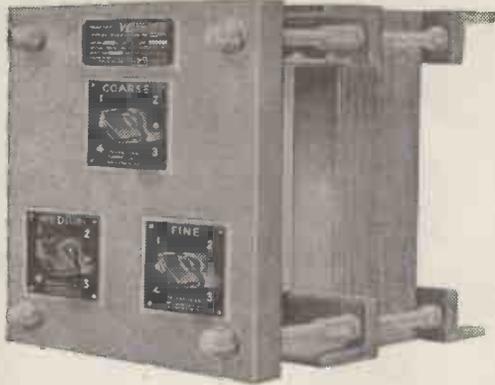
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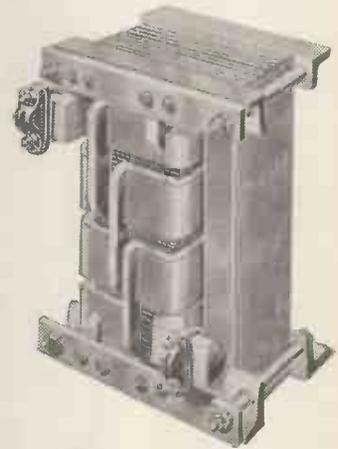


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4 V	100 A	12 V	100 A
5 V	80 A	18 V	30 A
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5 V	300 A	30 V	5 A
6 V	60 A	30 V	25 A
6 V	100 A	30 V	40 A
6-12 V	50 A	40 V	25 A
8 V	125 A	50 V	60 A
10 V	150 A	55 V	15 A
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10 V	700 A
10 V	1,000 A
20 V	3,000 A
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27 V	8,000 A
50 V	600 A
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These and other transformers can be supplied for 1 phase and 3 phase and for use with rectifiers.

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12 V	20 A	110 V	5 A
12 V	30 A	110 V	10 A
12 V	60 A	110 V	15 A
12 V	105 A	110 V	20 A
12 V	210 A	110 V	25 A
12 V	1,000 A	110 V	600 A
24 V	750 A	220 V	130 mA
24 V	12 A	250 V	6 A
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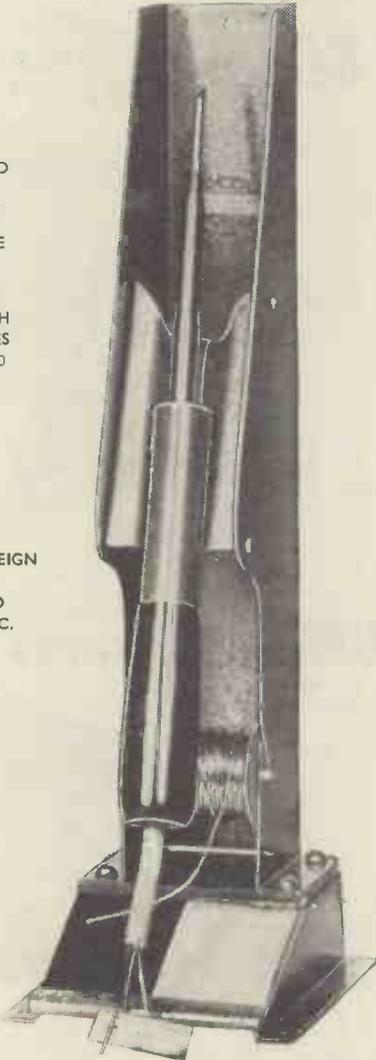
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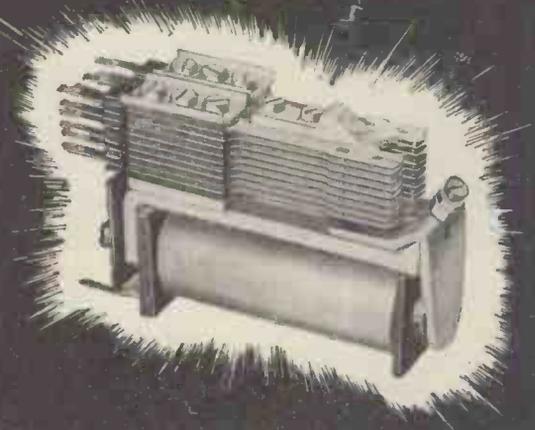
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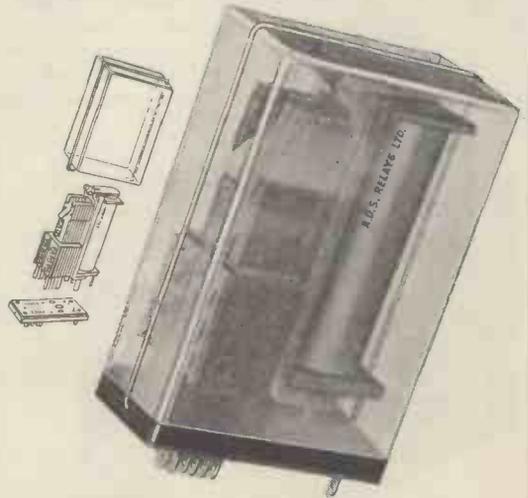
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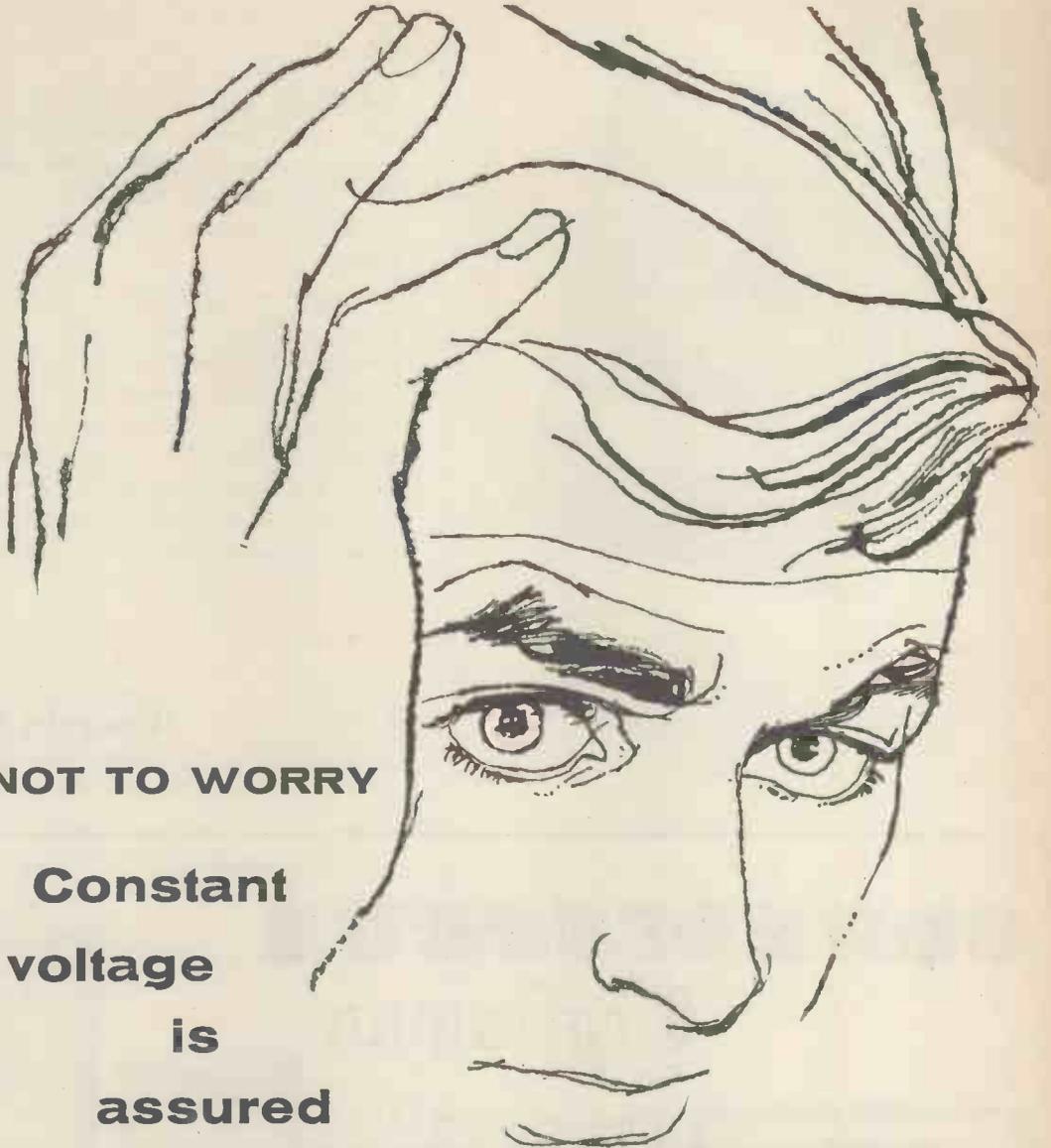
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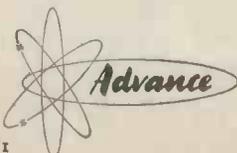
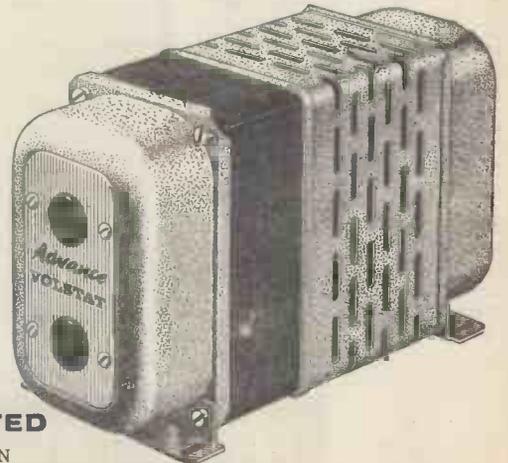
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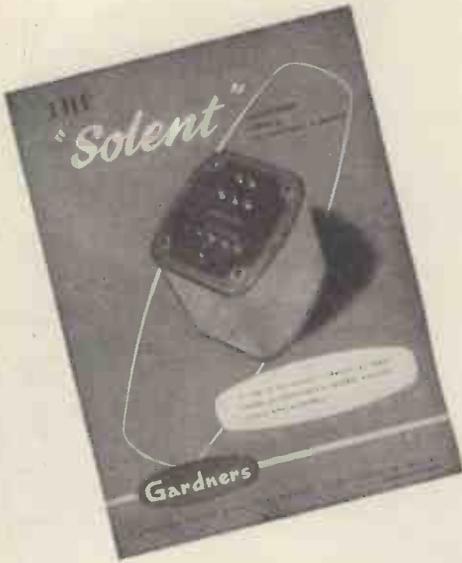


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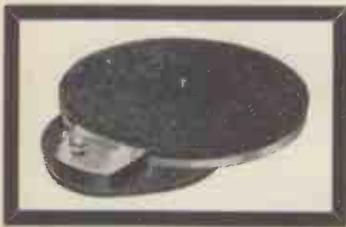
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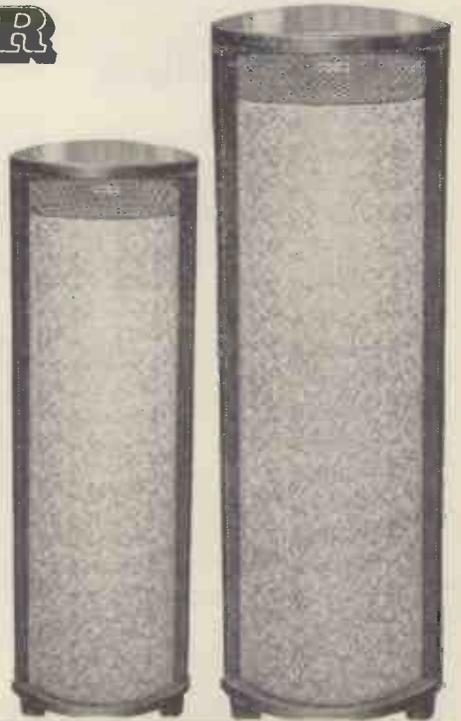
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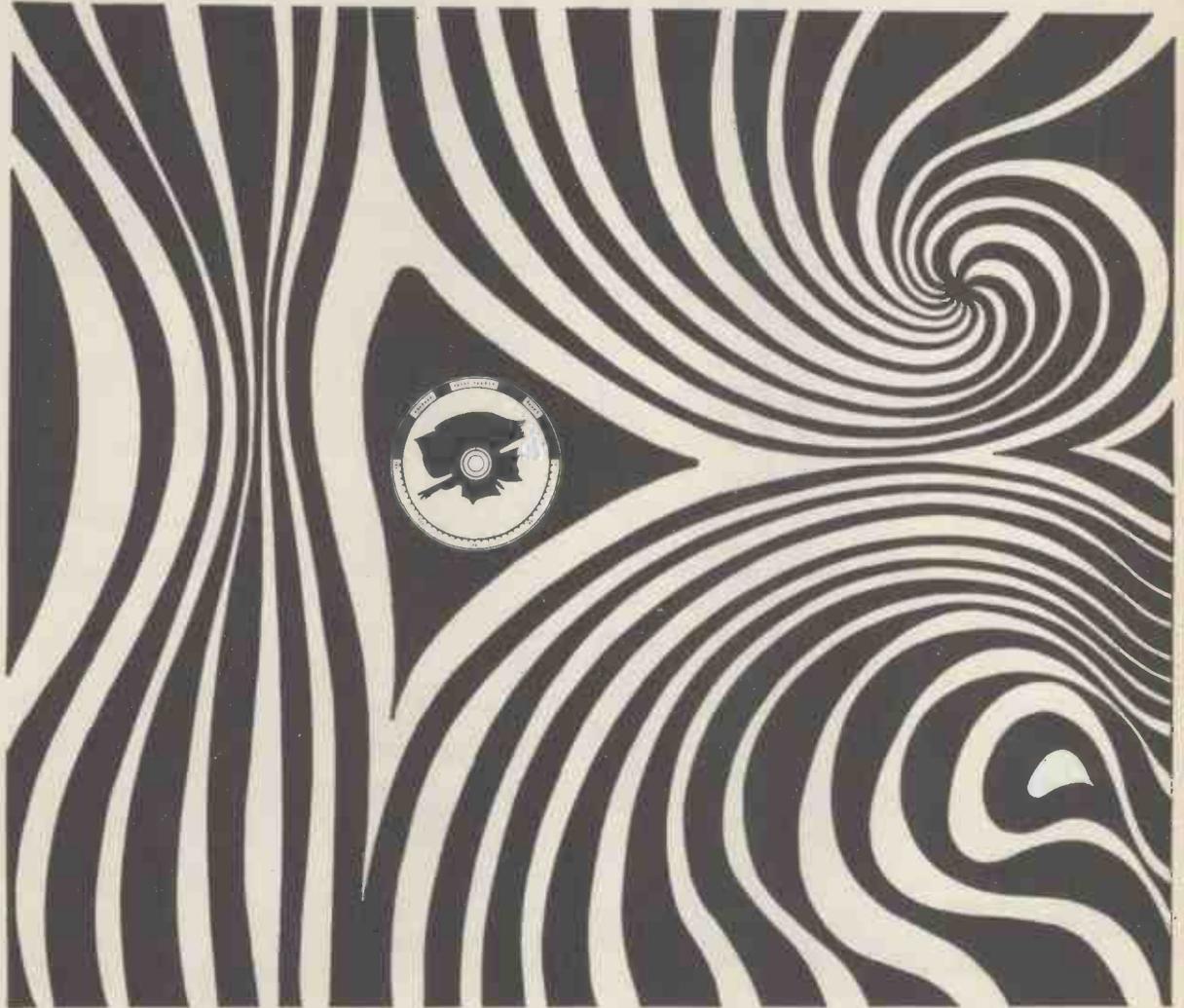


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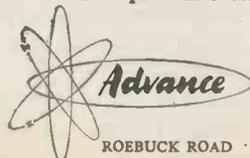


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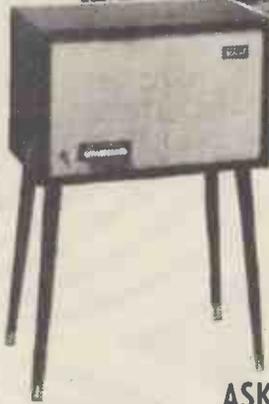


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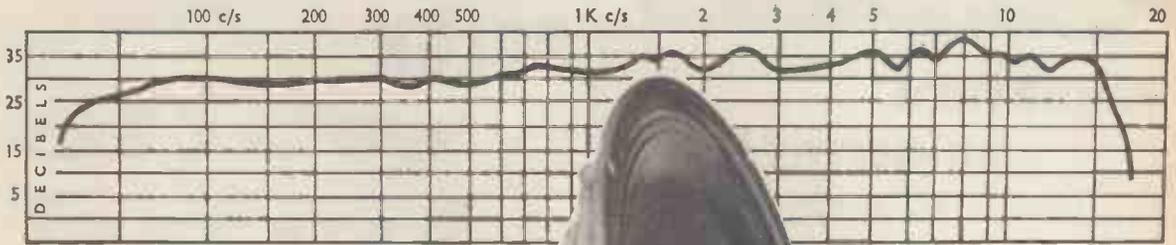
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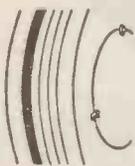
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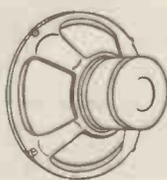
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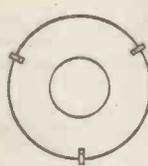
Frequency Range :—30 c/s to 16,000 c/s. See response curve. *Fundamental Resonance* :—35 c/s. *Power Handling Capacity* :—15 Watts. *Voice Coil* :—Aluminium, 15 ohms at 400 c/s. 1 3/4" dia. *Magnet System* :—Closed field low leakage. Flux density 14,000 Gauss. Total flux, 158,000 Maxwells. *Construction* :—Entire loudspeaker built into unique Rigidform die-cast chassis. Bass diaphragm vacuum formed controlled edge with plastic termination. Concentrically mounted high frequency radiator, terminated, with automatic mechanical crossover. Dustproof high stability corrugated centering device. Finished in grey hammered enamel. Terminal type connectors.



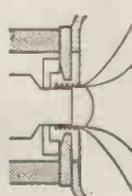
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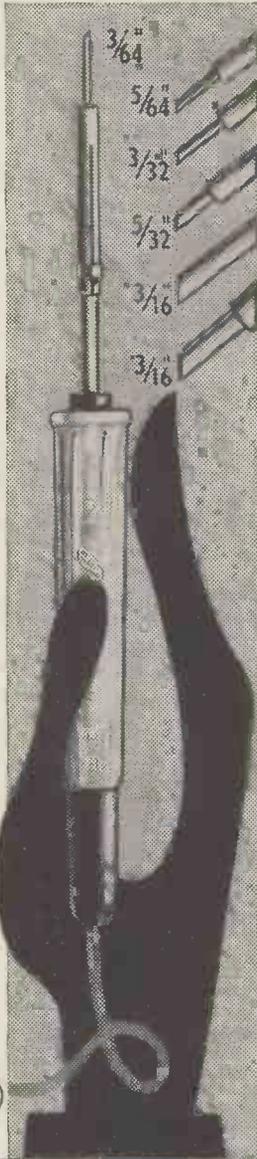
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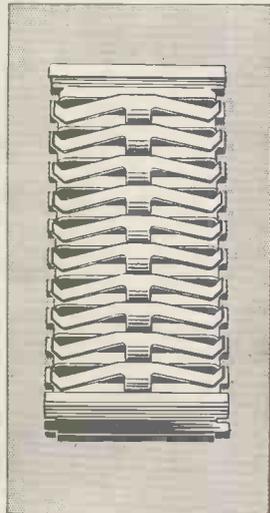
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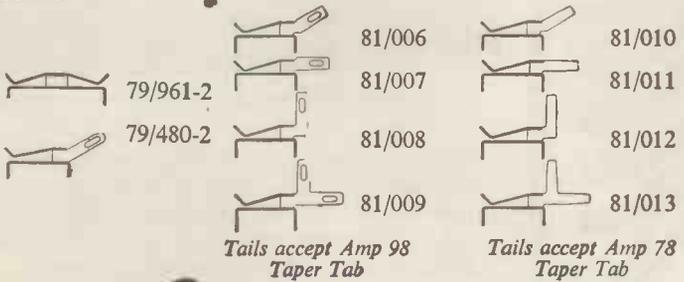
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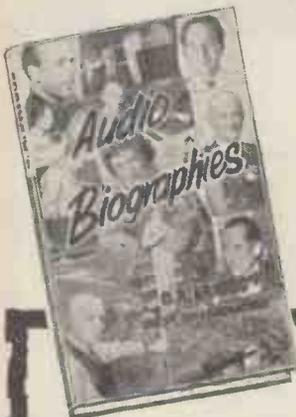
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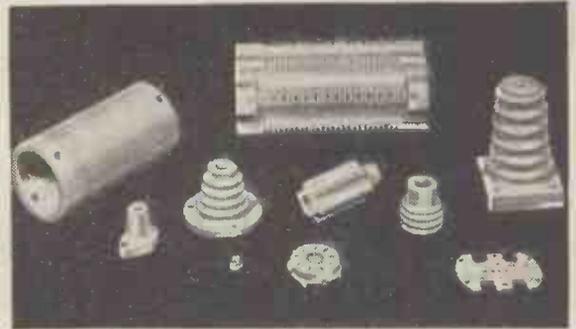
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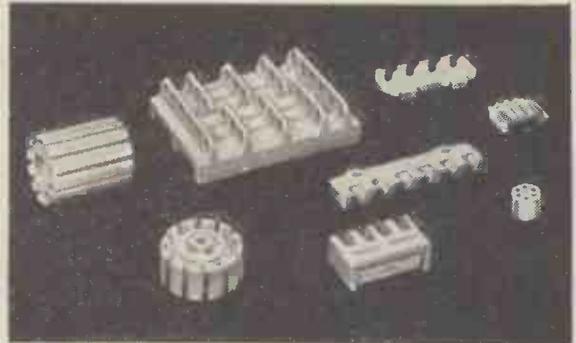
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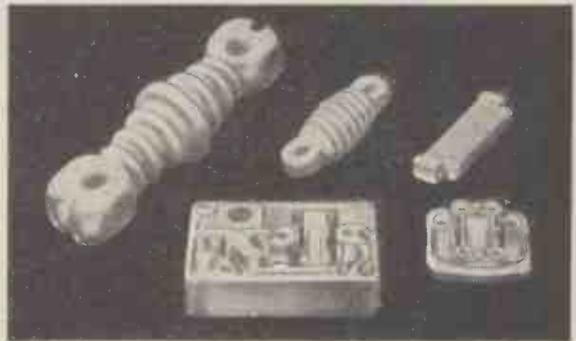
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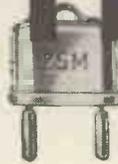
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Gaumont-Kalee
Fluttermeter
Type 1740

Brief Technical Data

Operating carrier frequency 3,000 c.p.s. $\pm 5\%$
 Minimum Input Signal 50 mV R.M.S.
 Input Impedance 1 Megohm.
 Input amplifier bandwidth -3db at 2,500 and 3,500 c.p.s.
 Effective limiter range $\pm 10\text{dB}$.
 Meter scaling—"Peak wow" 0 to $\pm 1\%$ (centre zero).
 "Wow" and "Flutter" 0 to 1% and 0 to 0.2% R.M.S.
 Crossover frequency 20 c.p.s.
 "Flutter" meter response -3db at crossover.
 -3db at 200 c.p.s.
 "Wow" meter response -3db at crossover.
 -1db at 0.5 c.p.s.
 C.R.O. output frequency response level down to zero frequency -3dB at 200 c.p.s.
 3,000 c.p.s. oscillator output level.
 5V R.M.S. into 0.5 Megohm 100 mV R.M.S. Into 500 ohms.
 Accuracy: Meter presentations $\pm 2\%$ f.s.d.
 Power consumption 35 watts.
 Mains 100/150v. and 200/250v.
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Accurate measurement of sound equipment speed deviations

The Flutter Meter measures those components which are commonly described as "Wow" and "Flutter" resulting from speed variations in sound recorders and reproducers. This instrument is equally suitable for use with machines employing perforated film, tape, wire or disc records.

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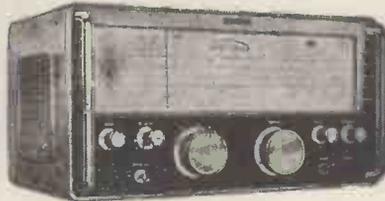
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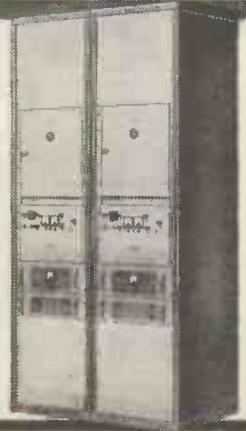
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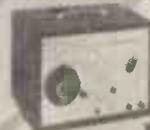


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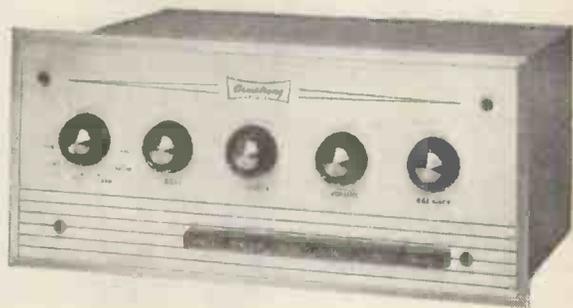
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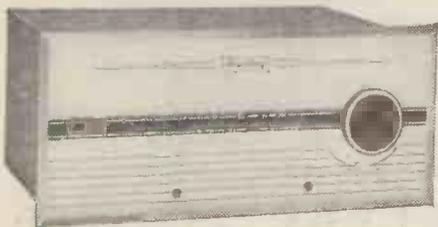
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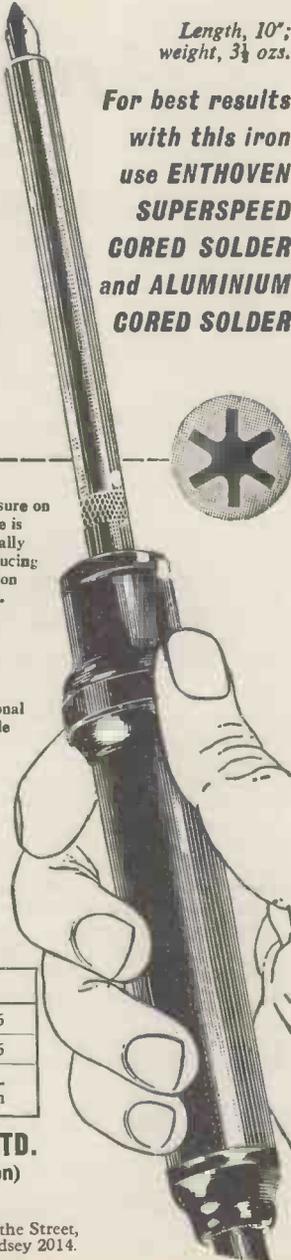
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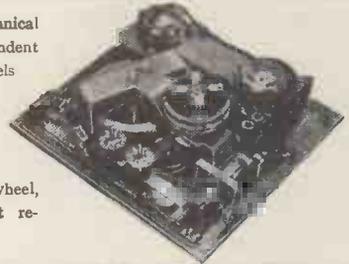
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Twin Track Tape Deck.

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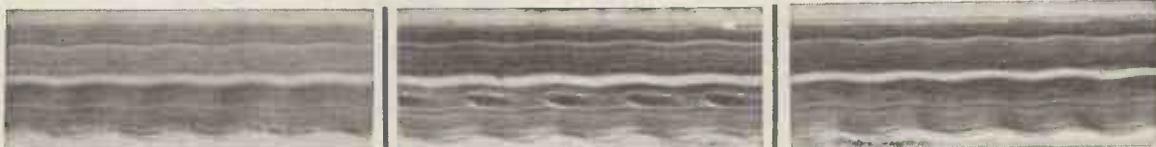
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Cabinet size 28" x 14" x 12".
Weight 48 lb. complete
Impedance 15 ohms
Max. input 15 watts

£39.10.0

complete, tax free

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Model 185 A/187 B - DC to 1000 MC

Completely new circuit approach permits viewing - on a bright 5"-cathode-ray tube - of repetitive short pulses requiring a bandwidth up to 1000 MC. Rise time of less than 0.45 millimicroseconds permits direct measurement and observation.

Sensitivity is 10 mV/cm to 200 mV/cm, horizontal sweep times 0.1 to 100 millimicroseconds/cm.

Price 185 A £ 800

187 B £ 400

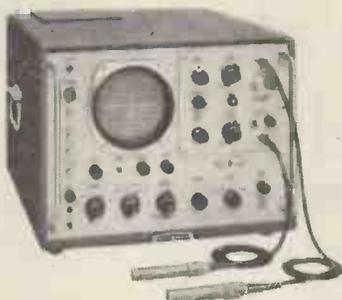


Photo 185 A

Model 150 A - DC to 10 MC

Broadly useful, high quality; has many plug-in amplifiers providing dual trace or differential input, voltage/current dual channel comparison, or high amplification eliminating preamplifiers between the oscilloscope and most transducers.

Sensitivity 200 mV/cm to 15 V/cm, horizontal sweep times 0.1 μ sec/cm to 5 sec/cm.

Price 150 A £ 520

(Plus Plug-in Amplifiers)



Photo 150 A

Model 130 B / BR* - DC to 300 KC

Highest quality, low-frequency oscilloscope. Includes universal automatic trigger.

Similar horizontal and vertical amplifiers with sensitivity 1 mV/cm to 125 V/cm. Horizontal sweep times 1 μ sec/cm to 12.5 sec/cm.

Includes times-5 magnifier.

Price £ 260

* Letter "R" indicates rack-mount instrument available.

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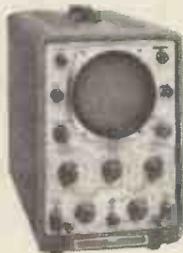


Photo 120 A

Model 160 B / BR* - DC to 15 MC

Militarized instrument meeting U.S.A. military standards for shock, vibration, humidity, temperature.

Maximum vertical sensitivity 20 mV/cm, horizontal sensitivity 0.1 V/cm to 10 V/cm.

Horizontal sweep times 0.1 μ sec/cm to 5 sec/cm in 24 ranges. Times 100 magnifier increases fastest sweep to 5 sec/cm.

Dual trace operation.

Price £ 740

(Plus Plug-in Amplifiers)

Model 122 A / AR* - DC to 200 KC

Dual trace, moderately priced instrument presents two separate traces simultaneously, or single trace when desired. Twin vertical amplifiers.

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Price £ 270

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Industrial and production as well as laboratory instrument. Has universal automatic trigger, automatic synchronization on any internal or external voltage.

Sweep speeds 5 μ sec/cm to 0.5 sec/cm, times-5 sweep expander, high sensitivity calibrated vertical amplifiers.

Regulated power supplies; steady, drift-free traces, ideal for photography.

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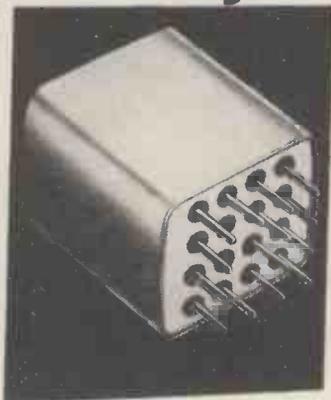
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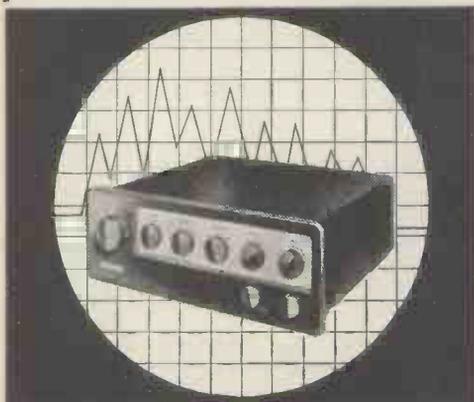
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- 6 watts r.m.s. per channel (nominal)
- Overall frequency response:
25 c/s—25 Kc/s ± 1 db, ref. 1 Kc/s.
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- Total Harmonic Distortion: < .25% at 1 Kc/s, 4 watts
- Inputs: Pickup 5 mV and 100 mV
Tape 100 mV
Tuner 100 mV
Mic. 4 mV
- Low pass filter: 5, 7 and 10 Kc/s.
- Filter slope control
- 6-position input and channel selectors: bass, treble, volume and balance controls
- Output Impedance: 7 or 15 ohms.

PRICE 37 GNS.

DOUBLE TWELVE STEREO AMPLIFIER

- 12 watts r.m.s. per channel (nominal)
- Input 200 mV for nominal output
- Frequency response:
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- Hum and noise better than 80 db relative to nominal output
- Total Harmonic Distortion: < .1% at 1 Kc/s, 10 watts
- Output Impedance: 7 or 15 ohms.

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Pickup 5 mV and 100 mV
Tape 100 mV
Tuner 100 mV
Mic. 4 mV.
- Low pass filter: 5, 7 and 10 Kc/s.
- Filter slope control
- 6-position input and channel selectors: bass, treble, volume and balance controls.
- Saville amplifiers are very attractively finished in low gloss black and off-white

Matching AM/FM Tuner available shortly.

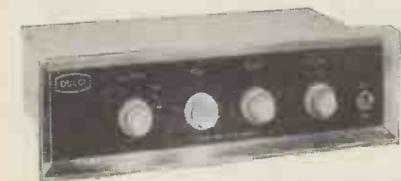
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STEREO FIVE

Twin Channel Pre-amplifier for high fidelity Stereo/Mono reproduction

	Sensitivity (for stated output)	Impedance
(i) Radio ..	100mV	250 K-ohms
(ii) Pick-up ..	50mV-2V adjustable	1 Megohm
(iii) Tape ..	100mV	250 K-ohms

Independent Bass and Treble controls; separate balance control; distortion factor better than 0.1%; Hum and Noise better than -60db on all channels; Power supply through multi lead cable terminated in Octal Plug; Finish: Front panel, black and matt silver; Case, cadmium plate grey hammer stove enamelled. Front panel size 12½ × 3½ in. (aperture 12½ × 2½ in.). Overall depth 5 in. Weight 4 lb.

Retail Price **11 gns.**

tion of sound from radio, pick-up or tape.

Input: There are phono sockets for all inputs at rear.

MODEL SP55

Twin Power-amplifier

Consisting of two identical power-amplifiers with a common power supply. Designed for stereo application, to operate in conjunction with a "Stereo Five" pre-amplifier control unit. Great care has been taken to match both amplifier sections for identical performance to close limits. Mains: 200-250V A.C. 40-60 c.p.s. Consumption 60 watts; Output: Power, 8-watts peak (4-watts per channel); Loudspeaker matching: 3-5 and 12-16 ohms adjustable; Frequency response: ± 1db

For low sensitivity pick-ups Model Stereo Five has facilities for the attachment of two type TA6 transistor amplifiers which will give a pick-up sensitivity greater than 5mV. The input impedance with this amplifier is then 75 K/ohms. The radio and tape sensitivities remain at 50mV.

TA6 Amplifiers.

Price each **4 gns.**

MODEL DPA-15 MONO AMPLIFIER

A superb high-fidelity laboratory-designed amplifier for domestic use or in assembly halls holding up to 500 people. The DPA-15 incorporates every facility needed for enjoyment of high quality sound from radio, record, tape or micro-

phone with a range of features and versatility rarely combined in any equipment. A pre-amp. and control unit is required. Mains supply: 200-250V. A.C. Output: 15 watts. Impedance: 3 ohms, 7½ ohms, or 15 ohms. Dimensions: 11½ × 6 × 7½ in. Weight: 13 lb. 4oz.

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MODEL DPA-15 MONO PRE-AMPLIFIER

The perfect component for the DPA-15 Amplifier. It possesses all features normally associated with equipment of this very high calibre. Every facility for high quality reproduction of sound from radio, record,

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Retail Price **9 gns.**

MODEL GA505

Stereophonic Amplifier with built-in pre-amp. for use on 200-250V. 40-60 cycles (A.C. only). Three inputs per channel for p.u., radio and tape; Output 5 watts per channel. Frequency response substantially level between 40-16,000 c.p.s. Output impedance 3 and 15

ohms; Controls: Combined bass, combined treble, twin concentric balance and volume control; Front panel: Black and matt silver (12½ × 3½ in.). Cut-out required 3 × 12½ in. Depth 7½ + 2½ in. for transformer projection.

Retail Price **18 gns.**

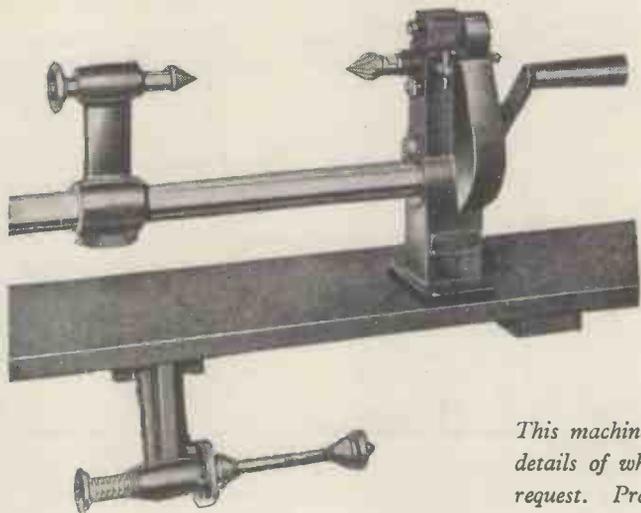
MODEL GA5

Similar in appearance to model GA505.

A high quality amplifier with built-in pre-amp., for use on 200-250V. 40-60 cycles (A.C. only). Suitable for shelf standing or building into cabinet (brackets and feet supplied). Three inputs for p.u., tape and radio,

5 watt output. Frequency response substantially level between 40-16,000 c.p.s. Front panel: Black and matt silver (12½ × 3½ in.). Aperture required 3 × 12½ in., depth 4½ + 2½ in. for transformer projection. Output impedance 3 and 15 ohms. Retail Price **£13.2.6**

THE KOLECTRIC TYPE RH/1 HAND COIL WINDING MACHINE



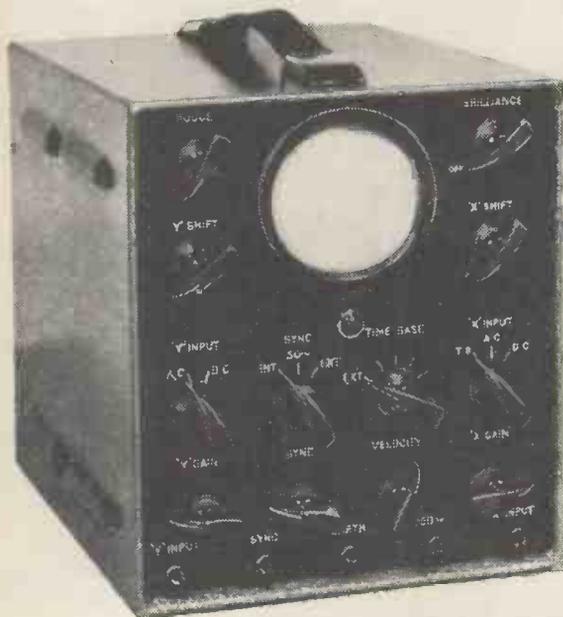
A substantially built Machine suitable for winding wire from 14 S.W.G. (0.080") upwards to the finer wire gauges.

A sturdy detachable winding handle is provided and two winding ratios are provided: 1-1 and 4-1.

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**No. 4
IN THE
SERIES**

Technical Information for the Transistor Circuit Designer

Thermal Runaway

The maximum temperature at which a circuit will operate is not always determined by the maximum power rating of the transistor but by its thermal stability in the circuit. The thermal stability of the circuit depends partly on the stability factor which was discussed in an earlier note in this series.

What, then, does the circuit designer want to know?

- (1) Given the maximum ambient temperature and power dissipation, he will want to know the stability factor.
- (2) Given a maximum ambient temperature, he will want to know the power he can dissipate for a given stability factor.
- (3) Given the dissipation and stability factor, he will want to know the maximum ambient temperature for safe operation.

For case (1) when the junction temperature (i.e. the ambient temperature and dissipation) and the value of I_{CBO} at that temperature are known, the expression for the stability factor is relatively simple:—

$$S < \frac{1}{V \theta K I_{CBO}} \dots\dots\dots(1)$$

where S is the stability factor (defined in No. 3 of this series).

V is the voltage

θ is the thermal resistance of the transistor (in a heat sink if used)

K is a constant = $\frac{\log_e 2}{T_D}$

where T_D is the temperature change to double or halve I_{CBO} . (K is typically of the order of 0.07 to 0.09 for germanium)

I_{CBO} is the value of the leakage current at the appropriate junction temperature T_j , and $T_j = T_{amb} + P_D \theta$

where P_D is the total device dissipation.

For case (2) the maximum allowable power dissipation is:

$$P_D < \frac{1}{\theta} \left(T_R - T_{amb} + \frac{2.3}{K} \log_{10} \frac{1}{K S V_C \theta I_{CBO}} \right) \dots\dots\dots(2)$$

For case (3) the maximum permissible ambient temperature is:

$$T_{amb} < \left(T_R - P_D \theta + \frac{2.3}{K} \log_{10} \frac{1}{K S V_C \theta I_{CBO}} \right) \dots\dots\dots(3)$$

where T_R is some reference temperature (usually 25°C) at which the value of I_{CBO} used in (2) and (3) above is known.

It is clear that the thermal stability can be improved by having a lower value of supply voltage and a more effective heat sink. In estimating the thermal stability, one should always consider the case of those transistors which have the highest values of I_{CBO} .

Of course, the above is subject to individual temperature, power and voltage ratings, given in the data sheet, not being exceeded.

STC TRANSISTOR TYPE	TK 20C	TK 23C	TK 25C	TK 28C	TK 30C	TK 31C	TK 40C	TK 41C	TK 42C
Max. I_{CBO} at 25°C (μA)	5	5	5	5†	5	5	5	6	6
Max. I_{CBO} at 60°C (μA)	30†	50†	30†	30†	30†	30†	50†	50†	50†
K	0.05 *	0.087	0.05 *	0.05 *	0.05 *	0.05 *	0.087	0.087	0.087

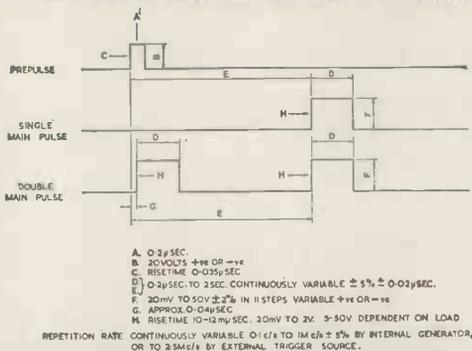
*Note that the value of K for a typical transistor is higher than that for a limit transistor and is about 0.077.

†95% limit.



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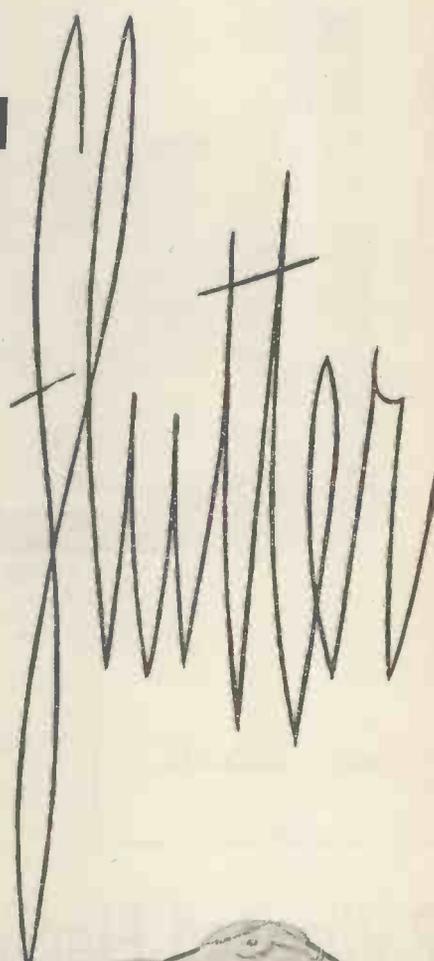
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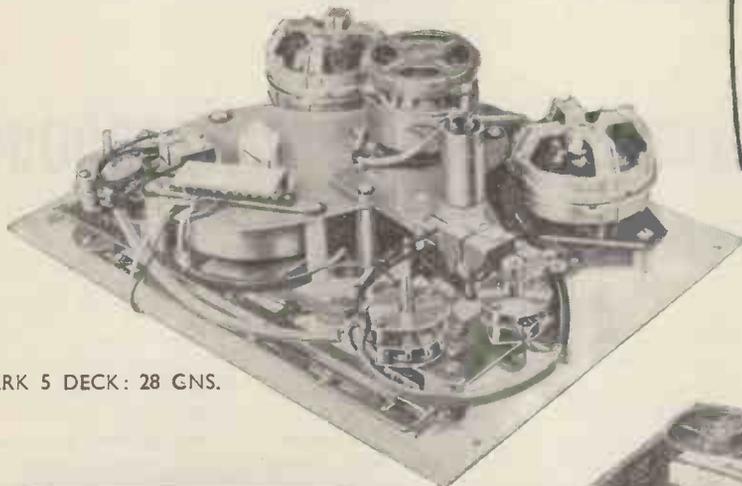
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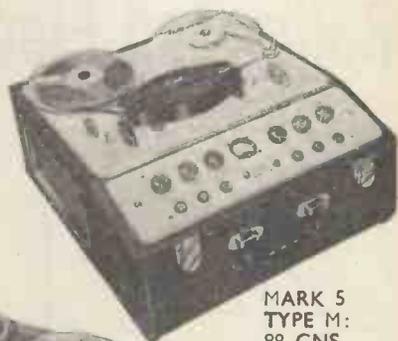
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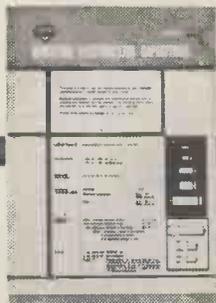
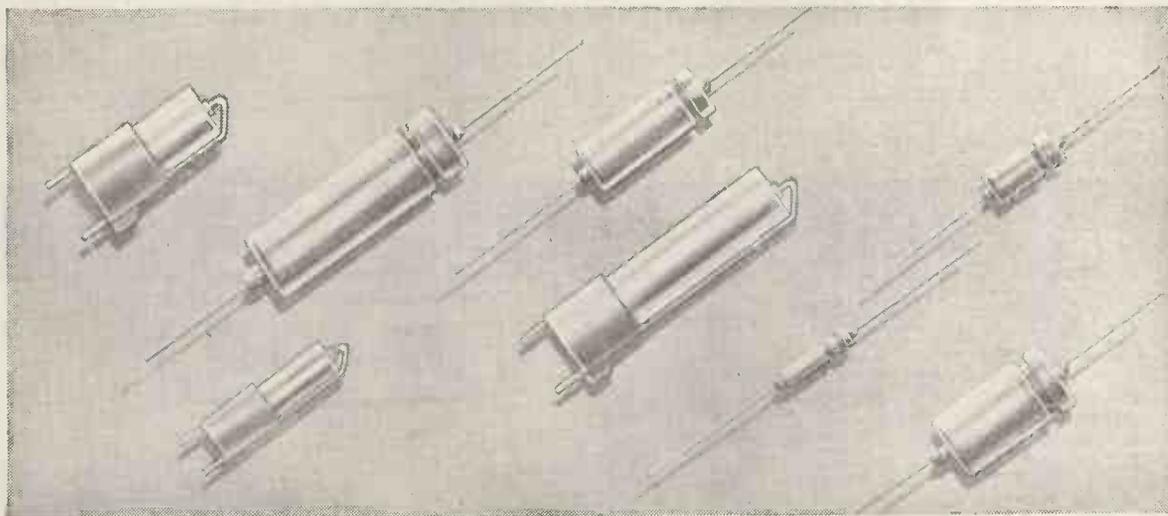
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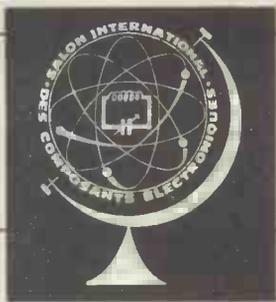
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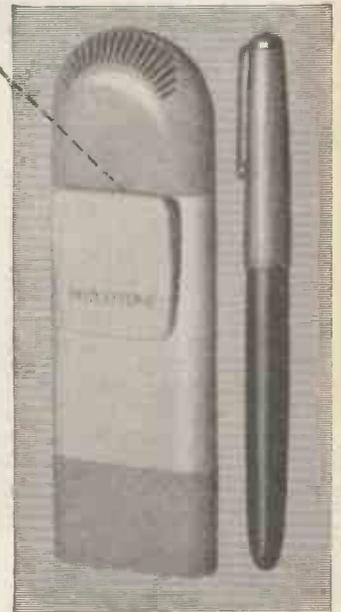
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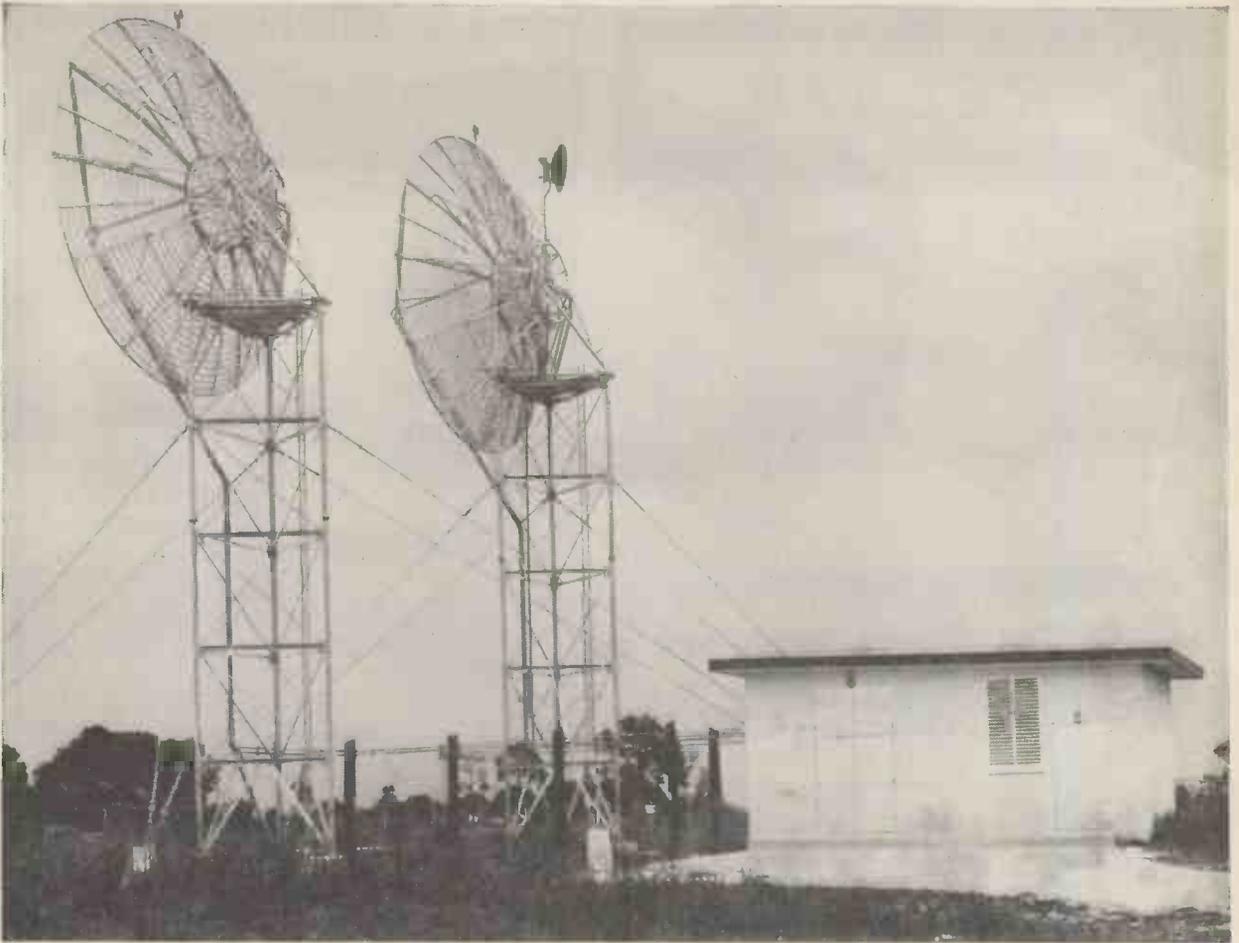
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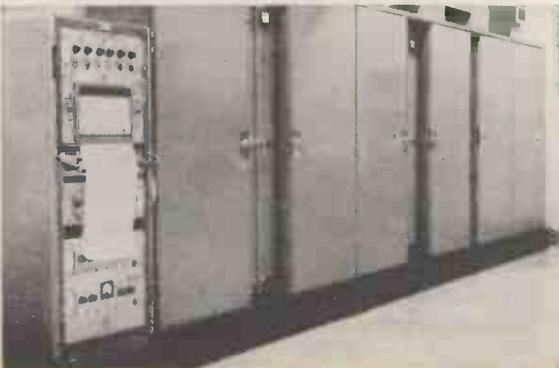
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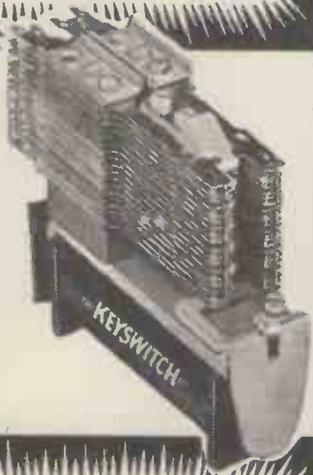
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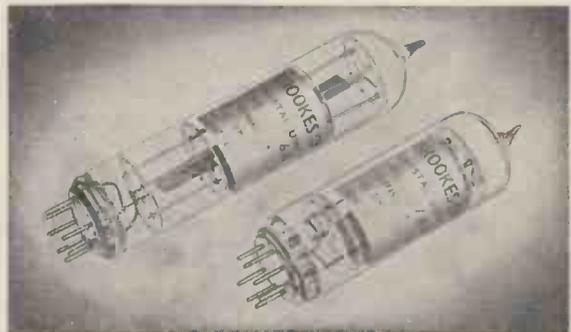
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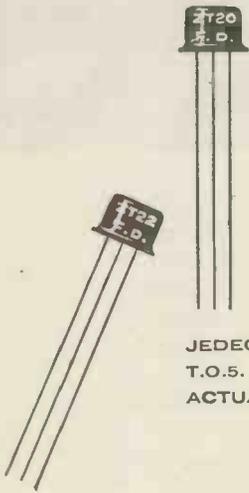
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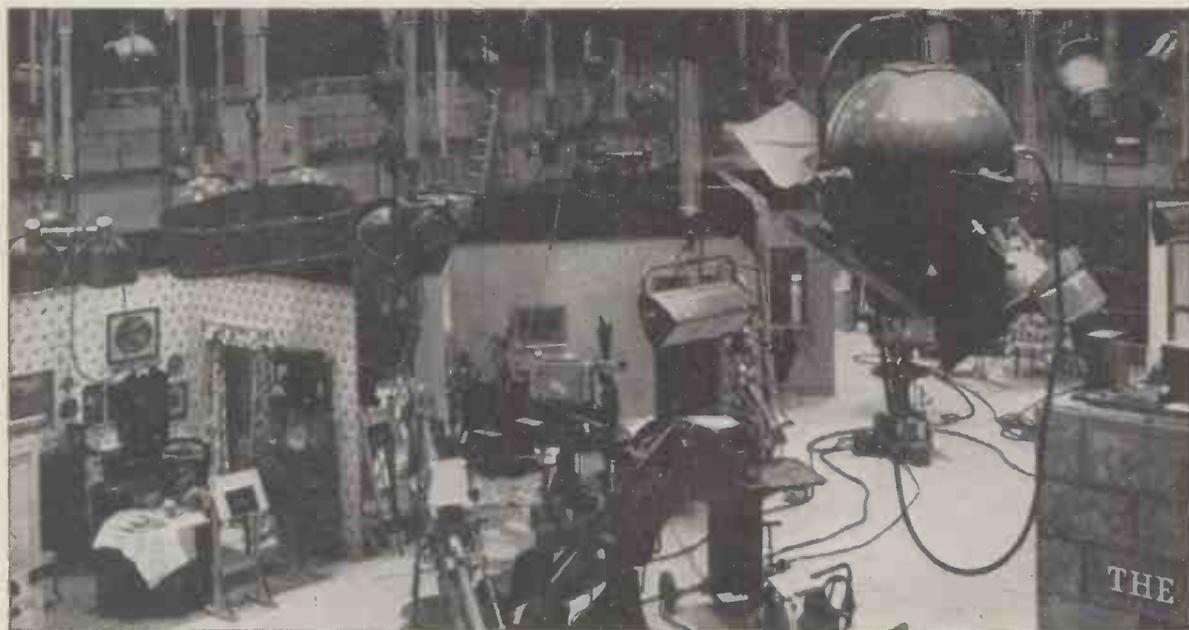
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ELECTRONICS, RADIO, TELEVISION

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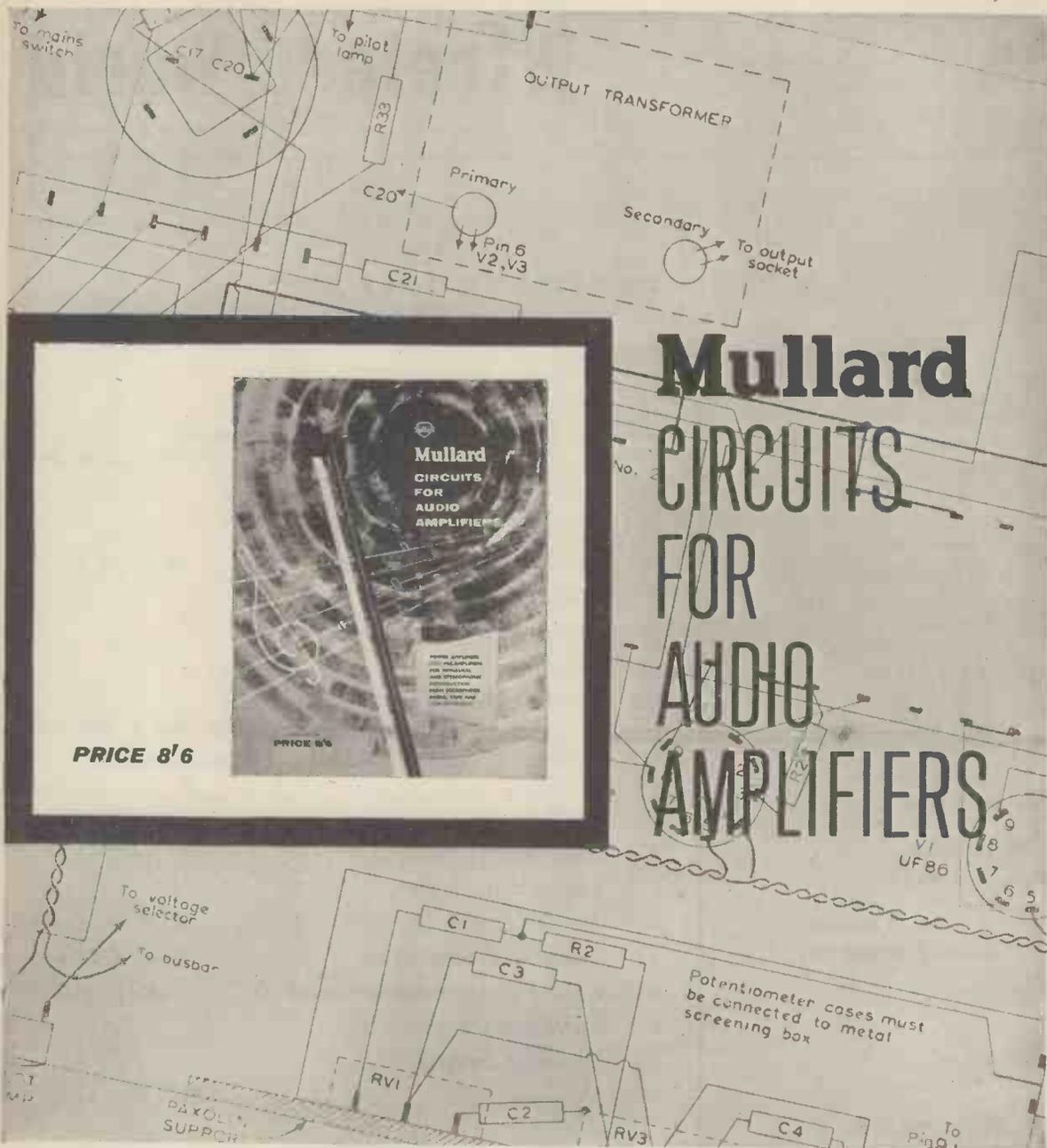
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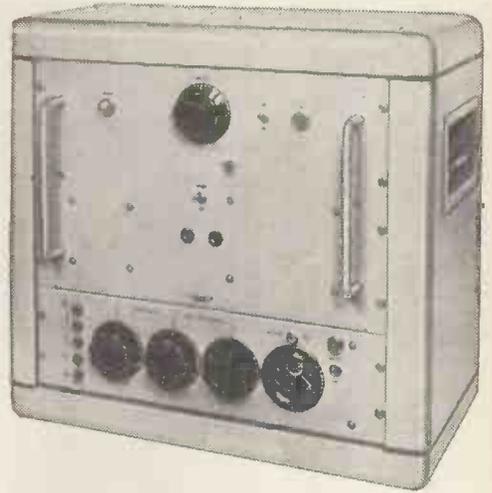
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Will deliver 120 watts continuous signal and over 200 watts peak Audio. It is completely stable with any type of load and may be used to drive motors or other devices to over 120 watts at frequencies from 20,000 down to 30 cps in standard form or other frequencies to order. The distortion is less than 0.2% and the noise level —95 dB. A floating series parallel output is provided for 100-120 V. or 200-250 V. and this cool running amplifier occupies 12½ inches of standard rack space by 11 inches deep. Weight 60lb.

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Gives 30 watts continuous signal and 50 watts peak Audio. With voice coil feedback distortion is under 0.1% and when arranged for tertiary feedback and 100 volt line it is under 0.15%. The hum and noise is better than —85 dB referred to 30 watt.

It is available in our standard steel case with Baxendale tone controls and up to 4 mixed inputs, which may be balanced line 30 ohm microphones or equalised P.U.s to choice.



ELECTRONIC MIXER/AMPLIFIER

This high fidelity 10/15 watt Ultra Linear Amplifier has a built-in mixer and Baxendale tone controls. The standard model has 4 inputs, two for balanced 30 ohm microphones, one for pick-up C.C.I.R. compensated and one for tape or radio input. Alternative or additional inputs are available to special order. A feed direct out from the mixer is standard and output impedances of 4-8-16 ohms or 100 volt line are to choice. All inputs and outputs are at the rear and it has been designed for cool continuous operation either on 19 x 7in. rack panel form or in standard ventilated steel case.

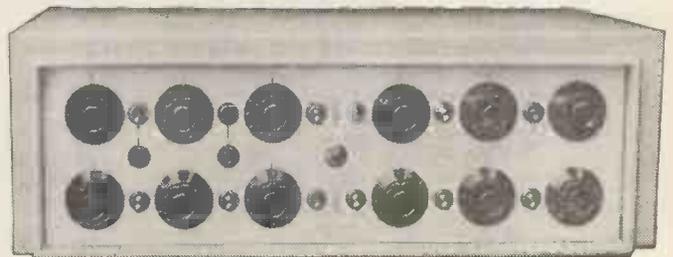
Size 18 x 7½ x 9½ in. deep.

Price of standard model £49.

The 12-way electronic mixer has facilities for mixing 12 balanced line microphones. Each of the 12 lines has its own potted mumetal shielded microphone transformer and input valve, each control is hermetically sealed. Muting switches are normally fitted on each channel and the unit is fed from its own mumetal shielded mains transformer and metal rectifier.

Also 3-way mixers and Peak Programme Meters. 4-way mixers and 2 x 5-way stereo mixers with outputs for echo chambers, etc. Details on request.

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DON'T FLUFF THE NOTES

Don't let gravel choke your Ravel. Don't let fluff fur up your Faith. Keep Britten tidy! Your records are valuable. Dust and grit are attracted to them by 'static'. If you allow impurities to settle, the stylus must grind them into the groove, damaging the sensitive sound track (and the stylus, too). This greatly reduces the life of your records (and of the stylus, too). By the time you can hear loss of quality, irreparable harm has been done. Prevent damage *before* it happens. Slip on an Acos Changer Dust Bug — and let it sweep away dirt *before* the stylus gets there.

USE AN ACOS DUST BUG

The Acos Changer Dust Bug easily clips onto practically every changer arm. Spring action automatically compensates for its weight, and no tracking adjustment is required. A durable Nylon brush cleans the groove, and a plush pad applies anti-static fluid *before* the stylus, collecting the dirt after. The Acos Dust Bug costs only 17/6 plus 6/5 P.T. It pays for itself over and over again by giving very much greater record life, and five times longer stylus life.



acos

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"BELLING-LEE" NOTES

No. 35 of a Series

Some mechanical aspects of design: Part 8

Standards of sealing are defined in terms of the maximum rate of leakage which will occur in a given time under a stated pressure differential. A typical specification, which applies to Services' Type Approved components (R.C.S. 262) requires that the leakage of gas shall not exceed 1 c.c. per hour under a pressure differential of 20lb. per square inch. Notice that this is the total leakage permissible, irrespective of the area of the seal. Thus the maximum leakage per unit area is lower on a large seal than on a small one, but this does not necessarily mean that a small seal is easier to effect, for tolerances become more critical as sizes are reduced.

In the case of hermetic seals, where the rates of leakage are very small indeed, a unit of measurement called the "lusec" is employed. This word has been coined as an abbreviation of litre, micron per second, the letter "u" sometimes being used for the Greek "m" (μ) which denotes "micro." The lusec is defined as the flow of as much gas into a vessel of 1 litre size as would produce a rate of pressure increase of 1 micron (.001 mm.) of mercury per second at 0°C. The pressure differential responsible for the leakage must be stated, of course. The lusec corresponds to a flow of approximately 5 c.c. per hour, but the leakage of quite an ordinary hermetic seal under a pressure differential of one atmosphere is better than 10^{-6} lusec, while a good seal measures less than 10^{-10} lusec, which is 1 c.c. in approximately 250,000 years!

Seals in the former category, i.e. non-hermetic, find applications in equipment which has to undergo a relatively short period of stress, e.g. equipment taken up to high altitudes (low pressure) in aircraft. The breakdown voltage of a component which measures 3 kV at sea level may fall to as little as 500 V. under the reduced pressure at 68,000ft., which could be disastrous. Also, since the performance of such seals is considerably higher as regards resistance to passage of moisture (owing to the larger size of the water molecules) they form an effective barrier to ingress by capillary action and by "breathing" which occurs in unsealed equipment as the external pressure rises and falls or as the internal pressure varies due to thermal changes.

Such seals are usually demountable, which means that they are assembled on the job, although they may contain built-in elements. Thus, a typical sealed panel fuseholder, such as L.1382, employs a seal at the panel which is assembled in mounting, but the body contact which is moulded in, is permanently sealed in the process. Incidentally, this requires a special technique because the adhesion of a phenolic moulding material to a metal insert cannot be guaranteed to be gas tight. Demountable seals of this type, in which mechanical pressures are relatively low, employ a resilient sealing medium, such as rubber, situated in an accurately dimensioned cavity. In the case of the fuseholder, L.1382, there is an annular groove of rectangular section in the rear face of the front flange, in which a sealing ring is placed. This ring, in the free state, stands proud of the groove, and makes contact with the panel over a circle. As the fuseholder is tightened on the panel, the ring is mainly distorted, since rubber has only a limited degree of compression, and the area of contact is thereby increased considerably. The sealing ring may be of square or circular cross section, but the latter is generally found to be more effective.

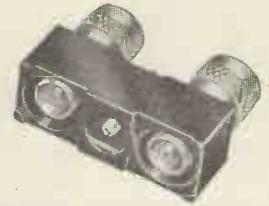
Hermetic seals, which are employed where long-term stability is required, e.g. in valves, transistors and other components where the internal environment must be maintained, and impurities excluded, are formed by fusion, or chemical bonding. Hermetic sealing between metals may be achieved by soldering, brazing, welding, etc., and in the case of glass-metal seals, which are used extensively when electrical insulation is required, an oxide layer of carefully controlled thickness is formed on the metal surface and the glass is melted and bonds to it.

The testing of seals to ensure their literal compliance with specification is a tedious business, even in the case of the lower requirements of demountable seals; it is obviously impracticable as a production routine. While it may not be permissible to accelerate the tests by increasing the pressure differential without risk of breaking down the seal, perhaps resulting in permanent damage, the time scale may legitimately be shortened if a smaller quantity of gas than 1 c.c. can be accurately measured.

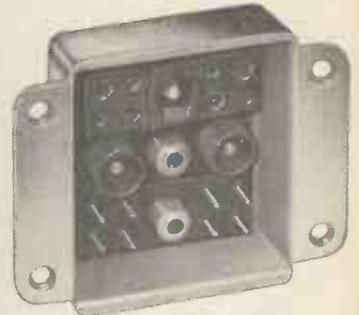
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"Belling-Lee"



Miniature Unitors



ACTUAL SIZE

Economy of space—reduction in weight—even greater versatility—these are the three major advantages of "Belling-Lee" Miniature Unitors over the standard pattern from which they were developed. All this has been achieved without any loss of performance. For example, the 12-pole Miniature Unitor effects a saving in space of over 70%, and a reduction in weight of nearly 50%, yet has the same working voltage (400V. peak) and current rating (5 amp), except that all poles are rated equally. One 8-pole type, however, includes four rated at 10 amp. All units have a common face area and are therefore physically interchangeable. Die-cast mounting shrouds are available for one, two or three units.

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STROWGER HOUSE, 8 ARUNDEL STREET, LONDON, W.C.2. TELEPHONE: TEMPLE BAR 9262

NEW TELEVISION VIDEO OUTPUT BEAM TETRODE

MAZDA 6F28

The 6F28 is a screened high slope frame grid beam tetrode for use in television video output stages. High peak current is available, enabling adequate video drive to be provided for the cathode ray tube with anode loads down to 4700 ohms; this low value of load eases the problem of HF video compensation.

This type has identical characteristics to the tetrode in the 30FL12 triode-tetrode combination.

Heater Voltage (volts)	V_h	6.3
Heater Current (amps)	I_h	0.3

TENTATIVE RATINGS AND DATA

Maximum Design Centre Ratings

Anode Dissipation (watts)	P_a (max)	2.5
Screen Grid Dissipation (watts)	P_{g2} (max)	1.3
Anode Voltage (volts)	V_a (max)	250
Screen Grid Voltage (volts)	V_{g2} (max)	250
Heater to Cathode Voltage (volts rms)	V_{h-k} (max) rms	150*

*Measured with respect to the higher potential heater pin.

Inter-Electrode Capacitances†(pF)

Input	C_{in}	8
Output	C_{out}	2.5
Control Grid to Anode	C_{g1-a}	0.03

†Measured in fully shielded socket without can.

CHARACTERISTICS

Anode Voltage (volts)	V_a	180
Screen Grid Voltage (volts)	V_{g2}	180
Anode Current (mA)	I_a	10
Mutual Conductance (mA/V)	g_m	12.5

TYPICAL OPERATION AS VIDEO AMPLIFIER

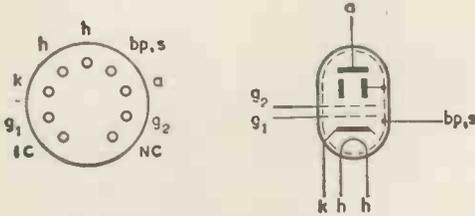
Allowance must be made in circuit design, not only for component variation, but also for valve spread and deterioration during life. Values of peak anode current, for an average valve when new and at the assumed end of life point for any valve, are as follows:—

	V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a (mA)
Average New Valve	70	180	-1	40
Assumed End of Life Condition..	60	180	-1	25

Mounting Position: Unrestricted

Base: B9A (Noval)

Connections

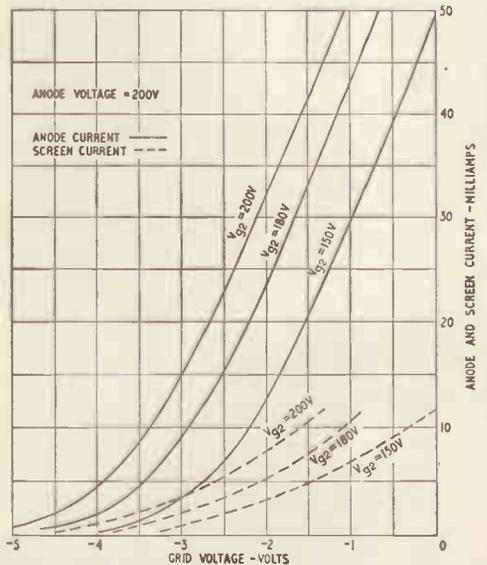
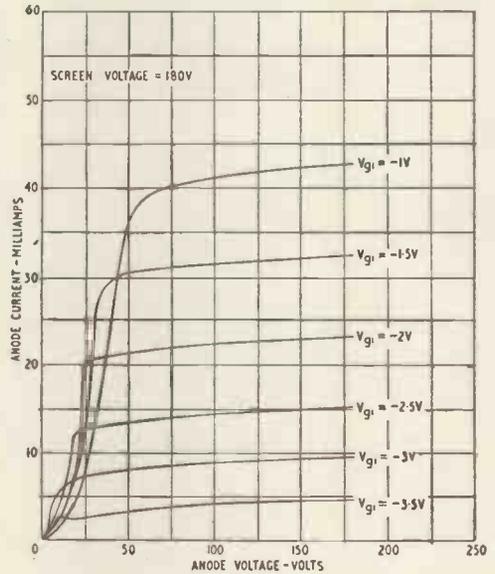


MAXIMUM DIMENSIONS (mm)

Overall Length	56
Seated Height	49
Diameter	22.2



Tentative Characteristic Curves of Mazda Valve type 6F28



Thorn-AEI Radio Valves & Tubes Ltd.

155 Charing Cross Road, London, W.C.2
Telephone: GERrard 9797

MAZDA

NEW TRIODE TETRODE FOR SYNC SEPARATOR CIRCUITS

MAZDA 30FL13

The 30FL13 consists of a high slope tetrode with frame grid construction and a general purpose triode for use in television sync separator circuits. The short grid base and high slope of the tetrode enable good pulse limiting to be obtained with the anode load resistance directly connected to the HT line and a fairly high screen voltage.

The triode has identical characteristics to the 6/30L2.

Heater current (amps)	I_h	0.3
Heater voltage (volts)	V_h	10.0

TENTATIVE RATINGS AND DATA

Maximum Design Centre Ratings

		Triode	Tetrode
Anode Dissipation (watts) ..	$P_{a(max)}$	1.5	1.5
Screen Grid Dissipation (watts)	$P_{g2(max)}$	—	0.5
Anode Voltage (volts) ..	$V_{a(max)}$	250	250
Screen Grid Voltage (volts) ..	$V_{g2(max)}$	—	250
Heater to Cathode Voltage (volts rms) ..	$V_{h-k(max)rms}$	150*	150*

*Measured with respect to the higher potential heater pin.

Inter-Electrode Capacitances†(pF)

		Triode	Tetrode
Input	C_{in}	2.3	10
Output	C_{out}	2.0	2.6
Control Grid to Anode ..	C_{g-a}	2.4	0.04
Grid Triode to Grid 1 Tetrode	C_{gt-g1}	—	0.003
Anode Triode to Anode Tetrode	C_{at-aq}	—	0.012
Grid Triode to Anode Tetrode	C_{gt-aq}	—	0.004
Anode Triode to Grid 1 Tetrode	C_{at-g1}	—	0.008

†Measured in fully shielded socket without can.

TETRODE CHARACTERISTICS

Supply Voltage (volts) ..	V_b	200
Anode Load Resistance ($k\Omega$) ..	R_a	4.7
Screen Grid Voltage (volts) ..	V_{g2}	80
Control Grid Voltage (volts) ..	V_{g1}	-0.6
Anode Current (mA) ..	I_a	4
		0.1

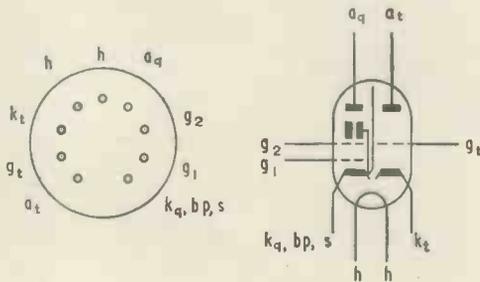
TRIODE CHARACTERISTICS

Anode Voltage (volts) ..	V_a	150
Anode Current (mA) ..	I_a	10
Mutual Conductance (mA/V) ..	g_m	3.7
Amplification Factor ..	μ	18

Mounting position: Unrestricted.

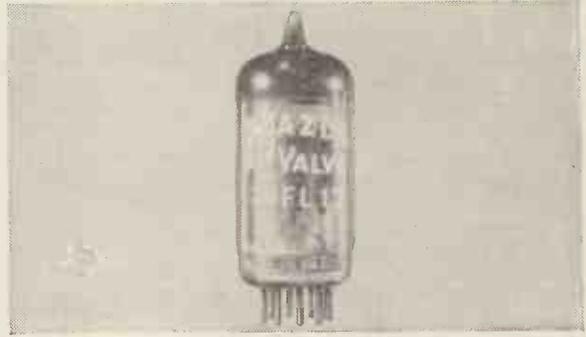
Base: B9A (Noval).

Connections :

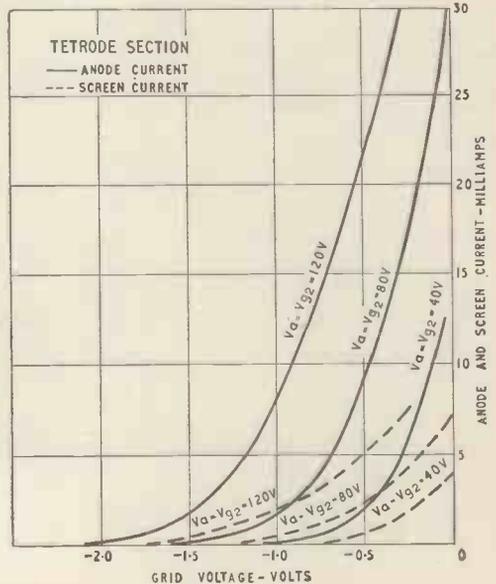
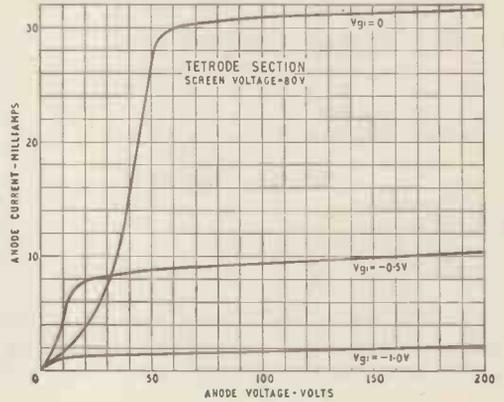


Maximum Dimensions (mm)

Overall Length	56
Seated Height	49
Diameter	22.2



Tentative Characteristic Curves of Mazda Valve Type 30FL13



MAZDA COMMERCIAL DIVISION
Thorn-AEI Radio Valves & Tubes Ltd.

155 Charing Cross Road, London W.C.2
 Telephone: GERrard 9797.

MAZDA

Wherever performance counts

the trend is towards 50cm radar for
airways surveillance and
terminal area control

50 CM

Ensures longer range for given transmitter power.

Penetrates thick weather without loss of efficiency.

Crystal controlled MTI for elimination of permanent clutter.

Provides instant readiness after prolonged shut down.

GIVES THE LONG, CLEAR VIEW

MARCONI

*Complete Civil, Military and Naval Radar Systems
Surveyed, Planned, Installed, Maintained*

RADAR DIVISION. MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED
CHELMSFORD, ESSEX, ENGLAND



MARCONI 50cm RADAR

has been chosen for

London Airport
Johannesburg
Gatwick
Dunedin (N.Z.)
Geneva
Oberpfaffenhofen
Boscombe Down
Bitteswell
Hong Kong
Manchester
Brussels
Warton
Calcutta
Hatfield
Istres
St. Annes
Birmingham
Rome
Jersey
Bretigny
Wellington (N.Z.)
Ostend
Copenhagen
Ohakea (N.Z.)
and the Royal research establishments at:—
Farnborough
Bedford and
Pershore

Plessey

**Aerial
Exchange
feeds
80 receivers
from one
aerial**

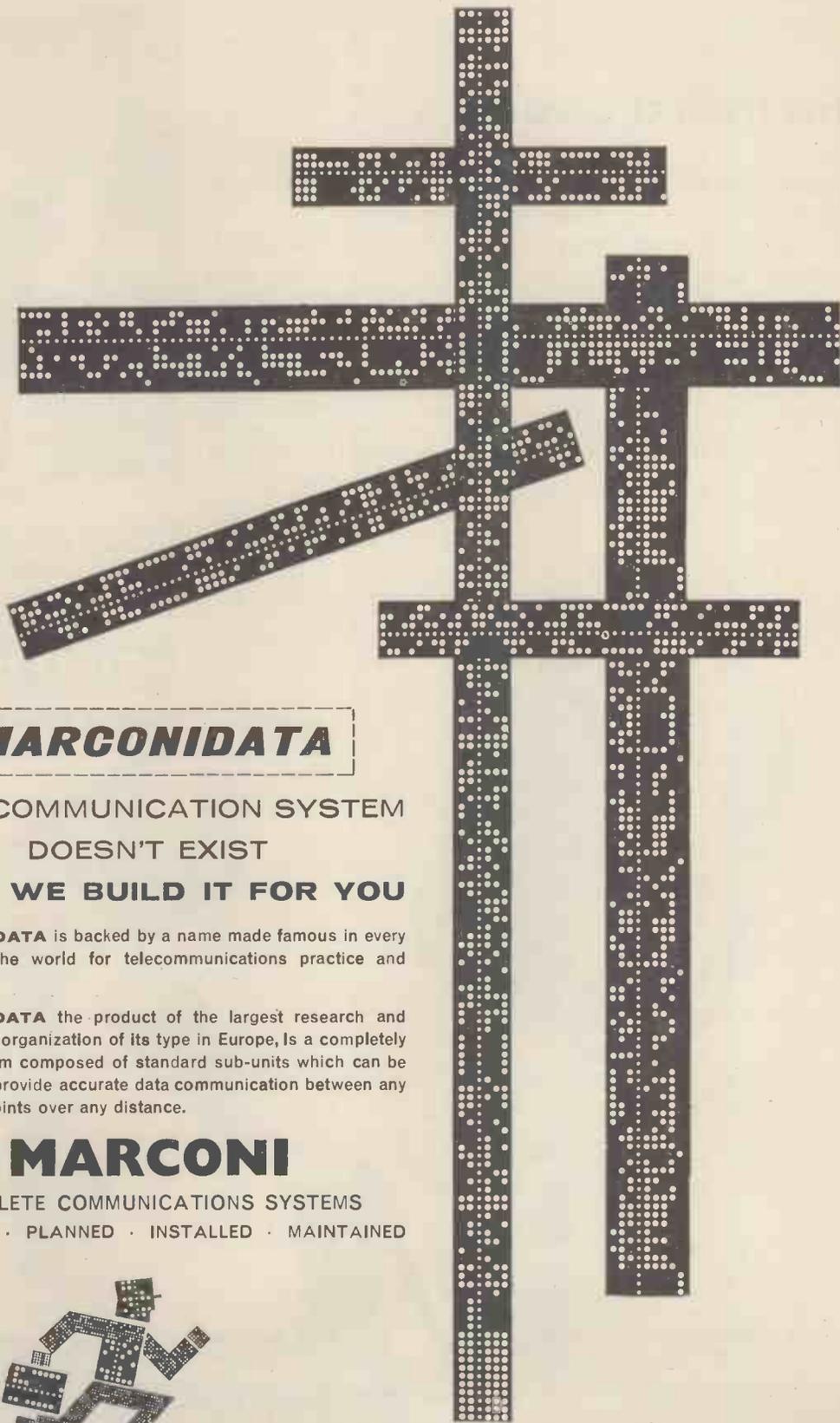


- 2 Mc/s to 30 Mc/s overall coverage; uses four basic units.
- Optional additional units link any receiver to any of several arrays.
- Standard unit range speeds maintenance, simplifies installation.
- Complete system gives ultimate capacity of 80 receivers working to 12 aerial arrays.
- Electronic switching minimises noise, heightens long-term reliability.
- Zero overall insertion loss; high-gain, low-noise wideband amplification.
- Easily arranged for dual-diversity working.

Comprehensive details of this flexible range of equipment are available on request.

Plessey

Telecommunications Division • Electronic and Equipment Group
THE PLESSEY COMPANY LIMITED • Ilford • Essex • Tel: Ilford 3040
Overseas Sales Organisation: Plessey International Limited



A

MARCONIDATA

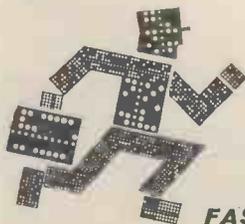
DATA COMMUNICATION SYSTEM
 DOESN'T EXIST
 UNTIL WE BUILD IT FOR YOU

MARCONIDATA is backed by a name made famous in every country of the world for telecommunications practice and technique.

MARCONIDATA the product of the largest research and development organization of its type in Europe, is a completely flexible system composed of standard sub-units which can be arranged to provide accurate data communication between any number of points over any distance.

MARCONI

COMPLETE COMMUNICATIONS SYSTEMS
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FAST ACCURATE DATA COMMUNICATION SYSTEMS

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX, ENGLAND

the truest sound

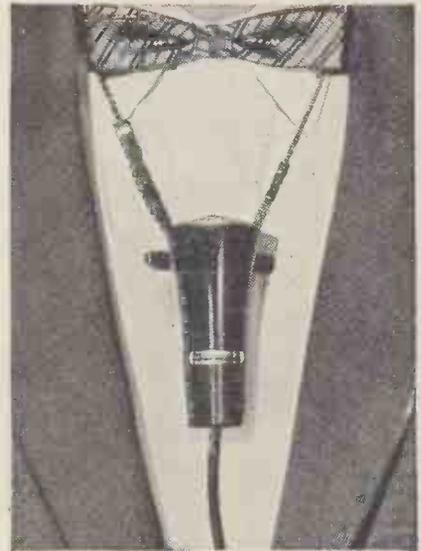
For sound reproduction as it should be—as close as possible to the original—make Shure microphones your unvarying choice. They are the finest for every purpose, years ahead of others in the technical excellence of their design and performance, the most comprehensive range obtainable anywhere.

Model 545 'Unidyne III' for public address, tape recording, communications and similar applications requiring compactness with maximum operating efficiency.

Model 420 'Commando' can be used indoors or outdoors, for all general-purpose applications. Quality performance at moderate cost.

Model 540S 'Sonodyne II' This versatile new microphone features *variable frequency response*, allowing the user to tailor the microphone to the application.

Model 55SW 'Unidyne' The most widely used microphone in the world, specified by leading sound engineers and requested by celebrities.



Model 420 'Commando'

The new Shure microphone catalogue is available on application to the address below

SHURE ELECTRONICS LIMITED
84 Blackfriars Road · London SE1
Telephone: WATerloo 6361

SHURE

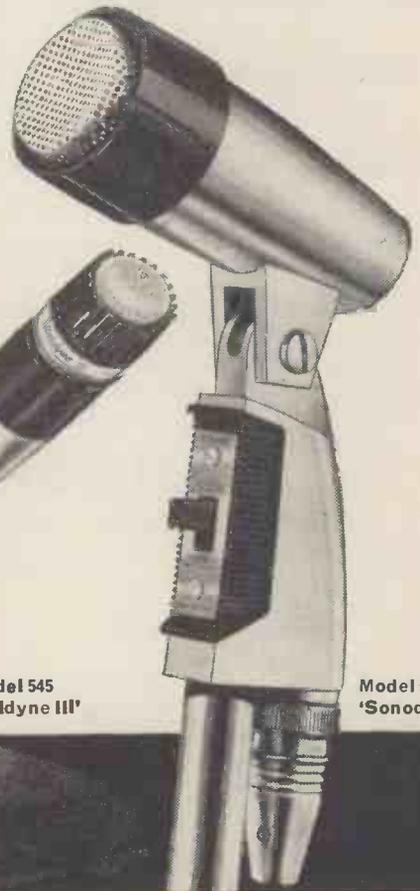
Setting the world's standard in sound



Model 55SW
'Unidyne'



Model 545
'Unidyne III'



Model 540S
'Sonodyne II'

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BRITAIN'S MOST COMPREHENSIVE PRACTICAL COURSE in RADIO · ELECTRONICS · TELEVISION!

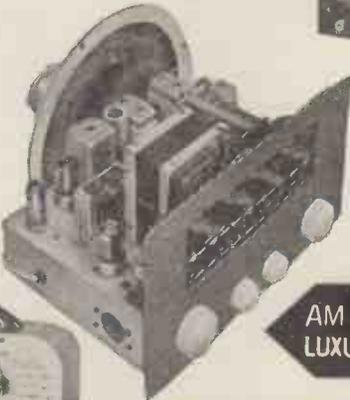
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Multi-Range TEST METER



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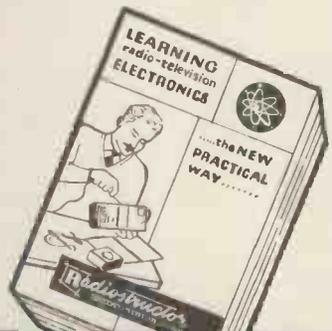


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(We do not employ Representatives.)

TRANSMITTING VALVES



The tables below give data relating to some of the Transmitting Valves manufactured by the English Electric Valve Company. The full list of these valves, complete specifications and characteristics can be obtained on application to the Company.

'ENGLISH ELECTRIC'

E.E.V. Type	Equivalent Types	Service Type	Filament		Frequency Mc/s §	Anode voltage max. (kV)	Anode dissipation max. (kW)	Type of cooling
			Voltage (V)	Current (A)				
5867	5867, TY3-250	CV1350	5.0	14.0	100/150	3.0	0.25	Natural to 30 Mc/s
833A	TY4-350, 833A	CV635	10.0	10.0	30	3.0	0.3	Natural
‡ 5762	TY6-5000A, ACT30	CV2383	12.6	29.0	30/220	4.0	0.4	Forced air
BR 161	—	CV2322	9.0	175.0	30/50	6.2	3.0	Forced air
BR 189	—	CV5218	9.0	240.0	5/50	12.0	15.0	Forced air
BR 1122	—	—	6.0	115.0	5/110	15.0	27.0	Forced air
BW 161	—	—	9.0	175.0	30/50	12.0	10.0	Forced air
BW 189	—	—	9.0	240.0	5/50	12.0	30.0	Water
BY 189	—	—	9.0	240.0	5/50	15.0	35.0	Water
						15.0	35.0	Vapour
CR 192	6166	—	5.0	175.0	30/220	6.0	10.0	Forced air
6181	6181, CR1101	—	120.0	1.6	900	2.0	2.0	Forced air

‡ Previously BR 191 B

§ The lower value indicates the operating frequency at full rating. Operation at the higher value is possible with suitable derating.

ENGLISH ELECTRIC VALVE COMPANY LIMITED

AGENTS THROUGHOUT THE WORLD

Chelmsford, England. Telephone: Chelmsford 3491

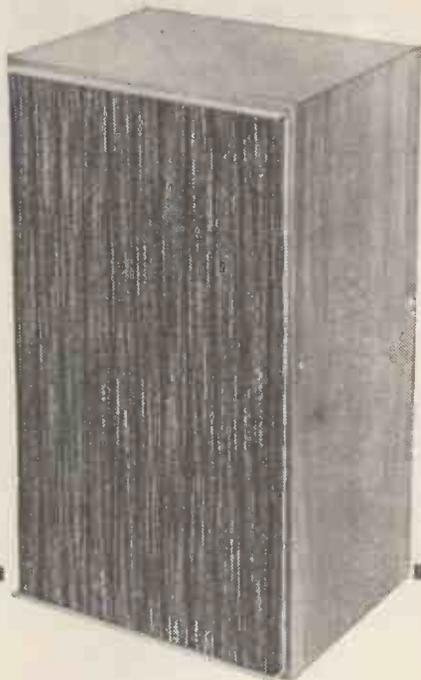
AN ASTONISHINGLY IMPROVED LOUDSPEAKER SYSTEM

invented by **LEAK**
the first name in High Fidelity

Leak speakers won the day

"This occasion proved a most stringent test as we were listening to a stereo recording of a very recent orchestral and operatic performance we had enjoyed either as audience or performer. By way of experiment other pairs of speakers were switched in, but the very smooth response of the Leak speakers won the day."

Quoted from the Test Report by Ralph West, B.Sc., M.Brit.I.R.E. The full report appeared in "Hi-Fi News," August, 1961.



Selecting the equipment

"Suggestions? The Leak line comes highly recommended on two continents, the pre-amp isn't cursed with superfluous knobs, and it looks good. The mono amp would thus be the TL/12 Plus and the stereo version would be the Point One Stereo 20 Amplifier. Both run about 10-12 watts per speaker, and frankly I think this is plenty. Even with that you can rattle the windows, and the reason is that this 10W is at minimum distortion, 10W sine wave power (which means that it'll put out a lot more on peaks). The price* of the Leak is also quite reasonable for uncompromised sound quality."

Quoted from the article "Frankly Speaking," by John Berridge, "Hi-Fi News," August, 1961.



The new LEAK "SANDWICH" LOUDSPEAKER SYSTEM is the product of many years of research and development work

The cabinet is of unique construction which damps panel resonances and permits the loudspeaker motor to reproduce full clean bass without the "bozy" coloration of conventional cabinets. A 3in. and a 13in. moving-coil loudspeaker motor of novel design and a half-section cross-over network complete the system which gives the highest quality of reproduction over the whole frequency range of the input signal from records, radio, tape or microphone. THE GREATEST ADVANCE IN THE DESIGN OF MOVING-COIL LOUDSPEAKERS SINCE RICE-KELLOGG INVENTED THE FIRST UNIT IN 1925 HAS NOW BEEN MADE BY LEAK WITH A NEW INVENTION WHICH ELIMINATES BREAK-UP DISTORTION IN THE WORKING RANGE. The 13in. unit employs a new cone whose stiffness to weight ratio is 200 times better than the best cones which are currently available. The low stiffness of conventional cones results in the flexing of the cone at large amplitudes and break-up resonances. The new LEAK cone, which has immense stiffness for no greater weight than a conventional cone, has, for the first time, given us a loudspeaker which behaves as the theoretical ideal of a rigid piston; thus there is no flexing of the cone at large amplitudes and there is no break-up distortion within the frequency range handled by the loudspeaker. It is this freedom from coloration, produced in conventional systems by break-up distortion of the cone and cabinet resonances, which distinguishes the superior quality of reproduction of the LEAK "SANDWICH" LOUDSPEAKER SYSTEM from that of the best currently available loudspeaker systems. The cabinet measures only 26in. x 15in. x 12in.; it can be used in the vertical or horizontal position to suit the convenience of the user.

Price £39 : 18s.

**The price of Leak studio quality Hi-Fi Equipment is as low as it is because we are kept fully and efficiently employed by the world-wide demand.*

See your LEAK dealer or POST THE COUPON now for full details of this superb new EQUIPMENT.

Please tick your requirements below:

- New Loudspeaker System.
- Hi-Fi Equipment.

Name

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WW/12/61

H. J. LEAK & CO. LTD · BRUNEL ROAD · WESTWAY FACTORY ESTATE
LONDON, W.3

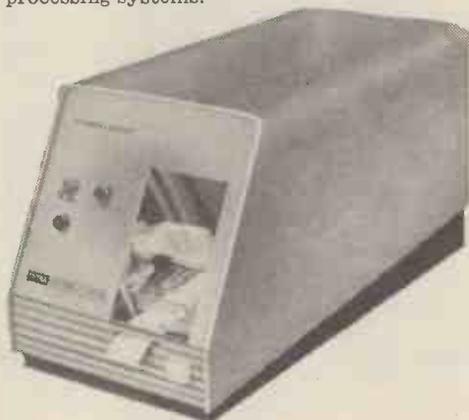
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Telegrams: SINUSOIDAL, EALUX LONDON.

Data Processing Equipment by **ULTRA** . . . 7

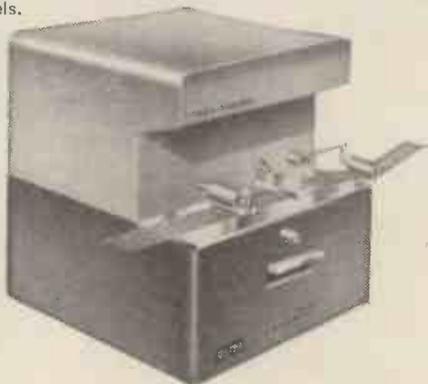
PUNCH AND READER

Our range of Automatic Business Equipment has now been increased by the addition of a paper tape encoder punch and a paper tape reader. These units provide an economic method of encoding and reading when used with other equipment in the Ultra range, or with existing data processing systems.



ENCODER PUNCH

A simple 5-hole paper tape punch with built-in coding facilities. Any desired code can be accommodated on the printed-circuit matrix, which is pre-wired to suit individual requirements. Operates at a maximum speed of 10 characters per second, using standard 1,000 ft. reels.



PAPER TAPE READER

A versatile photoelectric paper tape reader operating at a maximum speed of 150 characters per second. Standard-width 5, 6, 7 or 8 hole tape of varying thickness and colour can be accommodated. Simple loading and unloading of continuous tape loops.



Please write for further information

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WESTERN AVENUE · LONDON W.3 · TEL: ACORN 3434

A stylized advertisement for Radiospares. It features a large, tilted banner with the text "All good 'Labs' use Radiospares quality components for design development and prototype work". Below the banner is a cartoon character holding a sign that says "Service Engineers!". The Radiospares logo, a stylized 'RS' with a figure, is also present.

Remember- Radiospares components are delivered absolutely "by return"

AT LAST, FOR ONLY £1.3.0

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A really efficient Fan for use in Electronic Equipment



This is what the Electronics world has been waiting for! At extremely low cost air-stirring and extraction can be easily achieved. Also in production we have Low-Speed Motors from 8 r.p.m. to 40 r.p.m. Price £2.8.9 per unit inc. P.P.

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SUB-MINIATURE COMPONENTS

1. Ferrite aerial with Long and Medium Wave Coils, 4 1/2 in. long, for pocket superhet, complete with circuit showing component values, etc., 7/6.
2. Ferrite aerial, as above, but 1/2 in. diameter, 8 in. long, for table model receiver or portable, 10/6.
3. Three I.F. Transformers with oscillator coil and circuit details to work with item 1. 15/6.

TRANSFILTERS
Save alignment problems and improve performance. Use instead of I.F. transformer. Complete with circuit 8/6 each

4. Three I.F. Coils and oscillator to work with item 2. 23/6.
5. Smallest possible electrolytics. 1MFD, 2MFD, 4MFD, 6MFD, 8MFD, 10MFD, 20MFD, 30MFD, 50MFD, 100MFD, 200MFD, all 1/8 each.
6. Smallest 1/2 watt resistors, all 10 per cent. values. 5d. each.
7. Miniature condensers. .1, 1/-; .05, .04, .02, .01, all 5d. values below this 7d.
8. Miniature slide switch double pole change over, 2/6.
9. Edgewise volume controls, 2K, 5K, 10K and 20K, 2/6 each.
10. Small edgewise controls, with switch, 2K, 5K, 10K and 20K, 4/9 each.
11. Red Spot Transistors, tested and suitable all A.F. applications, 2/6.
12. White Spot Transistors, tested and suitable as I.F. or mixer, 3/6.
13. Set of Six Mullard transistors for superhet Mullards in original packets, fully guaranteed, comprising OC44, OC45, OC81D and matched pair OC81. 22 the set.
14. Special 500 sub-miniature diodes, 1/- each.

Watch for our POCKET COMPANION

15. Surface Barrier transistors, 5-10 Mc/s, 6/8 each; 10-15 Mc/s, 8/- each; 20-30 Mc/s, 9/- each; 40-50 Mc/s, 15/- each.
16. Push-Pull Driver and Push-Pull output transformers for pocket superhets, 150 mW. 10/- pair; 400 mW. 15/- pair; 750 mW. (driver only, no output needed), 8/6. all complete with circuit details.
17. Smallest Tuning Condenser, size approx. 1/2 in. sq., 15pF and 65pF, with trimmers, 17/6 each.
18. Oscillator coil to suit the above, 6/-.
19. Three I.F.s 455 k/c sub-miniature to suit items 17 and 18. 18/- the set.
20. Jackson 00 2-zang tuning condensers, 208pF plus 176pM, 1/2 in. spindle tapped 6BA with trimmers, 10/6, less trimmers 9/6.
21. Tuning condensers for items 1 and 3, 9/6.
22. Tuning condensers for items 2 and 4, 10/6.
23. Printed circuit for items 1 and 3, 6/6.
24. Printed circuit for items 2 and 4, 7/6.
25. 2 1/2 in. speaker, 3 ohm, 19/6; 80 ohm, 19/6.
26. 3 in. speaker, 3 ohm, 18/6; 80 ohm, 18/6.
27. 5 in. speaker, 3 ohm, 18/6; 35 ohm Hi flux, 19/6; 35 ohm Super Hi flux, 22/6.
28. Elliptical speaker, 7 x 4, 3 ohm, 19/6; 35 ohm, 19/6.
29. Battery connectors, large, 1/- pair; miniature, 1/- pair.

THE "PIMPERNEL"

You'll hear it here . . .
You'll hear it there . . .
You'll hear our "Pimpernel" everywhere!!

FULLY ASSEMBLED £5.10.0



Our amazing pocket size transistor set uses five transistors and is an all British product. There is nothing on the market to compare with it and it is many times better than any Japanese set at similar price. It is a complete ready-to-work Radio. Uses only the best and latest components including 3in. moving coil speaker, air spaced tuning condenser, two-tone cabinet, etc.

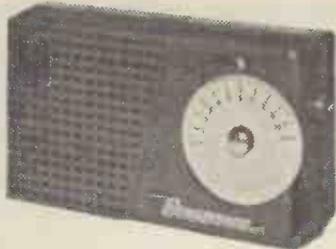
SEVEN DAYS' FREE TRIAL

Send today, you can keep the set for seven days and if you are not 100 per cent. satisfied return it and your cash will be refunded in full.

Post and Ins. 2/6.

Demonstrations at all branches.

THE POCKET "4"

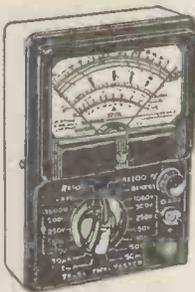


Circuit comprises 2 H.F. transistors reflexed to equal 4 stages. Permanent germanium diode and high gain A.F. output stage, fitted with miniature speaker, proper tuning condenser, volume control and in case with handles as illustrated (less monogram), completely portable. No aerial or earth required. Pocket 4 uses 3 transistors and 1 diode, price 42/6, plus 2/6 post and insurance. Pocket 5 uses 4 transistors and 1 diode and has feedback control, price 55/-, plus 2/6 post and insurance. Prices are for medium wave models, long or medium versions 8/6 extra.

GOOD RESULTS EVERYWHERE

Nothing can be more disappointing than to find that despite care in making up, your radio just will not work or needs a long high aerial and water pipe earth. We can prove good results in all areas and we guarantee all components for 12 months. Hundreds of testimonials received. Send in confidence. Plans free with parts, or separately 1/6. Demonstrations at all branches.

MULTI-METER BARGAINS!



MODEL TP55. (illus. on left). 20,000 ohms per volt, D.C. volts, 5 ranges up to 1,000. A.C. volts, 5 ranges up to 1,000, resistance, 2 ranges up to 10 meg. capacity, 2 ranges up to .1, decibels -20 to -26. One switch control, really beautifully made precision instrument, size only 3 1/2 x 5 1/2 x 1 1/2 in., price only 25/19/6. Post free.

MODEL 200H (illus. on right). 20,000 ohms per volt, 20 ranges comprising A.C. volts, 5 ranges up to 1,000 v. D.C. volts, 6 ranges up to 2.5 KV, D.C. current, 3 ranges up to 25 ohms, resistance, 2 ranges up to 6 meg. capacity 2 ranges up to .1, decibels -20 to +22. Scale corresponds to the equivalent of 4 in. movement is a pocket size instrument measuring 4 1/2 x 3 1/2 x 1 in. Complete with test leads, battery and operating instructions, price 16/19/6. Post free.



MODEL U1. A robust instrument of 1,000 ohms per volt sensitivity, A.C./D.C. volts up to 1,000, D.C. current up to 500, resistance up to 200K, size 5 1/2 x 3 1/2 x 2 1/2 in., complete with test leads, single switch control, large easily read scale, price only 22/19/6. Post free.

MODEL TE10. Similar in size and appearance to 200H except that this is 10,000 ohms per volt and maximum D.C. volts 1,200 instead of 2.5 K., also no capacity range. Price 25/19/6. Post free.

THE GOOD COMPANION

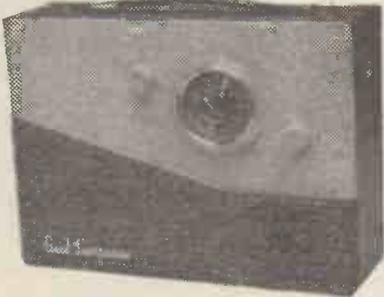
CAR RADIO AND PORTABLE

Largely due to the helpful criticisms and suggestions received from purchasers of our previous set "The Real Companion" we have improved and now supersede this with a new set which we call "The Good Companion." We feel confident that this new set is one of the finest of its kind available. The design is the combined efforts of our own technicians and of those of several of the leading manufacturers in the country, and the resulting set has a performance as good as if not superior to those selling at £20 and more. It has the eight transistor set performance.

Features include American Philco R.F. transistors and Mullard A.F. transistors—Q.P.P. output giving 750 mW.—full coverage on Medium and Long—very fine tuning arrangement—excellent reception of difficult stations like 208—variable feed-back control—full tonal qualities—really superior looking cabinet size 11 x 8 x 3 in. approximately—car aerial attachment—several months operation from battery costing only 3/6.

Circuit employs six transistors and two diodes, it incorporates all latest refinements and oscillator I.F. Transformers are pre-aligned so no instruments are necessary. Any one who can solder competently can make this set. The instructions are fully comprehensive with plenty of illustrations. Service is available in the unlikely event of your getting into difficulties. All components fully guaranteed. Price of all components and cabinet to make set as illustrated £9/19/6. Post and insurance 5/-. Battery 3/6 extra.

Mk. II using transistors instead of I.F. transformer available 10/- extra.



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post orders are dealt with from Eastbourne, so for prompt attention please post your orders to 66 Grove Road, Eastbourne, marked Department 2. Callers may use any one of the Companies below.

226 London Road, Croydon.
Phone: CRO. 6558.
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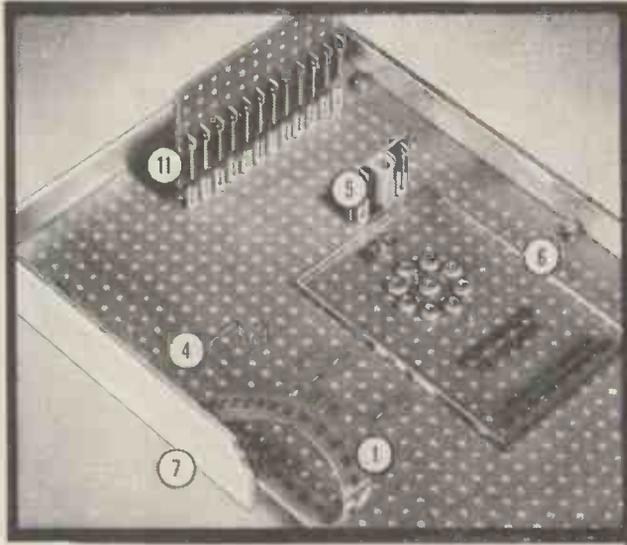
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Phone: ARCHWAY 1049.
Half-day, Thursday.

520 High Street North, Manor Park, E.12.
Phone: ILFORD 1011.
Half-day, Thursday.

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246 High St., Harlesden, N.W.10.
Phone: ELGAR 4444.
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Fast, simple, low-cost circuit assembly



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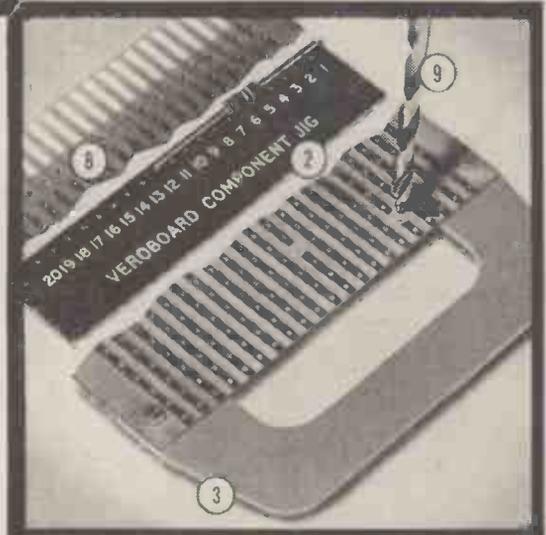
vero board

accessories

VEROBOARD is the universal wiring board that combines all merits of the printed circuit technique—*without the expense!* Simplicity, speed, cheapness, and reliability are the direct results of the VEROBOARD principle: standard pitching of standard-size holes on a resin-bonded laminate board backed by bonded copper continuity strips.

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- 3 Plastic Handles for plug-in VEROBOARD card circuits. Part Nos. VB3051 (black) and VB3052 (red)
- 4 Jumper Links of tinned copper wire for cross connections between bonded copper backing strips on VEROBOARD. Part Nos. VB3061 (0.2") and VB3062 (0.4")
- 5 Semiconductor Holders for mounting transistors, etc. with plug-in contacts on 0.2" matrix. Part No. VB2011 and VB2012
- 6 Valveholder Templates for drilling holes at correct pitch and location on VEROBOARD. Part Nos. VB3041, VB3042 and VB3043
- 7 Extruded Edging in light-alloy for strengthening VEROBOARD panels. Part No. VB3091

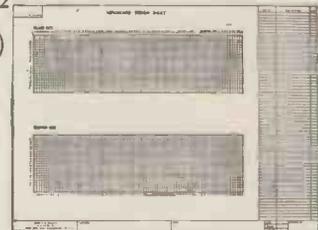


- 8 Plug-in Panels 4.8" x 5.8" VEROBOARD, gold-plated at one end for use with edge connectors. Part No. VB2001
- 9 Spotface Cutter to make a clean separation where necessary in copper backing strip. Part No. VB3011
- 10 Design Sheets on high quality tracing paper for designing circuits on VEROBOARD and for producing workshop prints. Part Nos. VB3071 (18") and VB3072 (6")
- 11 Varicon Connectors which can be used as single point contacts or in rows to form connections between VEROBOARDS. Available in strips of 20. Part No. VB3081 (in-line) and VB3082 (right-angle)

vero board

Notching Tool for Extruded Edging to enable it to be mitred for making corners and for slotting to take VEROBOARD panels. Part Nos. VB3101 Press, VB3102 Mitre die set, VB3103 Slotting die set.

VEROBOARD Kit contains supply of VEROBOARD and accessories.



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The example shown on the right is a Quarter-Track—Four-Track Stereo Head, for 1/4 in. tape.



Size: 1/2 in. x 1/2 in. x 1/2 in.

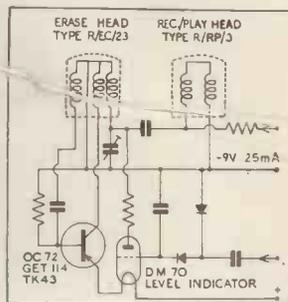
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LOW LOSS ERASE HEAD. This is a standard form of erase head that requires only a very low input power. Several would work off a single OC72 Oscillator! Patents pending.



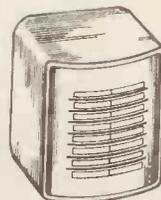
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The example shown on the right is for eight tracks on 1/2 in. tape.

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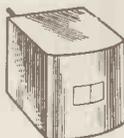


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NOTE: ALL ILLUSTRATIONS ACTUAL SIZE.

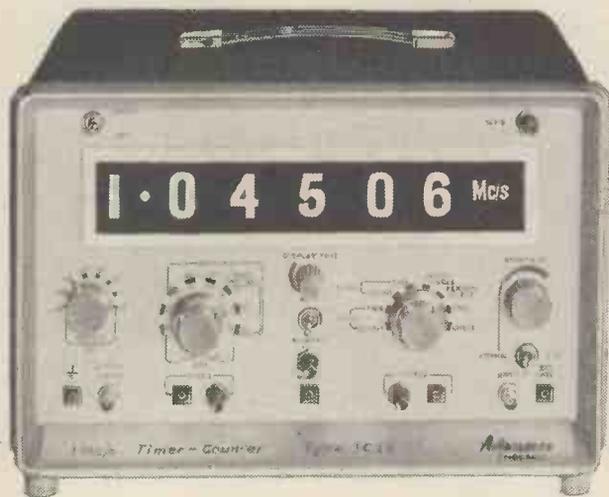
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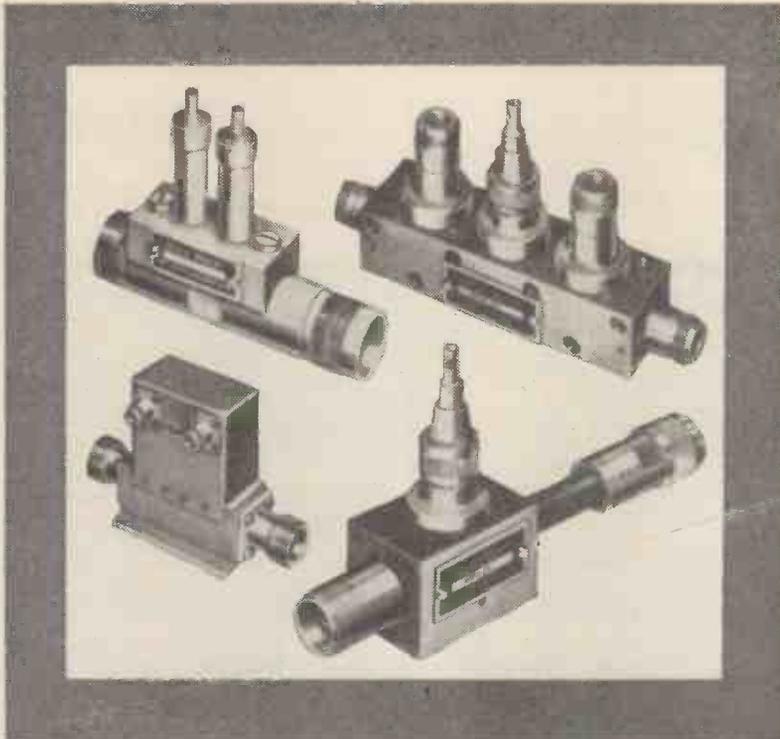
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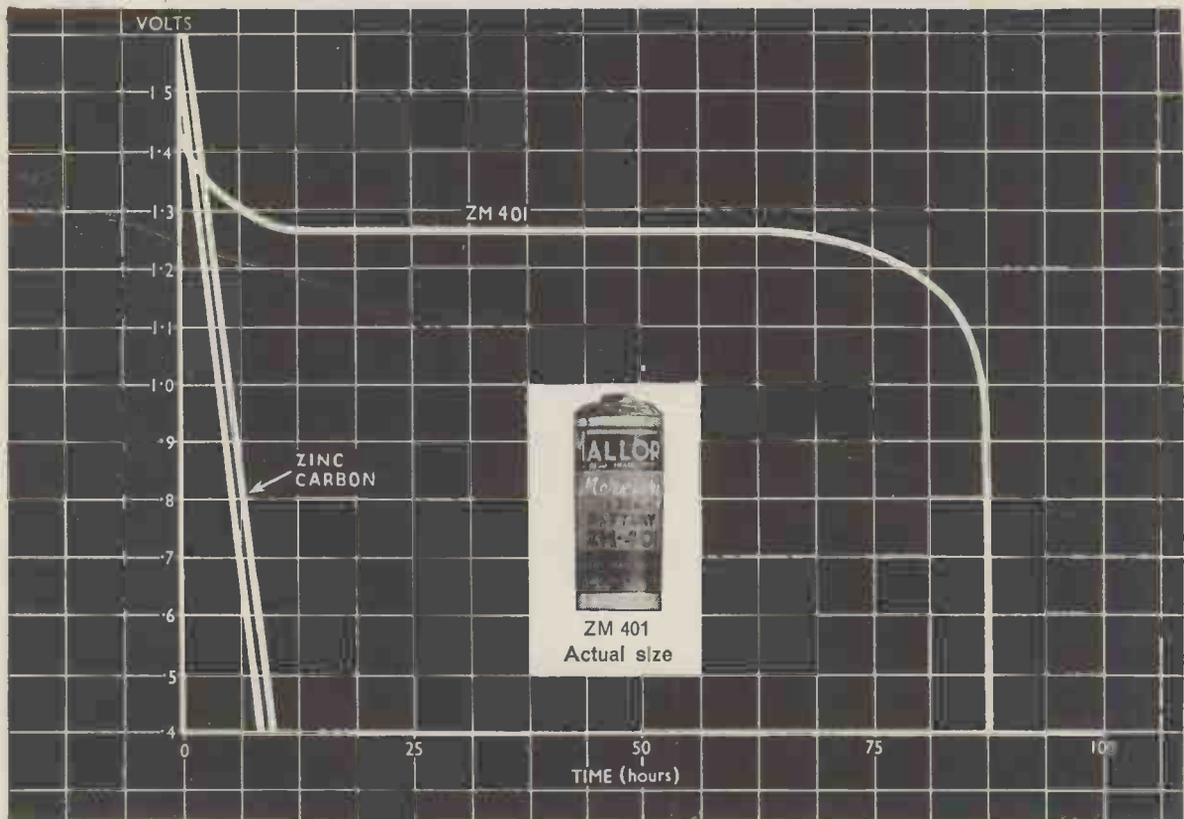
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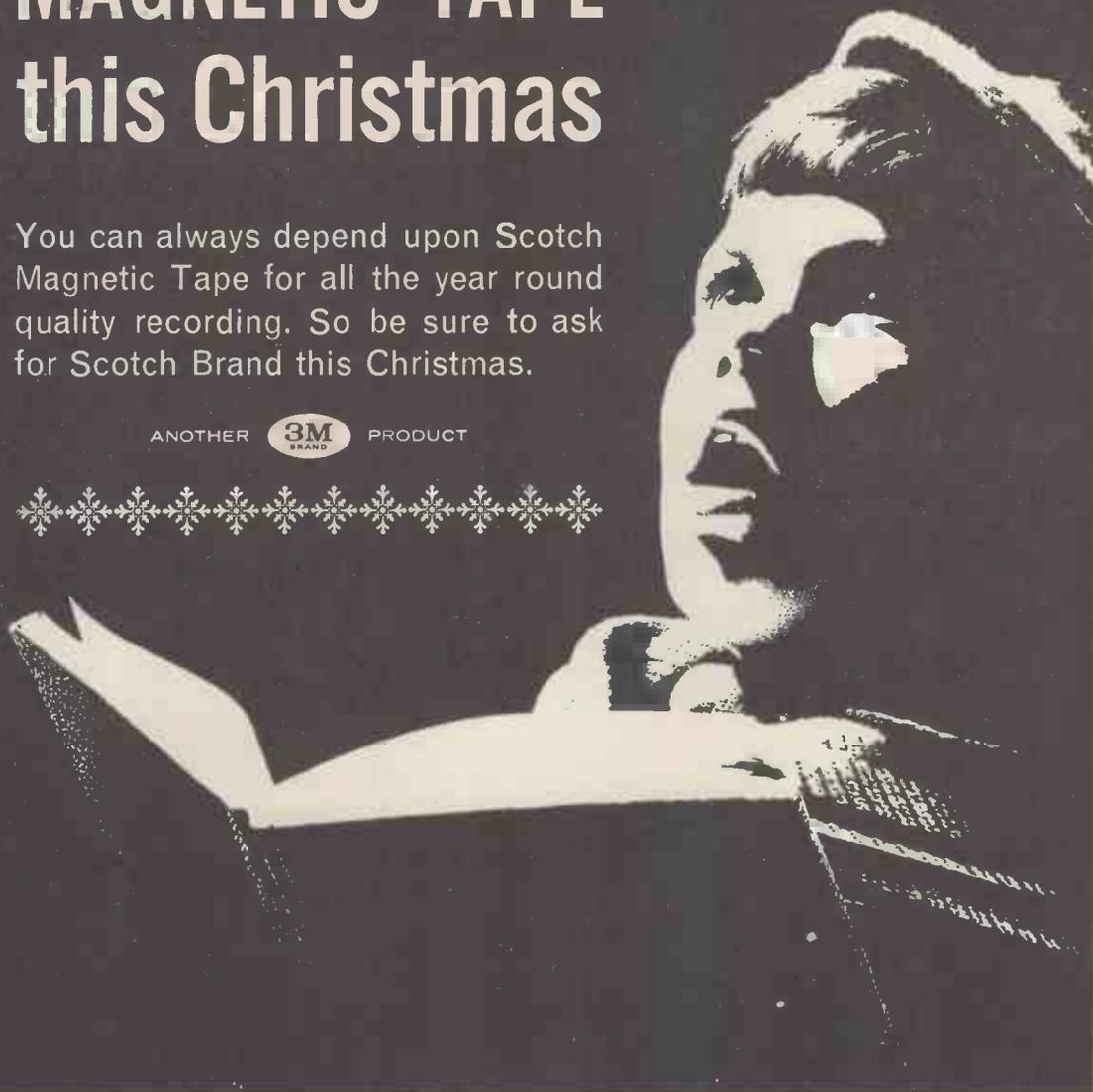
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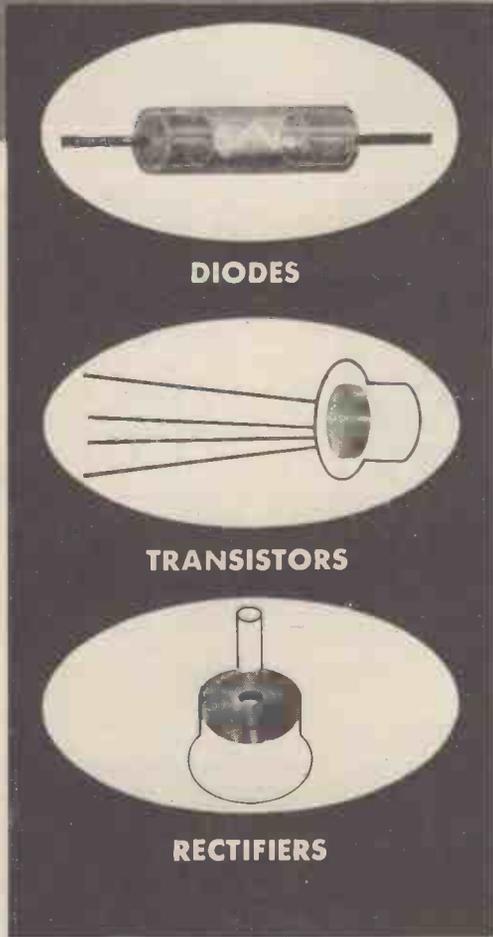
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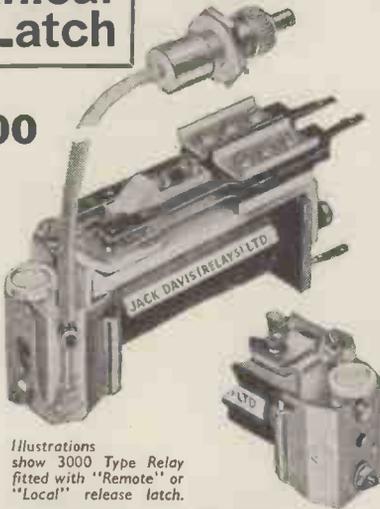
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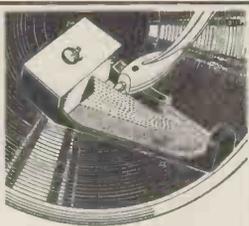
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LIKE THIS FOR £35.0.0

Deposit: £7.0.0, 12 months at £2.11.4 FOR THIS WE SUPPLY

- Complete Kit of Parts to Build the HF/TR3 Tape Amplifier.
- The New Collaro "Studio" Tape Deck.
- Portable Carrying Case (as illustrated).
- Rola/Celestion 10in. x 6in. p.m. Loudspeaker.
- ACOS Crystal Microphone and 1200ft. Spool E.M.I. Tape.

Alternatively for those who prefer another make of Tape Deck—we will supply precisely as above—but in place of the Collaro "Studio" Deck. We will include

- The New Truvox Mk. VI Deck . . . **£40 10 0**
Deposit £8/2/0, 12 months at £2/19/5.
- For Constructors with their own cabinet—WE OFFER—
- (a) COMPLETE KIT to build the HF/TR3 MARK II Amplifier together with the COLLARO "STUDIO" DECK . . . **£26. 0.0**
Deposit £5/4/-, 12 monthly payments of £1/18/2.
- (b) As above with the HF/TR3 MARK II supplied ASSEMBLED and TESTED . . . **£29.10.0**
Deposit £5/18/-, 12 monthly payments of £2/3/4.
- (c) COMPLETE KIT to build the HF/TR3 MARK II together with the TRUVOX Mk. VI TAPE DECK . . . **£31.10.0**
Deposit £8/18/2, 12 monthly payments of £2/6/2.
- (d) As above but with HF/TR3 MARK II supplied ASSEMBLED and TESTED. . . **£35. 0.0**
Deposit £7, 12 monthly payments of £2/11/4.
- (e) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENNEL MK. V TAPE DECK . . . **£42. 0.0**
Deposit £9/3/8, 12 monthly payments of £3/1/7.
- (f) As above but with HF/TR3 MARK II supplied ASSEMBLED and TESTED. . . **£45.10.0**
Deposit £9/2/-, 12 monthly payments of £3/6/9.
- (g) THE ASSEMBLED and TESTED HF/TR3 MARK II AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates Wearite Head Lift Transformer, etc. . . **£56. 0.0**
Deposit £11/4/-, 12 monthly payments of £4/2/1.
Carriage and Insurance on each above is 10/- extra.

DEPT. W. 109 FLEET ST., LONDON, E.C.4
STERN RADIO LTD.
Telephone: FLEET STREET 3812/3/4

Stereophonic Sound by Stern's

THE "STP-1" STEREO TAPE PRE-AMPLIFIER DESIGNED TO OPERATE WITH

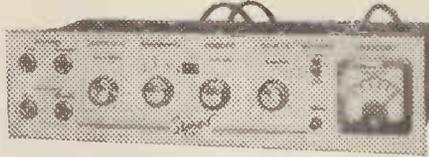
TRUVOX Mk. VI TAPE DECK, incorporating the latest 4-TRACK MINIFLUX TAPE HEADS.

BRENELL Mk. V TAPE DECK, incorporating similar 4-TRACK MINIFLUX TAPE HEADS.

COLLARO "STUDIO" TAPE DECK, incorporating the latest 4-TRACK REUTER TAPE HEADS.

BRIEF SPECIFICATION OF PRE-AMPLIFIER

- PUSH PULL OSCILLATOR CIRCUIT.
- 4-SPEED EQUALISATION.
- FERROXCUBE OSCILLATOR TRANSFORMER.
- SENSITIVE METER FOR SIGNAL LEVEL.
- SEPARATE GAIN CONTROLS IN EACH CHANNEL.
- MULLARD VALVES INCORPORATED.



OVERALL SIZE CASE 13½ x 3in.
FRONT PANEL (choice of Black or White) 14 x 3¼in.

PRICE

£26 0 0

Including separate Power Supply Unit.
Deposit £5/4-, 12 months £11/18/2.

COMBINED PRICE SCHEDULE

THE "STP-1" PRE-AMPLIFIER IS OFFERED WITH TAPE DECKS AS FOLLOWS:

TRUVOX Mk. VI 4-TRACK MODEL.....	£45 0 0
DEPOSIT £9, 12 months £3/6/-.	
BRENELL Mk. V 4-TRACK MODEL.....	£65 0 0
DEPOSIT £13, 12 months £4/15/4.	
COLLARO "STUDIO" 4-TRACK MODEL.....	£41 10 0
DEPOSIT £8/6/-, 12 months £3/0/11.	

THE MULLARD "10+10" STEREO AMPLIFIER (described below) with the "STP-1" PREAMPLIFIER and one of the TAPE DECKS provides a COMPLETE Stereophonic Installation. WE OFFER "10+10" AMPLIFIER, "STP-1" PRE-AMPLIFIER and the TRUVOX Mk. VI DECK..... **£65 0 0**

Deposit £13, 12 months £4/15/4.	
As above with BRENELL Mk. V DECK.....	£85 0 0
Deposit £17, 12 months £6/4/8.	
As above with COLLARO "STUDIO" DECK.....	£61 10 0
Deposit £12/6/-, 12 months £4/10/2.	

DESCRIPTIVE LEAFLET AVAILABLE, PLEASE SEND S.A.E.

**STEREOPHONIC RECORD PLAYER UNITS
MICROPHONES and TWIN LOUDSPEAKERS
ARE AVAILABLE FROM STOCK**

STEREO DUAL CHANNEL PRE-AMPLIFIER

This model incorporates two 2-valve Pre-Amplifiers (described above) combined into a Single Unit enabling it to be used for both STEREOPHONIC and MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 250 mv.



Price: COMPLETE **£12.10.0** Alternatively ASSEMBLED **£15.0.0**
KIT OF PARTS AND TESTED

H.P. Terms on assembled unit: £3 Deposit and 12 months of £1/2/-.

MULLARD'S "10+10" STEREO POWER AMPLIFIER

A HIGH FIDELITY DESIGN BASED ON THE FAMOUS MULLARD "5-10" PROVIDES UP TO 10 WATTS (per channel). SUPERB REPRODUCTION. FREQUENCY RESPONSE FLAT TO WITHIN 3 db from 3 c/s. to 60 Kc/s. at 50 mW. TOTAL HARMONIC DISTORTION AT 10 WATTS..... 0.1%

PRICE:
(a) ASSEMBLED COMPLETE AMPLIFIER, including CONTROL UNIT **£21.0.0**
(as illustrated)

Deposit £4/4-, 12 months of £1/10/10. **£18.10.0**

(b) A complete KIT OF PARTS for.....

This amplifier is built to the very highest technical standards and presented strictly to MULLARD'S specification. It incorporates a complete Mullard valve line-up including two of the new triode-pentodes, type ECL86, in each channel. Two specially designed GILSON OUTPUT TRANSFORMERS with 20% taps are used in class AB push-pull output stages for ultra linear operation.

The matching CONTROL UNIT is designed to be either attached to the Amplifier (as illustrated) or it can be detached for separate mounting on a Cabinet panel. It provides inputs for CRYSTAL PICK-UPS, RADIO TUNING UNIT, and TAPE REPLAY.

AS AUDIO SPECIALISTS WE CONFIDENTLY RECOMMEND THIS DESIGN IT IS A MUST to the serious-minded sound enthusiast.

We can also supply the assembled MAIN AMPLIFIER only (excludes control unit) for operation with our DUAL CHANNEL PREAMPLIFIER, this provides for a more versatile or elaborate installation and would be essential if a low output Magnetic Pick-up, such as the Decca, is to be used.

PRICE: (a) THE ASSEMBLED MAIN AMPLIFIER with the ASSEMBLED DUAL CHANNEL PREAMPLIFIER..... **£30.0.0**
Deposit £8, 12 months of £2/4/-.

(b) A complete KIT OF PARTS for both Units for..... **£26.0.0**
When ordering specify loudspeaker impedance.



STEREO 'TWIN-THREE' AMPLIFIER with specially designed PORTABLE CASE

A most compact portable design consisting of TWIN CHANNEL AMPLIFIER based on the latest design by MULLARD LTD., incorporating top grade Output Transformers, and the new audio Triode-Pentode Valves Mullard ECL86. Separate Bass and Treble controls. Suitable for use with Crystal Pick Ups and capable of genuine high quality reproduction up to 3 watts per channel. An attractive and contemporary portable Case in two tone colours. The unique feature of the design is the loudspeaker mounting. Two 8 x 5in. p.m. elliptical loudspeakers are separately baffled and mounted in the lid, which is detachable, allowing for each speaker to be individually positioned in any part of the listening area.



We offer a very versatile stereo arrangement tested and guaranteed which can be assembled in the minimum of time, at a comparatively Very Low Cost.

PRICE for the ASSEMBLED AMPLIFIER. Two 8in. x 5in. ROLA SPEAKERS and PORTABLE CASE..... **£14 0 0**
Deposit £2/16/-, 12 months of £1/0/6.

INDIVIDUAL UNITS available SEPARATELY...
ASSEMBLED AMPLIFIER supplied for..... **£7 15 0**
8in. x 5in. ROLA LOUDSPEAKERS (3 ohms), each..... **£1 1 0**
PORTABLE CASE..... **£5 0 0**

A CHOICE OF SINGLE RECORD PLAYERS and AUTOCHANGERS is available from Stock (send S.A.E. for details).

A BULK PURCHASE OF MARCONIPHONE TAPE RECORDING EQUIPMENT ENABLES US TO OFFER

THE MODEL MTR/I PORTABLE TAPE RECORDER

(FOR ONLY **£25.0.0** Carr. & Ins. 10/- extra)

Deposit £5, 12 months of £1/16/8.

The list price of the MTR/I is £45/2/-. It is a 3 Speed Twin Track Recorder incorporating the latest Collaro "Studio" Tape Deck and operates at 11, 31 and 71 in./sec. speeds. It incorporates a "Pause" Control, a safety interlock device which ensures that a recorded tape cannot be accidentally erased and a low level output socket so that the output may be fed into an external high fidelity amplifier for monitoring purposes or for high quality reproduction on playback.



WE CAN ALSO SUPPLY

The MTR/I AMPLIFIER & LOUDSPEAKER

with the

COLLARO "STUDIO" TAPE DECK

all assembled on a top board TESTED AND READY FOR USE **£19.19.0**

Deposit £4, 12 months £1/9/4.

(Carr. & Ins. 10/- extra)

STERN RADIO LTD. DEPT. W. 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

Still by far the finest value

STERN'S MULLARD DESIGNS

COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNS strictly to specification



MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2-stage pre-amplifier with which an undistorted power output of up to 10 watts is obtained. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of the latest Ultra-linear PARMEKO or the PARTRIDGE Output Transformer.

Price: COMPLETE KIT (Parmeko O/pout Trans.)..... **£10.00**

Alternatively we supply ASSEMBLED AND TESTED..... **£11.10.0**

ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.

MULLARD'S 2-VALVE PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves and designed to operate with the Mullard MAIN AMPLIFIER but also perfectly suitable for other makes.

- Supplied strictly to MULLARD SPECIFICATION and incorporating
- Equalisation for the latest E.L.A. characteristics.
- Input for Crystal Pick-ups and variable reluctance magnetic types.
- Input (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.
- Sensitive Microphone Channel.
- Wide range BASS and TREBLE Controls.

Price: COMPLETE KIT OF PARTS **£6.6.0**

ASSEMBLED AND TESTED **£8.0.0**



COMPLETE MULLARD 5-10 AMPLIFIER

The popular and very successful complete "5-10" Incorporating Control Unit providing up to 10 watts high quality reproduction.

Specified components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE Ultra Linear Output Transformers.

Price: COMPLETE KIT. Parmeko Transformer..... **£11.10.0**

Alternatively we supply ASSEMBLED AND TESTED..... **£13.10.0**

Hire Purchase (Assembled Amp. only). Deposit £2/14/-, 12 months at 19/10. ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/6 extra.



COMPLETE MULLARD 3-3

A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT... **£7.10.0**

OF PARTS..... **£7.10.0**

(Plus 6/6 carriage and insurance)

Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 6/6 carriage and insurance)..... **£8.19.6**

H.P. TERMS: Deposit £2 and 8 monthly payments of £1.

Our kit is complete to the MULLARD specification including supply of specified components, valves and PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.

COMPLETE STEREO AMPLIFIER

Meets the many requests for a low priced but good quality Stereophonic Amplifier. Output power is 4 watts. Inputs for Crystal Pick-ups and Radio Tuner.

KIT OF PARTS **£8.10.0** or ASSEMBLED **£10.10.0**

Mk. II "Fidelity" FM TUNING UNIT

An attractively presented Unit incorporating MULLARD PERMEABILITY TUNING HEART and corresponding Mullard valve line-up. Very suitable to operate with our Mullard Amplifiers.

FOR THE CONSTRUCTOR **£10.0.0** or ASSEMBLED **£14.5.0**

SPECIAL CASH ONLY OFFER !!

The very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER. ALL FOR ONLY Plus 7/6 carr. and ins.). The Amplifier consists of a 2-stage design incorporating the 3 modern BVA valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Auto-changer and is attractively finished in Grey Colour Resine—WE ALSO SUPPLY SEPARATELY:—

- (a) The 2-stage (plus Rectifier) AMPLIFIER **£4 2 6**
- (b) THE PORTABLE CARRYING CASE **£3 17 6**
- (c) 6in. P.M. SPEAKER..... **18 9**

£8.7.6



(Carriage and insurance 4/- extra).

!! A BARGAIN !!

WE ARE ABLE TO OFFER BRAND NEW AND FULLY GUARANTEED

TRUVOX Mk. VI TAPE DECKS

List Price £26.50 FOR **£18.18.0**

Deposit £3/16/- and 12 months £1/7/8. (Carr. & Ins. 7/8 extra).

A twin track model operating on 3 1/2 and 7 1/2 in/sec. Speeds and incorporating Pause Control and Rev. Counter.

THE ABOVE INCORPORATING THE LATEST 4-TRACK MINIFLUX HEADS FOR STEREO OPERATION IS

AVAILABLE FOR **£21.10.0** (Carr. and Ins. 7/6 extra).

Deposit £4/6/-, 12 months of £1/11/7.

"COMBINED ORDER" PRICE REDUCTIONS

- (a) THE COMPLETE KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-stage Pre-Amplifier Control Unit..... **£15.15.0**
- (b) The "5-10" and the 2-Stage Pre-Amplifier both Assembled and Tested..... **£18.18.0**

H.P. TERMS: Deposit £3/16/- and 12 months of £1/7/8.

RECORD PLAYERS

Many at REDUCED PRICES !!! Send 8 A.E. for ILLUSTRATED LEAFLET

- THE COLLARO "JUNIOR" 4-speed single player with separate crystal pick-up..... **£3.15.0**
- THE NEW GARRARD "AUTORLM" 4-speed Auto-changer with Crystal Pick-Up..... **£8.10.0**
- THE NEW COLLARO "C90" 4-speed auto-changer unit with Studio "O" pick-up..... **£7.19.6**
- THE NEW COLLARO Model RP594 4-speed Single Record Player Studio Cartridge..... **£9.18.6**
- THE E.M.L. 4-speed Single Record Player, incorporating a high output crystal pick-up..... **£6.9.6**
- B.S.R. MODEL UA14, a 4-speed Mixer Auto-changer with crystal pick-up..... **£7.10.0**
- Available incorporating the B.S.R. STEREO Pick-up, plays L.P. and 78 records..... **£8.13.10**
- GARRARD RC210 4-speed Autochanger fitted with latest crystal pick-up..... **£10.10.0**
- The latest GARRARD TRANSCRIPTION MOTOR "301"..... **£22.7.3**
- The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 pick-up arm and G.C.S. crystal Cartridge..... **£19.8.7**
- GARRARD Model 7A/ML II Single Record Player fitted with high output crystal Pick-up, detachable head..... **£8.10.0**

HIRE PURCHASE TERMS available on all units £8/10/6 and over. Carriage and insurance on each above 5/- extra.

MULLARD FOUR CHANNEL MIXING UNIT

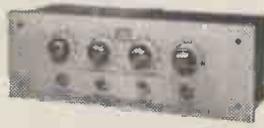
Self powered Cathode follower output. Incorporates two inputs for CRYSTAL MICROPHONES, one for CRYSTAL PICK-UPS and a fourth for Radio or Tape.

KIT OF PARTS **£8.8.0**

ASSEMBLED AND TESTED **£10.0.0**

Terms: Deposit £2 and 12 months at 15/-, Model LL

one microphone input matched for moving coil or ribbon mike £1/17/- extra.



STEREO "3-3" MAIN AMPLIFIER

Comprise two MULLARD 3-3 Main Amplifiers on one chassis. Operates with above MULLARD STEREO PRE-AMPLIFIER. Output power 6 watts. Inputs for Crystal Pick-up and Radio Tuner **£10.0.0** or ASSEMBLED **£11.15.0**

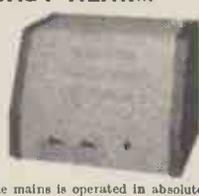
STERN'S INTER-COMM or BABY ALARM

A small versatile Unit employing the new MULLARD ECL86 valve and designed to provide two (or three) way conversation up to extreme distances. Operates from A.C. mains 200 to 250 volts and as in all our designs only new high-grade and guaranteed components are incorporated. PRICES—MASTER UNIT and ONE EXTENSION

KIT OF PARTS **£6.17.6** ASSEMBLED AND TESTED **£8.0.0**

The equipment consists of a MASTER UNIT, size only 8 1/2 in. x 5 1/2 in. x 6 in. and ONE EXTENSION (a second extension may be added at any time).

The Master Unit incorporates switching and power supply and with the chassis completely isolated from the mains is operated in absolute safety. Attractively presented in cases covered in quality leatherette.



!! HOME CONSTRUCTORS !!

A RANGE OF "EASY TO ASSEMBLE" PREFABRICATED CABINETS Designed by the W.B. "STENTORIAN" COMPANY for "Hi-Fi" Loudspeaker systems or to accommodate high quality equipment. The acoustically designed Bass Reflex Cabinets containing the very successful "Stentorian" speakers give really first class reproduction and are well recommended. Models are also available to accommodate high-quality Amplifiers, Pre-amplifiers, Tuning Units, Record Players, etc. All models are very easily assembled, in fact only a screwdriver is required. Fully illustrated leaflets are available, including complete specifications of the various STENTORIAN LOUDSPEAKERS. Please send 8 A.E.

"Hi-Fi" LOUDSPEAKERS WE HAVE IN STOCK A COMPLETE RANGE BY

GOODMANS' WHARFEDALE—W.B. ILLUSTRATED AND PRICED LEAFLETS ON REQUEST

SPECIAL OFFER OF TAPE

- 900ft. on 5 in. — **18/6**
- P.V.C. base on latest type 1,200ft. on 5 1/2 in. — **21/-**
- Plastic Spools, New, boxed 225ft. on 3 in. — **5/9**
- and guaranteed. 1,200ft. on 7 in. — **21/-**
- 1,800ft. on 7 in. — **32/6**

H.P. TERMS ARE AVAILABLE ON ALL ASSEMBLED EQUIPMENT OVER £9

STERN RADIO LTD. DEPT. W. 109 FLEET ST., LONDON, E.C.4

Telephone: FLEET STREET 5812/3/4

TESTMETERS FOR EVERY POCKET AND PURPOSE



1,000 OHMS PER VOLT
MODEL U.1. Reads A.C. and D.C. volts up to 1,000; D.C. current to 500 mA; Resistance to 200 K. Basic movement 300 μ A. Easily read open scale. Size $5\frac{1}{2} \times 3\frac{1}{4} \times 2\frac{1}{4}$ in.

£2/19/6



2,000 OHMS PER VOLT
MODEL TP-10. Reads A.C. and D.C. volts up to 1,000; D.C. current to 500 mA. Resistance to 1 Meg.; Capacitance to 1 μ F; Decibels from -20 to +36; Output jack for Audio measurements. Size $3\frac{1}{4} \times 5 \times 1\frac{1}{2}$ in.

£3/19/6



20,000 OHMS PER VOLT
MODEL TP-5S. Reads voltages up to 1,000, D.C. at 20,000 ohms per volt and A.C. at 10,000 o.p.v.; D.C. current to 500 mA; Resistance to 10 Megs; Capacitance to 0.1 μ F; Decibels from -20 to +36. Size $3\frac{1}{4} \times 5\frac{1}{2} \times 1\frac{1}{2}$ in.

£5/19/6



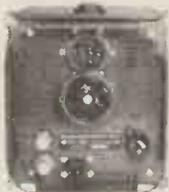
30,000 OHMS PER VOLT
MODEL 500. Reads voltages up to 1,000, D.C. at 30,000 ohms per volt, and A.C. at 15,000 o.p.v.; D.C. current to 12 amps; Resistance to 60 Megs; Decibels from -20 to +56; Incorporates internal buzzer for audible warning of direct shorts and blocking condenser for AF Output measurements. Size $3 \frac{1}{8} \times 6 \frac{1}{8} \times 2\frac{1}{2}$ in.

£8/19/6

All instruments supplied with test leads and prods, instructions, and internal batteries, and are fully guaranteed. Further details sent on request.

CRYSTAL CALIBRATOR No. 10

A superb Crystal Controlled Wavemeter. Has directly calibrated dial for nominal coverage of 1.5-10.0 Mc/s, but may actually be used from 500 kc/s up to 30 Mc/s. Complete with 500 kc/s. Crystal, 2 valves type 1T4, 1 of 1R5 and 1 of CV286 (Neon Stabiliser), and Instruction Book. Size 7in. x 7in. x 4in., weight 5 lbs. Used but in first-class condition. **ONLY £2/19/6.** Carr. 3/6.



W 1101A WAVEMETER. Crystal controlled heterodyne frequency meter covering 100 kc/s. to 20 Mc/s. in 8 switched bands and is virtually the British BC221. Power requirements 2 v. L.T. and 40-60 volts H.T. Complete with Calibration Book, Crystal, Operating Valves and full set of spares. Used but in perfect order. **ONLY £5** (carriage 15/-).

PANEL METERS

F.S.D.	SIZE AND TYPE	PRICE
25 microamps	D.C. 2 1/2in. Proj. circular	59/6
50 microamps	D.C. 2 1/2in. Flush circular	59/6
50 microamps	D.C. 3 1/2in. Flush circular	80/-
200 milliamps	D.C. 2 1/2in. Flush circular	12/6
20 amps	D.C. 2in. Proj. circular	7/6
40 amps	D.C. 2in. Proj. circular	7/6
300 volts	A.C. 2 1/2in. Flush circular	25/-
500 volts	A.C. 2 1/2in. Flush circular	25/-

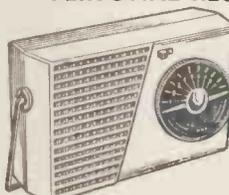
PCR COMMUNICATIONS RECEIVERS

Manufactured by Pye & Philips. One of the Army's most versatile and sensitive sets. RF Stage and 2 of I.F., using 6 British I.O. valves. Large 180 Degrees Illuminated and Calibrated Dial. Flywheel Tuning with locking device, Aerial Trimmer, Tone and Volume controls, Band Switch, front panel jacks for speaker or phones. In black metal case. Size 17in. L. x 8in. H. x 10in. D. Model PCR covers 6-18 Mc/s., 200-550 metres and 850-2,600 metres, and has internal 5in. speaker. REME reconditioned AS New **£6/19/6.** Model PCR 2 has similar Long and Medium Waveband coverage. Short wave 6-18 Mc/s., but no speaker. Used, but excellent condition **£5.** Every receiver aerial tested before despatch. Add 10/6 carriage all models. Designed to operate from bulky EXTERNAL power supply, but any set can be fitted with BRAND NEW COMPONENTS INTERNAL PACK for 200/250 v. A.C. at an extra cost of **£2.**

BC 221 FREQUENCY METERS

Coverage 125 kc/s to 20 Mc/s. and known the world over as a first class standard. Complete with original calibration book, crystal, valves, and instruction book. Used, but in very good condition. **ONLY £16.** Illustrated descriptive leaflet available on request.

"P.W." 6 TRANSISTOR PERSONAL RECEIVER



Designed by the technical staff of Practical Wireless, easy to build, using printed circuit, and 1st Grade Matched Transistors and Diode. Full Medium and Long Wave coverage to internal speaker. All parts sold separately (new components only) enabling you to buy as required, and full detailed price list will be sent on request. Constructional details 1/8. **TOTAL COST INCLUDING BATTERY AND CABINET, £8/19/6.**

AMPLIFIER N24. As previously advertised. 4 valves, rack mounting, with internal A.C. mains pack for nominal 110/230 volts. Output to 600 ohms line, provision for 600 ohms or High Impedance Input. A first-class job. **ONLY 89/6** (carr. 10/6).

BC 342 RECEIVERS. A few only of these famous American sets covering 1.15-18.0 Mc/s., in six bands. Internal 115 v. A.C. Mains pack. A super receiver in first-class condition and perfect working order. **ONLY £20** (carriage 15/-).

UNISELECTOR. 25 way 8 bank 15 ohm coil for 24 volt operation, unused, ex-brand new equipment, only **62/6.**

SPRAGUE CONDENSERS. Metal cased wire ends. New, .01 mfd. 1,000 v. and .1 mfd., 500 v. 7/6 per dozen. Special quotes for quantities.

"GOOD COMPANION" 6 TRANSISTOR COMBINED PORTABLE AND CAR RADIO

The finest Transistor Portable ever designed for the constructor.

- ★ 750 mW Output.
- ★ 6 Transistors plus 2 Diodes.
- ★ Covers 540-1,640 Kc/s (180-550 metres) and 160-285 Kc/s (1,050-1,880 metres).
- ★ Latest printed circuit technique.
- ★ Pre-aligned I.F.T.s.
- ★ Very fine tuning with calibrated dial.
- ★ Internal high gain aerial with car aerial socket.
- ★ Brilliantly styled 2 colour cabinet size 11in. x 8in. x 3in.

Technical knowledge is not required to build this set, the easy-to-follow illustrated data which can be purchased for 3/6 making construction simplicity itself.

TOTAL COST INCLUDING CABINET AND DATA (Battery 3/6 extra.)

All parts sold separately, detailed list on request.

£9.19.6



Cash with order please, and print name and address clearly
 PLEASE ADD POSTAGE OR CARRIAGE COSTS ON ALL ITEMS

HARRIS ELECTRONICS (LONDON) LTD.

Radio Corner, 138 Gray's Inn Road, London, W.C.1. Phone: TERMINUS 7937

Open until 1 p.m. Saturdays.

We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross.



PREMIER RADIO

23 Tottenham Court Rd., London. W.1. Tel: MUSEum 3451/2

AND AT 309 EDGWARE ROAD, W.1. TELEPHONE PADDINGTON 6963

THE PREMIER TR/2 TAPE RECORDER



PRICE including Microphone, Tape and Spare Spool. Plus 15/- P. & P.

19 Gns.

Once again Premier is first with another magnificent offer. Introducing the "TR/2" the latest and cheapest addition to our range of popular Recorders.

Star features:

- ★ Latest BSR Tape Deck with interlocking device to prevent accidental erasure.
- ★ Single speed 3 1/2 in. per sec.
- ★ Playing time 8 1/2 in. std. tape—1 1/2 hours. L.P. tape—2 hrs. 8 mins.
- ★ Volume on/off and tone control.
- ★ Power output 3 watts.
- ★ Input sockets for Microphone, Radio/Gram.
- ★ Extension speaker socket.

Size: 13 1/2 x 9 1/2 x 6 1/2 in., weight 17 lb.

The SUPER 60

6-Transistor Battery Receiver

MAY BE BUILT FOR **£9.15.0** Plus 6/- P. & P.

Ever Ready PP10 Battery Extra 11/-

- ★ STAR FEATURES:
- ★ Six 1st grade Mullard Transistors and one Diode.
 - ★ Internal Ferrite Rod Aerial.
 - ★ 7 1/2 in. x 4 in. Elliptical Speaker.
 - ★ Printed Circuit.
 - ★ 500 mW Push-pull Output.
 - ★ Full medium and long waveband coverage.
 - ★ Calibrated Direct Drive Dial Drive Assembly



- ★ Full point-to-point instructions supplied.
- ★ Dimensions 18 in. x 7 1/2 in. x 5 1/2 in.

The Receiver is housed in an attractive contemporary mahogany finished cabinet trimmed with gilt, supported by gilt stands. The Receiver will operate for months on one 9-volt long-life battery. Instruction Book separately at 2/6 p.p.

4-TRANSISTOR PORTABLE RADIO

MAY BE BUILT FOR **95/-**

Plus 3/- P. & P.

PP7 Battery Extra 3/6



A 4-transistor and 1 diode Portable Receiver ideally suited for the young enthusiast, having full medium waveband coverage and internal Ferrite Rod Aerial, it incorporates a pre-tagged circuit chassis ensuring ease of construction, a Hi-Flux 5in. Speaker is used and the receiver is housed in an attractive two-tone rexine covered Cabinet with carrying handle.

sis ensuring ease of construction, a Hi-Flux 5in. Speaker is used and the receiver is housed in an attractive two-tone rexine covered Cabinet with carrying handle.

SAVE £££'s

BY BUILDING YOUR OWN

TAPE RECORDER



CABINET **£3.15.0**

AMPLIFIER KIT..... **£8.19.6**

SPEAKER 7 x 4..... **16.6**

If above items are purchased together **£12.19.6** P. & P. 10/-



A complete Tape Amplifier Kit, with complete 17 assembled main chassis and power supply, using 3 modern miniature valves, metal rectifier and tuning indicator, 3 watts undistorted output from the EL84 Output Valve, volume on/off and

tone control. This Amplifier was designed for use with the Collaro Studio Tape Deck and has built-in speed compensation switch, ready to couple to the Tape Deck.

The above Cabinet is supplied ready cut-out to mount the above Amplifier, Speaker and Collaro Tape Deck and is finished in two-tone blue Rexine with gilt Speaker escutcheon and fittings.

Collaro 3-speed Studio Tape Deck, **£10.19.6** plus P. & P. 10/-

4-SPEED PORTABLE SINGLE RECORD PLAYER

MAY BE BUILT FOR

9 GNS.

Plus 6/6 P. & P.



Consisting of:

- The new EMI 985 4-speed single Player **£4 9 6**
 - 2 valve Printed Circuit Gram. Amplifier **£2 15 0**
 - 8in. x 2 1/2in. Elliptical Speaker **£1 1 0**
 - Portable Case—finished rexine covered red and white polka dot **£1 1 0**
- All items available separately if required.

Introducing THE TELEFUNKEN STEREO HI-FI AMPLIFIER

FOR ONLY **£7.19.6**

Original Price 16gns. P. & P. 6/-

- Power Output 5 Watts total (2 1/2 watts per channel).
- Frequency Response 30 c/s to 40 Kc/s 2dB. 45 c/s to 30 Kc/s 1dB.
- Sensitivity sufficient for all normal inputs from Tape Recorders, Pick-ups, Microphones, Radios.
- Power Requirements 110, 125, 150, 220, 240 volts A.C.
- Piano key selecting.
- Preselected tone control.
- Size 12in. wide x 9in. deep x 2in. high.
- Finish: Hammered enamel in grey/green with gold trimmings. Controls and press buttons in cream.

Why not convert your battery portable to mains operation with the COSSOR HU2 BATTERY EXAMINATOR? This Eliminator is completely assembled and supplied with 4ft. of Mains Lead and Torpedo Type of On/Off Switch. It is housed in 2 Metal Containers approximately the same size as the AD35 and B126 Batteries, and suitable for receivers using DK96 range valves for use on 200-250V A.C. mains. Size: L.T. Unit 3in. x 2 1/2in. x 1 1/2in. H.T. Unit 4in. x 2 1/2in. x 2in. Original price 3 gns. OUR PRICE **39/6** (plus 2/- P. & P.) for a limited period only

THE 'MID-FI'

A NEW DESIGN 4 1/2

WATT AMPLIFIER

KIT 95/- Plus 5/-

p.p.

BUILT **£6** POST PAID

A new circuit for the home constructor requiring a good quality medium-powered Amplifier for reproduction of Records or F.M. Broadcasts. Technical Specifications: separate bass and treble controls. Valve line-up EP86, EL84, EZ80. Voltage adjustment for A.C. mains from 200/250 volt 3 or 15 ohms impedance. Negative feedback Size 7 x 5 x 2 1/2 in., overall height 6in. Silver-hammered finished Chassis.



WHY NOT DO IT YOURSELF!

SUPERHET may be built for **£7.7.0** Plus 5/- P. & P.

T.R.F. may be built for **£5.10.0** Plus 5/- P. & P.

These two receivers use the latest type circuitry and are fitted into attractive cabinets 12 x 6 1/2 x 5 1/2 in. in either walnut or Ivory Bakelite or wood 1/- extra. Individual instruction books 1/- each, post free.



THE VERDIK QUALITY TEN AMPLIFIER & PRE-AMPLIFIER



A truly High Fidelity Ultra-linear Amplifier with a push-pull output of 10 watts and incorporating negative feedback. Provision for tuner, also bass and treble control and 5-position selector switch

for Microphone, Radio Tape and L.P. and Standard Recordings. Finished in an attractive grey/green stove enamel. FOR A LIMITED PERIOD ONLY **£14.19.6** Original cost 23 gns. P. & P. 7/6

30 Watt PORTABLE SOLDERING IRON. Complete with Vinyl Bag, lead and plug. 18/9. plus 1/3 P. & P.

WHY NOT VISIT OUR HI-FI AND DEMONSTRATION SHOWROOMS.

THE NEW MODEL E.P.-10K POCKET

MULTI-METER
10,000 O.P.V. ON
A.C. & D.C.



Out-performs instruments many times its size and price.

PRICE **£5.19.6** Plus 2/6 P. & P.

FULL SCALE RANGES
DC Volts: 0-5, 0-30, 0-120; 0-600; 0-1200.
AC Volts: 0-5, 0-30, 0-120; 0-600; 0-1200.
DC Current: 0-120µA; 0-12M, 0-300M.
Resistance: 0-20K; 0-3 meg.
Decibels: -20 to +63 in five scales.
Capacity: 50µF to .01µF and .001µF to .15µF.
Output Ranges: 0-5; 0-30; 0-120; 0-600; 0-1200.
Large 5 1/2 in. Meter Face, unique slide range selector switch, can be carried conveniently in the pocket, also featuring an unusually sensitive 10K ohm per volt AC/DC Meter, 1% precision resistance, and largest Meter ever placed on an instrument of this size. Complete with Test Leads and Battery, size 4 1/2 x 3 1/2 x 1 in.

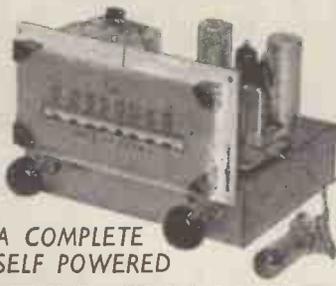


THE 'CLARION'
Transistorised miniature battery-operated
TAPE RECORDER

16 1/2 gns.

- ★ Completely transistorised circuit.
 - ★ Constant governed speed of 3 1/2 I.P.S.
 - ★ Recordings interchangeable with other recorders.
 - ★ Remarkable reproduction on both speech and music.
- Price includes Microphone and Tape. Batteries 3/4 extra. P. & P. 6/-.

BARGAIN OFFER!



A COMPLETE SELF POWERED

FM TUNER

MAY BE BUILT FOR ONLY **£4.19.6** PLUS 5/- P. & P.

This tuner has been designed to the highest possible modern standards with all the features found only in the more expensive Units and yet still within a price range that all can afford. No extras required.

STAR FEATURES

- ★ Self powered
 - ★ Permeability Tuning
 - ★ Philips FM Tuning Unit
 - ★ Absolutely no drift
 - ★ Frequency coverage: 88-100 mc/s.
 - ★ Two IF Stages and Discriminator
 - ★ OA 81 balanced diode output
 - ★ Valve lineup: ECC85, 2-EF80, EZ80 Rectifier, EM84 Magic Eye.
- Attractive full vision maroon and gold Glass Dial size 7 in. x 3 in., overall dimensions of Tuner 8 x 7 1/2 x 5 1/2 in.

THE 'MAGNAPHON'

PRICE **29**
GNS.
Plus 2/- P.P.



A truly top quality and versatile Tape Recorder at a price well below the original cost.

Incorporating the latest Collaro 3-speed Studio Tape Deck

STAR FEATURES

- ★ Volume and Tone Control for recordings.
- ★ Volume and separate Bass and Treble Controls for replay.
- ★ Facilities for monitoring.
- ★ Output 4 watts.
- ★ Separate Output Sockets for Amplifier and Extension Speaker.
- ★ Mixing Facilities.
- ★ Housed in attractive red and beige two-tone Cabinet with detachable lid.
- ★ Fully guaranteed and supplied complete with microphone 5 1/2 in. reel of tape and spare spool.

THE LEECO 6 TRANSISTOR POCKET RECEIVER COMPLETE WITH EARPIECE AND PLASTIC CASE

Ideally suited for pocket or handbag, only 4 1/2 x 2 1/2 x 1 1/2 in. in size and 7 oz. in weight, it has full medium wave coverage and incorporates 6 high grade transistors and 1 diode in a superb circuit. Available in black, grey, green or cream.

£8.19.6

P. & p. 2/-
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PREMIER RADIO

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Abacs — Abbreviations — Addresses of Radio Organizations — Aerial Sharing Circuits — Aerials — Amateur Transmission — Attenuators — B.A. Screws and Drill Sizes — Binary Code — Circuit Diagrams — Coil Winding Data — Component Coding — Conversion Table — Decibel Equivalents — Electrical and Magnetic Units — Frequency Allocations — Greek Alphabet — Interference Suppression — Licence Regulations — M.K.S. and C.G.S. Units — Mathematical Signs — Modulation Classification — Morse Code — Radar Bands — Resistance of Metals — Resistor and Capacitor Markings — Resistor Ratings — Standard Frequencies — Symbols, Graphical and Letter — Television Stations (U.K.) — Television Standards — Time Constants — Unit Abbreviations — V.H.F. Broadcasting — Valve Base Connections — Waveband Classification — Weights and Measures — Wire Tables — Wood Screws — Transistor Types & Connections.

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6 VALVES. Frequency coverage on three bands:—850-2000M. 190-550M. 6-18Mc/s.
Super slow motion drive. Aerial trimmer. Volume and tone controls. Output for 3 ohm speaker or phones.

Available as follows:—
AS NEW WITH BUILT-IN SPEAKER, £7/19/6.
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Carriage 10/- extra on all models.

All above models can be supplied with a built-in power unit for operation on 200/250 volt A.C. at an additional cost of 39/6 or alternatively the original plug-in A.C. mains power units are available at 35/- extra.



CONTROL BOX with 0.1 ma. meter (flush mounting 2½ in. scale), 5 microswitches, 2 toggle switches, 2 wafer switches, 2 Leach relays, condensers, etc., in a neat box 10×7×3 inches. New in cartons. 30/- 2/6 post.

CONVERTORS. 12 or 24 volts D.C. input, 117 volts A.C., 60 cycles, 75, 100 125, 150 or 175 watts output. Mounted in a strong metal case with shock absorbers, 2 vibrators, smoothed, silent operation. New 26/10/- Carr. 7/6.

AERIALS. Complete dipole sets for the B44 receiver, suitable for FM, television, etc. Simple and very easy to assemble, can be strapped to a pole in a few minutes, etc. Four sets of aerial rods that push into ready-made sockets. No. 1 set 30 inches (each rod). No. 2 33 inches. No. 3 37½ inches. And No. 4 42 inches. All rods ¼ in. dia. Ideal aerial for mobile use. Complete 27/6. Carr. 2/6.

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TELEPHONE SETS. 3 desk telephones, 3 G.P.O. magneto generators, 3 bulls-eye indicators, 75ft. twin lead covered cable and terminal blocks, etc. For use Nos. 2 and 3 C.B. and auto systems or DEL's, P.B.X. £12/10/- Carr. £1.

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TANNOY power microphones No. 1A. 8/6 each, 2/- post.

MOTOR ASSEMBLY. Servo unit, C-1-11 A G1020. 26 volts D.C. Auto. pilot. New in cartons. Price 23/10/- each. Carriage 7/6. C-1 Auto. pilot fibro gyro. unit. Price 23/10/- each. Carriage 5/-.

VARIABLE FEEDSTOCKS, 3 ohms 10 amps., 18/6 each. Post 3/-.

TRANSFORMER (drop thro' type). 110 and 230 volts pri., 275-0-275 at 125 ma., 0.35 v. at 0.9 amps., 6.4 v. at 4 amps. Size 4×4×4½ in., 22/6 each. Post 3/-.

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ROXAY CONVERTERS, Type 8A. 24 v. D.C. input, 115 v. A.C. at 1.8 amps, 400 cycles, 3-phase, 26/10/- each, carr. 7/6. Other types in stock.

NEW LIST AVAILABLE SEND 6d. IN STAMPS.

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EDISWAN MAZDA TRANSISTORS

- Unrepeatable. Brand New. Guaranteed.
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- XA 123. R.F. mixer 7/6
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FAMOUS AMERICAN RECORDING TAPES.

First grade quality. Fitted with leader tapes and stop foil.

- 5in.std. play 600ft..... 13/-
 - 5in.long play 900ft..... 16/6
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 - 5½in.double play1800ft..... 37/-
 - 7in.std. play1200ft..... 21/-
 - 7in.long play1800ft..... 28/6
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Send for full list of tape bargains.

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1.5 to 10 mc/s. Can actually be used from 500 kc/s. to 30 mc/s. Few only available. Brand new with instruction manual, 72/6 each. Postage 3/6.

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1,000 ohms per volt AC/DC. 37 ranges. Fitted with automatic overload cut-out. Supplied in perfect condition complete with batteries and leads. £9/19/6 each. Reg. post 5/- extra.



PARMEKO TABLE TOP TRANSFORMERS. Input 230 volts. Output 620/550/375/0/375/550/620 volts 250 ma. 2 x 5 volt 3 amp. New, boxed, 45/- ea. Carriage 5/-.

24-AMP. VARIAC TRANSFORMERS. Input 230 volts. Variable output 185 to 250 volts 24 amps., £12/10/- each. Carriage 10/-.

RC.221 HETERODYNE FREQUENCY METERS. 125 kc/s. to 20 Mc/s. As new condition. Supplied complete with valves, crystal and calibration charts, £16 each. Carriage 7/6. Also available less charts, £9/10/- each.

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BRAND NEW MEDRESCO HEARING AIDS. Supplied complete with earpiece, leads and battery pouch. Only 32/6 each. P/P 1/- Batteries 5/- extra.

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R.C.A. PLATE TRANSFORMERS. Primary 200/250 volts. Secondary 2,000/1,500/0/1,500/2,000 volts 500 ma. New, boxed, £6/10/- each. Carriage 10/-.

FIELD TELEPHONES TYPE F.

Ideal for all intercom. systems, house, office, building sites, etc. Generator bell ringing, 2 line connection. Supplied complete with batteries and wooden carrying case, fully tested, £4/19/6 pair. P/P 5/-.



R.C.A. AR 88D RECEIVERS

This world-famous 14-valve receiver offered reconditioned, perfect working order and in superlative condition throughout. Frequency coverage on 6 bands 500 kc/s to 32 mc/s. Circuit incorporates variable selectivity with crystal filter, tone control, aerial trimmer, b.f.o., a.v.c., R.F. and A.F. gain controls, mechanical bandspread, etc. Output is for phones or speaker. Operation 115 or 230 volts A.C., £35 each. Carriage 30/-.

PORTABLE PRECISION VOLTMETERS. Brand new moving iron instruments housed in polished teak case with 8in. mirror scale. 2 ranges, A.C. or D.C. 0-160 v. and 0-320 v. Accuracy within 2%, £5/19/6 each. P/P 3/6.

MINE DETECTOR NO. 4A

Will detect ferrous and non-ferrous metals. Complete and as new in transit cases. Supplied fully tested with instructions. 39/6 each. Carriage 10/- Batteries 8/- extra.

MARCONI TF-373 UNIVERSAL IMPEDANCE BRIDGES. Reconditioned to maker's spec., £35 each.

SOUND POWERED TELEPHONE HANDSETS. Brand new boxed, 15/- each. P/P 1/6.



BRAND NEW Boxed 100 MICROAMP METERS. Standard 2½in. flush panel mounting. Scale calibrated 0-100 microamps, 42/6 each. P/P 1/3.

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Senior model, table mounting. Supplied with complete set of 9 coils covering 50 kc/s to 30 Mc/s. Special features include: S meter, variable selectivity, crystal, phasing. Output for phone or speaker. Supplied fully tested and aligned, superb condition throughout. Price 21 gns. Carriage 10/- Power units available 59/6 each extra.



24 VOLT D.C. FUEL PUMPS.

Perfect condition, 15/6 ea. P/P 2/6.

CLASS D WAVEMETER No. 2. Crystal controlled, 1.2-19.2 Mc/s. Operation 230 volt A.C. or 12 volt D.C. Complete with calibration chart, £9.19.6 each. Carr. 10/6.

SELENIUM L.T. METAL RECTIFIERS.

Full wave bridge connected, all new and guaranteed.

12/18v. 1 amp.... 4/3	24/36v. 4 amp.... 18/6
12/18v. 2½ amp.... 6/9	24/36v. 6 amp.... 22/6
12/18v. 4 amp.... 9/9	24/36v. 10 amp.... 45/-
12/18v. 5 amp.... 12/6	24/36v. 15 amp.... 47/6
12/18v. 6 amp.... 13/6	36/48v. 6 amp.... 32/6
12/18v. 10 amp.... 22/6	48/60v. 2 amp.... 18/6
24/36v. 1 amp.... 9/6	48/60v. 10 amp.... 82/6

Please add postage.

L.T. TRANSFORMERS. All primaries tapped 200/250 volts. 3.5, 9 or 17 volts 1 amp., 9/9; ditto 2 amp., 14/3; ditto, 4 amp., 16/6. 9 or 17 volt 6 amp., 26/- 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volts 2 amp., 18/6. Ditto, 4 amp., 27/6. Please add postage.

AMERICAN ARB RECEIVERS Frequency coverage on 4 bands 195 kc/s to 9.05 mc/s. Precision vernier drive. Valve line-up: 12SA7, 4-12SF7, 12A6 and 9V1. Operation 24 volts D.C. Supplied fully tested and checked, £6/19/6 each. Carriage 7/6.

1 OHM 14 AMP. SLIDER RHEOSTATS, 15/6 each. P/P 2/6.

PHOTO VOLTAGE AMPLIFIERS These special units contain a 1 microamp. Tinsley mirror galvanometer, twin selenium photo cell. 12 v. lamp, lamp housing and focusing unit. Brand new; boxed, £9/19/6 each. Carriage 7/6.

AR.88D SPARES. Complete wchange switch assembly with screens, new, boxed, 17/6 each. P/P 2/6. 1st L.F. transformers, new, boxed, 3/6 each. P/P 9d.

SPEAKER BARGAINS
All brand new and guaranteed.

2½in. 75 ohm ... 17/6	12in. 3 ohm ... 29/6
2½in. 30 ohm ... 17/6	12in. 15 ohm ... 42/6
2½in. 3 ohm ... 17/6	7 x 4in. 3 ohm 15/6
3in. 3 ohm 17/6	8 x 2½in. 3 ohm 17/6
4½in. 3 ohm 15/6	8 x 6in. 3 ohm 17/6
5in. 3 ohm 15/6	10 x 2½in. 3 ohm 17/6
6½in. 3 ohm 17/6	10 x 6in. 3 ohm 27/6
8in. 3 ohm 19/6	13 x 8in. 3 ohm 47/6
10in. 3 ohm ... 27/6	Please add postage.

MINIATURE PANEL METERS

Entirely new range of meters with clear plastic cases. 1½in. square front Panel hole 1½in. dia. Brand new guaranteed, individually boxed. Available in the following ranges.

- 50 MICROAMPS 39/6
- 500 MICROAMPS 32/6
- 1 MILLIAMPS 27/6
- VU METER.
- Range -20-0+3VU
- 0-100% (OVU)
- at 600 ohms 42/6
- "S" METER. Range "S" Units—
- 0-9 terminating
- +10 and +30db
- 0-5 and 0-10 linear scale..... 35/-

ANNOUNCING A COMPLETELY NEW POCKET RADIO
THE "CAPRI" POCKET SIX



- ★ Full medium wave tuning—preset Light on long wave.
- ★ 6 Mullard transistors.
- ★ Push-pull speaker output.
- ★ Printed circuit.
- ★ Moulded two-tone cabinet with mesh grille.

Size 4½ x 2½ x 1½ in.
 ● Really pocket size!

A REMARKABLE EASY TO BUILD POCKET RADIO GIVING OUTSTANDING RESULTS.

TOTAL COST OF ALL PARTS £7.10.0 P.P. 2/-
 No Extras to Buy.

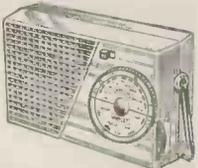
● Fully Descriptive Leaflet on Request ●

IDEAL PRESENTS FOR ANY OCCASION

★ ★

Send 1/- stamp for full details of our new ranges

"QUINTET" MEDIUM & LONG WAVE POCKET LOUDSPEAKER RADIO



- 250mW Push-Pull Output.
- Plainly marked Printed Circuit Board.
- 5 Mullard Transistors.
- Carded Components.

A new design. Fully tunable on both wavebands. Guaranteed reception of Continental and local stations, including Luxembourg, anywhere with full station separation. Fitted Car Aerial and Earpiece Sockets.

Size 5½ x 3 x 1½ in.

TOTAL COST OF ALL PARTS £5.10.0 P.P. 2/- NO EXTRAS TO BUY

VERY EASY TO BUILD AND USE After Sales Service—All Parts Sold Separately.

● Illustrated Instructions FREE ON REQUEST ●

3-TRANSISTOR AND DIODE PERSONAL POCKET RADIO



Quality Output on Personal Earphone. A simple to build local station with personal earphone output. Built-in Ferrite Aerial and Battery lasting 9 months. Size 4½ x 3 x 1½ in.

ALL PARTS 37/6 P.P. 1/6

"TRANSFIVE" PORTABLE MEDIUM AND LONG WAVE PORTABLE RADIO



- 325 mW Push-Pull Output on 5in. Speaker.
- Fully illustrated Plans.
- Easy to Build Printed Circuit.
- Carded Components.
- 5 Mullard Transistors.

Size 8½ x 6½ x 3½ in.

AFTER SALES SERVICE AND FULLY GUARANTEED

TOTAL COST OF ALL PARTS £6.19.6 P.P. NO EXTRAS 2/6. TO BUY

● Full coverage on Medium and Long wavebands. Excellent quality with full station separation. Car aerial socket.

Building Plans and Prices Free on Request.

"RANGER-3" NO EXTERNAL AERIAL OR EARTH 3-TRANSISTOR and 2 DIODES PERSONAL POCKET RADIO with 5 stages giving clear reception on medium wave, amateur top band and shipping. Only first grade components used throughout. As described in March R.C.



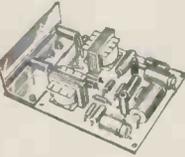
Size 4½ x 3 x 1½ in.

ALL COMPONENTS 79/6 P.P. 1/6 NO EXTRAS TO BUY
 Everything Supplied

- ★ Easy to follow instructions with pictorial layout.
- ★ Reception of Radio Luxembourg guaranteed (most areas). Free Instructions and Price List on request. Easy to build.

★ AFTER SALES SERVICE—Guaranteed.

750mW 4-TRANSISTOR PUSH-PULL AMPLIFIER



(over 1 watt peak output).
 ★ Uses OC71/OC81D, 2—OC81.
 ★ ±3dB 70 cfs to 12 kc/s.
 ★ Overall size 4 x 2½ x ¾ in.
 ★ Built on printed circuit.

BUILT & TESTED 69/6 P.P. 1/6 OR COMPLETE KIT 62/6 P.P. 1/6
 Ideal for Record Player, Intercomm., Baby Alarm, for Tuners, etc.

★ 3 ohm output, fully guaranteed, 9 volt operated. Descriptive leaflet with uses FREE on request.

The "CONTESSA" COMBINED PORTABLE AND CAR RADIO



● Size 10 x 7½ x 3½ in.

UNBEATABLE FOR PERFORMANCE AND APPEARANCE

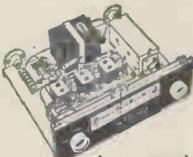
DESCRIPTIVE LEAFLET ON REQUEST.

Employs the latest techniques. Double tuned IF's, AVC and first-grade components are standard features. Excellent tone, sensitivity and selectivity on both wavebands.

Total Cost of All Parts £10.19.6 P.P. All Parts sold separately.

● Guaranteed the best obtainable. ●

TRANSISTOR FM TUNER



Fully tunable with A.F.C., A.G.C. Incorporating Transistors and Printed Circuit Pre-assembled units.

- 2-OC171 and 3-OC170 Selected Transistors.
- Fully Tunable 85 to 108 Mc/s.
- 10.7 Mc/s. I.F. A new design for Hi-Fi to feed quality valve or transistor amplifiers.

R.F. amp./osc. mixer stage; I.F. disc-stage available separately.

● Cover removed. All Parts 18 gns. P.P. 3/-

Fully Illustrated Book 3/6
 Details on request.

BABY SITTER



ALL TRANSISTOR BABY OR INVALID ALARM

Battery operated, push-pull, 400mW output. Low impedance microphone enables unit to be used up to 200 yards. Output on quality speaker.

- ★ GUARANTEED FOR 6 MONTHS and 100% SAFE.
- ★ Microphone is placed within 10ft. of baby; twin flex is taken to amplifier unit and placed in any room required. COMPLETELY BUILT AND TESTED. **£5/10.- P.P. 2/6.**
- ★ Used All Night, Every Night, Battery Life 3 to 4 months.

ALSO TELEPHONE AMPLIFIER FOR OFFICE OR HOME. £5.10.0. P.P. 2/6.

WATT TRANSISTOR AMPLIFIER

● EMI 4-transistor Amplifier with speaker, tone and volume controls. Ready assembled for use with crystal pick-ups. 7½ to 9 volt operated. 89/6. P.P. 1/6.

BATTERY RECORD PLAYER

● 6-7½ volt Garrard Turntable with crystal pickup. Plays 45 r.p.m. Ideal for above amplifier. 79/6. P.P. 1/6.

TRANSISTOR INTERCOMM

★ Two-way Intercomm. with clear reproduction. Incorporates unique buzzing system. 2 speakers, volume control. Cabinet sizes about 3½ x 1½ x 3½ in. Ready to use.
 ★ Printed Circuit Amplifier.

FULLY GUARANTEED.

SUPPLIED IN PRESENTATION BOX WITH BATTERY AND 60FT. WIRE. FOR HOME OR OFFICE. 10 gns.

TRANSISTOR PORTABLE TAPE RECORDER



- Play/record up to 60 minutes.
- Built-in speaker, volume control, batteries and play / record / rewind.
- Quality reproduction.
- Sturdy case 6 x 8½ x 2½ in.

Supplied complete with microphone, tape, batteries and personal phone.

12 gns. FULLY GUARANTEED.

HENRY'S RADIO LTD.

5 HARROW ROAD, EDGWARE ROAD, PADDINGTON, LONDON, W.2
 Opposite Edgware Road Tube Stn. PADDINGTON 1008/9. OPEN MON. to SAT. 9-6. THURS. 1 o'clock.

LET US HAVE YOUR ENQUIRIES FOR COMPONENTS, MINATURE AND STANDARD, VALVES, TUBES, CRYSTALS, SPEAKERS, ETC., ETC.

MODEL TP5S

A.C./D.C. voltage up to 1,000 in 5 ranges. D.C. current 4 ranges up to 500 mA. 4 Range resistance to 10 meg. Capacity, dB scales, etc.



20,000 ohms/volt
Size 5 1/2 x 3 1/2 x 1 1/2 in.

£5.19.6 P.P. 1/6.
With Test Leads, Battery and Instructions

MODEL 200H



20,000 ohms per volt

£6.19.6 P.P. 1/6.

With Test Leads, Battery and Instructions.

6 Ranges D.C. voltage to 2 1/2 kV.
5 Ranges A.C. voltage to 1 kV.
3 Ranges D.C. current to 250 mA.
Resistance to 6 meg.
Capacity and dB range.

★ **Model TE10** ★
10,000 ohms/volt version or above
£5.19.6 P.P. 1/6.
SAME SIZE AND RELIABILITY.

AVO-7

Famous Multi-meter. Reconditioned and fully guaranteed.



Full A.C./D.C. voltage and current, resistance, dB, power, etc. etc.

Supplied with Batteries, Leads and Instructions.
£11.10.0 Regd. Post 5/-.
(Normal price £19/10/-.)

BARGAIN OFFER!

MODEL TP10

A.C./D.C. voltage up to 1 kV. in 4 ranges. D.C. current up to 500 mA. in 2 ranges. 2 Range resistance to 1 meg. Capacity, dB ranges, etc.

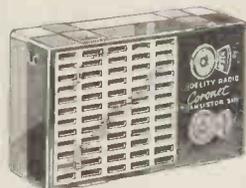
2,000 ohms/volt.
Size 5 x 3 1/2 x 1 1/2 in.

79/6 P.P. 1/6.

With Test Leads, Battery and Instructions.



FIDELITY POCKET RADIO "CORONET" MEDIUM AND LONG WAVE



- Attractive 2-tone cabinet.
- Size 4 1/2 x 2 1/2 x 1 1/2 in.
- Earphone/Record socket.
- 12 Months' Guarantee

£9.19.6 P.P. 2/- With Battery and PVC Case.

BRITISH DESIGN AND CONSTRUCTION

PERSONAL EARPHONE FOR CORONET 12/6 EXTRA.

MERCURY BATTERIES



1.3V, 2200 mA/H, 3/4 x 1 1/2 in. dia., 2/6; 1.3 V, 5000 mA/H, 2 x 3/4 in. dia., 2/6; 1.3 V, 500 mA/H, 3/4 x 3/4 in. dia., 1/3; 1.3 V, 14000 mA/H, 2 1/2 x 1 1/2 in. dia., 5/-.

★ **EXTENSION SPEAKER UNIT** ★
Gives "Big Set" performance from any Transistor Portable—just plugs into Earphone Socket. 57/6. P.P. 1/6.
Ideal for "Coronet" or 7 transistor.

★ **CRYSTAL LAPEL MICROPHONE**

Ideal for Tape Recording Very sensitive.

17/6 P.P. 1/-.



★ **LIGHT-WEIGHT**

4,000 OHM HEADPHONES

12/6 P.P. 1/-.



7-TRANSISTOR MEDIUM AND LONG WAVE LUXURY POCKET RADIO

- Superb Reproduction.
 - Exceptional sensitivity.
 - Two-tone Cabinet.
 - Lever operated MW/LW switch.
- Fully guaranteed.



Size 6 x 3 1/2 x 1 1/2 inches.

Supplied in presentation box complete with leather case, carry straps, personal earphone, battery, etc. **16 gns.**

ELECTRONIC DESIGNS VALVE VOLTMETER

FULLY GUARANTEED



D.C. ELECTRONIC VOLTMETER
6 Ranges. 0-3-10-30-100-300 and 1,000 volts. Input res.: 11-meg. constant on all ranges. Sensitivity: 3,666,666 ohms per volt on 3 v. scale.

A.C. VOLTMETER
5 Ranges: 0-10-30-100-300-1,000 volts. Sensitivity: 1,000 ohms per volt.

ELECTRONIC OHMMETER
6 Ranges, from 0.1 ohms to 1,000 megohms. Movement. 200 microamperes. D.C. accuracy ±2%.

COMPLETE WITH INSTRUCTION BOOK AND TEST PRODS, BRAND NEW.

Input 110-250 volts A.C.

£12.10.0 P.P. 3/6.

PRACTICAL TRANSISTOR CIRCUITS

3/6 Post Free.
Contains easy to follow plans of 40 all transistor units, including light operated switches, amplifiers, transmitters, receivers, test oscillators, signal tracers, hearing aids, radio control, etc. All parts available separately.

★ **600 ohm PERSONAL EARPHONE** with jack plug and socket. 10/6. P.P. 1/-.

STEREO AMPLIFIER

BARGAIN OFFER

- 2 watts per channel.
- Full tone, balance and volume controls.
- Complete with sockets, dials, etc. **97/6** P.P. 2/6.

Suitable Speakers, 10 x 6 in., 49/6 pair. UA14 Stereo Deck, £8/19/6. P.P. 3/6. **READY BUILT & TESTED.**

PORTABLE LOUD HAILER
★ Pistol grip action. Special shape horn. Built-in batteries and detachable microphone. Made of lightweight materials. Weight 4 lbs. **£14/10/-**

CRYSTAL MIC INSERTS
★ ACOS 43-2 2 1/2 in. round, 12/6. P.P. 6d.
★ ACOS 1 1/2 in. round, 7/6. P.P. 6d.
★ 3/4 in. square, 3/6. P.P. 6d.

LOUD IMPEDANCE HEADPHONES, 6/-. P.P. 1/3.

RECORD PLAYER AMPLIFIER

- 2-watt output.
- Ready built with Valves and 8 x 5 Speaker, Tone and Volume controls. Printed circuit.

75/- P.P. 2/-.

Ideal for Portable Record Player.

● UAB 4-speed Record Changer, ideal for above. **£6/19/6.** P.P. 3/6.

TELEPHONE ADAPTOR

★ Ideal for recording telephone conversations. Supplied with screened cable. Fitted rubber sucker. **14/-** P.P. 9d.

CRYSTAL MICROPHONES



ACOS 39-1. Stick Microphone with screened cable and stand (list 5 gns.), 39/6. P.P. 1/6.

ACOS 40. Deck Microphone with screened cable and built-in stand (list 50/-) 19/6. P.P. 1/6.

ACOS 45. Hand Microphone with screened lead, very sensitive, 29/6. P.P. 1/6.



POCKET IRON

★ Pocket Soldering Iron, 220/250 v. A.C./D.C. 30 watts, complete with mains plug, case, etc. Handle unscrews to cover element, enabling iron to be carried in pocket. 18/6. P.P. 1/-.

I Kohn DYNAMIC MICROPHONE

Hand held or desk stand, complete with screened cable. Excellent response. 49/6. P.P. 1/-.



TRANSISTORS

We Stock a Transistor FROM and Components for Every Purpose. **3/6**

ENQUIRIES WELCOMED LIST

SEND FOR LATEST PRICE LIST

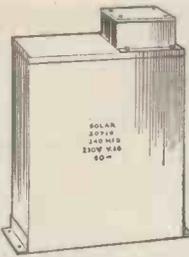
1st GRADE—FULLY GUARANTEED

SEND 1/- STAMP FOR COMPLETE LISTS AND NEW CATALOGUE

HENRY'S RADIO LTD.

5 HARROW ROAD, EDGWARE ROAD, PADDINGTON, LONDON, W.2.
Opposite Edgware Road Tube Stn. PADDINGTON 1008/9. OPEN MON. to SAT. 9-6. THURS. 1 o'clock

SOLAR OIL-FILLED CONDENSER. 240 mfd. for 230 v. A.C. or 600 volt D.C. Overall size 14in. x 9in. x 5½in. plus feet. Weight 46 lb. Brand new. Guaranteed perfect. Manufacturer's packing. Price £7/10/- Carriage 10/-.



METERS GUARANTEED PERFECT

Charging Types

2½ amp. D.C. M.I. 2in. fl. rnd.	7/6
5 amp. D.C. M.I. 2½in. fl. rnd.	11/6
7½ amp. D.C. M.I. 3½in. proj. rnd.	12/6
9 amp. D.C. Hot Wire W.R. 2½in. fl. rnd.	6/6
15 amp. D.C. M.C. 2in. rnd.	10/6

Voltmeters

20 v. D.C. M.C. 2in. fl. sq.	10/6
30 v. M.I. 3in. proj. rnd.	10/6
300 v. A.C. M.I. 2½in. fl. rnd.	22/-
400 v. A.C. M.I. 4½in. rnd.	35/-
90-180 v. A.C. M.I. 4½in. fl. iron	25/-

Milliammeters

1 mA. M.C. 2½in. fl. rnd.	25/-
200 mA. M.C. 2½in. fl. rnd.	12/6
500 mA. M.C. 2½in. fl. rnd.	12/6

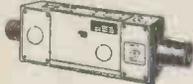
500 microamp., M.C. 2½in. rnd. F.L. scaled 15/600 volt. NEW 16/6
Postage on all meters 1/- each.

MINIATURE LATEST TYPE MOVING COIL MICROAMP METER, F.S.D. 300 microamp, flush mounting, square rim 1½in. x 1½in., round dial 1½in. Ideal as field strength meter or output level recorder or tuning meter. Price 26/- P. & P. 1/-.

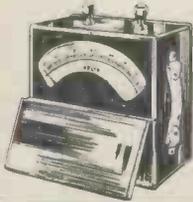
LATEST TYPE ERNEST TURNER. 0-200 volt A.C. RECTIFIED M.C. METER. Flush mounting, round, 3in. scale. Price 37/6. P. & P. 2/-.

SANGAMO WESTON DUAL RANGE VOLTMETER. 5 & 100 volt D.C. 3in. scale, F.S.D. 1 mA. Brand new in carrying case with Test Prods and Leads. Price 27/6. P. & P. 3/-.

AIRCRAFT CINE CAMERA G45B Mk. III. Fully modified, fitted with f/3.5 triple anastigmat lens, takes 25ft. of 16 mm. film, fitted with 24 v. motor, 16 exposures per sec. Brand new, original packing, £4/10/- each. P. & P. paid.

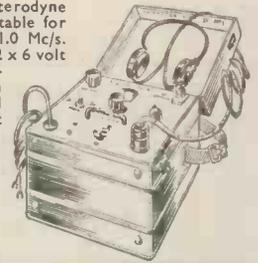


LABORATORY PRECISION VOLTMETER. Brand new in polished teak case. Moving iron instrument reading D.C. or A.C. 0-160 volt on 8in. mirror scale. Accuracy 2% £4/19/6 each. P. & P. 3/6.



BRAND NEW FREQUENCY METERS manufactured by Nalder & Thompson Ltd. Calibrated 45 cycles to 55 cycles per second. 6in. dial. Panel mounting type. In original manufacturers' boxes. PRICE £10/15/- each. Postage 3/6.

CLASS D WAVE METER. Latest release of these famous Heterodyne wave meters with directly calibrated illuminated dial, most suitable for amateur transmitters, covers two ranges 1.9-8.0 Mc/s. and 4.0-1.0 Mc/s. Complete with reference crystals for zero settings, two valves, 2 x 6 volt vibrators, MAKER'S instruction book and matched set of headphones for monitoring. Designed for 6-volt D.C. operation, can easily be modified for mains and suitable transformer supplied for 7/6. In spot-on condition as tested by R.E.M.E. In transit case. Price 5 gns. each, plus 6/6 carriage.



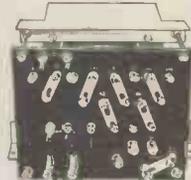
Magnetic Counters, very latest High Speed type, ex P.O., guaranteed perfect, type No. 100B, coil 2,300 ohms, for 48 volt D.C. operation (will work on 36 volt), overall size 4 x 1 x 1in. Price 15/- each, P. & P. 1/6.



GEARED MOTORS, 200/250 Volt A.C. Input, single phase, 6.6 r.p.m., reversible, torque 35 lbs/inch. Stepped shaft ¼ and ⅜. A compact and extremely powerful motor with double gearbox which can be adjusted for horizontal or vertical drive. Brand new in maker's carton. British made to B.S.S. 170. Price £6/5/- each, plus 4/- each P. & P.



PLATE TRANSFORMER of very best U.S.A. make, brand new, original manufacturer's cases. Input tapped at 190/210/230/250v Output 2250-0-2250, centre tapped 400 mA. Nett weight 76lb., size 13in. x 9in. x 6½in. Price £6/10/- each, plus carr. 10/-.



HEAVY DUTY L.T. TRANSFORMER. Very conservatively rated for continuous duty. New in manufacturer's cases. Input 110-260 volt multi-tapped. 50 cycles, single phase. Output 28-29-30-31 volts at 21 ampere. Price £6/15/- Carriage 10/-.



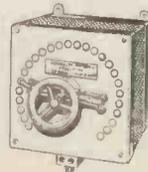
MIDGET ROTARY TRANSFORMERS. 2½ in. dia. x 4½in. Input 11.5 volt. Output 310/365 volts at 30 mA. Brand new. 10/6 each. P. & P. 2/-.

AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded New. 300 watt type £2/2/- each. P. & P. 2/6. 500 watt type £3/3/- each. P. & P. 3/9. 1,000 watt type £4/4/- each. P. & P. 6/6.

BRAND NEW SELENIUM FULL WAVE BRIDGE RECTIFIERS, in manufacturer's original packing. D.C. output 36 volt 10 amp., made up of 12 x 110 mm. dia. plates. These fitted in cooling funnel. (Removable.) Size 1½in. x 8in. x 4½in. Price 45/- P. & P. 4/-.

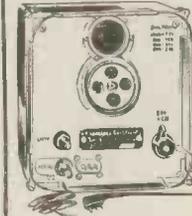
S.T.C. BRIDGE RECTIFIER. New, perfect. 8 plates each 115 mm. Maximum A.C. input 36 v. D.C. output 5 ampere, 24 volt. Price 20/- P. & P. 3/-.

ROTARY SWITCH REGULATOR. 25 ohms, very conservatively rated at 4 amp., will handle 8 amp. Overall size 7 x 8 x 6in. Price 15/- P. & P. 2/6.



BUILD AN EFFICIENT STROBE UNIT, the ideal instrument for workshop lab. or factory. This wonderful device enables you to "freeze" motion and examine moving parts as if stationary. We supply a simple circuit diagram and all electrical parts including the NSP2 Strobe tube which will enable you to easily and quickly construct a unit for an infinite variety of speeds, from 1 flash in several seconds to several thousands per second. New modified circuits bring price down to 37/6 plus 3/- P. & P.

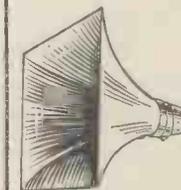
CRYSTAL CALIBRATOR. No. 10. A crystal controlled 4-valve high-grade instrument in the same category as the famous B.C. 221. Directly calibrated, does not require cross reference or charts — functions as follows: (1) A crystal controlled oscillator which provides fixed frequency signals of 500 KC and all harmonics of 500 KC up to beyond 10 Meg. and up to 30 Meg.



(2) A variable oscillator from 250 KC to 500 KC, this enables all intermediate frequencies between 250 Kc/s, and 30 Meg. to be produced and modulated.

Supplied complete with 3 spare valves, all leads and instruction book in carrying haversack. The complete outfit is brand new—repeat NEW. Price £4/10/- Carr. 3/6.

NEW GALVANOMETERS Solid brass, 3in. dial, in polished wooden case. 70 degree scale, 35 mA either side. 100 ohm coil. Price 12/6 each. P. & P. 1/6.



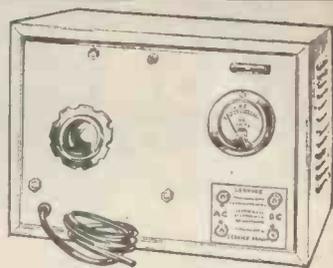
TANNOY P.A. LOUDSPEAKER. For outdoor use, metal exponential horn with 20in. square flare. Overall length 30in. Speech coil 15 ohms. Guaranteed in working order and good condition. Price £7/10/- Carr. 10/-.

BRAND NEW SOUND POWER OPERATED ADMIRALTY HEAD AND BREST SETS. Two such sets connected up will provide perfect intercom., no batteries required. Will operate up to ½ mile. Original manufacturer's boxes. Price 17/6 each, plus P. & P. 3/-; or 32/6 per pair. P. & P. 4/-.



A.C./D.C. OUTPUT UNIT

FIRST IN THE FIELD AT A PRICE THAT DEFIES ALL COMPETITION. This unique power unit will give variable outputs of 0-260V. A.C. or 0-230V. D.C. at 8 ampere, from normal 230V. 50 cycles A.C. input. A voltmeter is fitted so that an indication of output voltage A.C. or D.C. is always available. Robustly constructed sheet metal case well ventilated for continuous operation, complete with safety fuse, neon indicator and meter. A modern instrument for up to date development and research. Size 17in. x 12in. x 7in. Weight 36lb. Brand new, freshly manufactured. Price £34/10/0. Carriage 20/-.



MAINS POWER SUPPLY UNITS.

Potted and sealed transformer and choke by famous maker. Mounted on metal chassis 6½ x 7½in., complete with 5Z4 rectifier valve and full smoothing.



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Set of six 1 x OC44; 2 x OC45; 1 x OC81D; 2 x OC81. Six for 39/6.



14-day clockwork TIME SWITCH

Contacts 2½ amp., 230 volt, 24 hour phase, ¼ hour divisions, allow setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 2/6.

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1,750 ohms 100 watt. Wound on Ceramic former. In metal case with lin. x ¼in. spindle. New in maker's packing. 32/6 each. P. & P. 3/-.



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Used but perfect. Complete with two-way calling system (buzzer), internal battery. All ready for simple two-wire connection. Price £3/2/6 each or £6 the pair. P. & P. 3/6 each handset.



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Capstan drive, push-button controls. Constant speed 3 1/2 i.p.s., uses 3in. spool. High impact plastic case with transparent upper. Size: 9 1/2 x 5 x 3 1/2 in. List 25 Gns.

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THE LATEST COLLARO STUDIO TAPE TRANSCRIBER. 3 motors, 3-speed 1 1/2, 3 1/2, 7 1/2 i.p.s., takes 7in. spools. Push-button controls, Digital counter. Lasky's Price complete with Spool, **£10.19.6** Carr. & Ins. 12/6.

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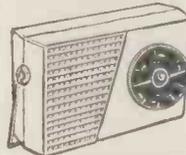
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Circuit diagram and data 1/6 (free with parcel). All components available separately.

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MINIATURE EARPIECES for Pocket Transistor Radios. Transparent ear-insert with 3ft. cord, sub-min. jack and socket. Fully guaranteed. Post free.

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COLLARO Studio Tape Deck, 3 motors, 3 speeds, etc. LASKY'S PRICE **£10.19.6** Carr. 12/6

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RC.88	£12	19	6
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BUILD THE NEW LASKY FM TUNER FOR £4.19.6

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Non drit permeability lining pack by famous manufacturer, frequency 88/100 mc/s., OAS1 balanced diode output 2IF stages and discriminator. Smart gold and maroon glass dial 7x3in., self powered, valve line-up: ECC93, 2E8 80's, EZ 80 rectifier. Everything ready for assembly. All components available separately. Dimensions 8x6x5in. Optional extra EM34 magne eye tuning indicator 8/6. Circuit diagram and full data supplied 1/6 post free.

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Twin 4 watt (or 8 w. monaural), using two ECL82 and EZ80 rect. valves, double wound mains transformer, etc. Separate panel with bass, treble and volume controls. Indicator lamp, push button on/off switch. Kit comprises two amplifier units and power unit. Dim. 5x2in. Fully assembled ready to be wired. Priced without speaker so that you can choose type and size required. Lasky's Price for kit with 3 new Mullard valves 56/-, Post 0/6. Full data, circuit diagram, assembly instructions and layout supplied. Special offer of speakers for this kit. Two 5in. for 20/-. Two 6x4in. 25/-. Suitable cabinets at bargain prices.

MARTIN RECORDAKITS TAPE AMPLIFIERS

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KIT A. 4TR AMP for Monardeck. LASKY'S PRICE 9 gns.

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- ★ Small size. Will fit any car
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 - ★ New type Brimar valves
 - ★ No Vibrator, 12 volt H.T. & L.T.
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 - ★ 7in. x 4in. elliptical speaker
- Instruction Booklet giving full details illustrations dimensions, circuit diagram and shopping list. 2/6 post free (returned if you order)

CAR RADIO TUNING HEART

Permeability tuned superhet, coil pack covering medium and long waves with tuned R.F. stage. Complete with pointer, needs no gang condenser. Its compact construction, small size 7x5x1½in., make it ideal for use in car radios (valve hybrid or transistor). I.F. 465 Kc/s. Lasky's Price 49/6. P. & P. 3/6. With circuit diagram and full data. Dial 2/6 extra.

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P.N.P. Junction types. AUDIO, suitable for high gain and low freq. amplifiers and for output stages up to 250 milliwatts. Double spot—yellow and green 3/6 R.F., suitable for medium and low freq. oscillators, freq. changers and I.F. amplifiers (1.5 to 8 Mc/s.). Double spot—yellow and red... 4/6 Type T81. Suitable for all audio applications 2/6 Post 6d. One dozen 28/- post free. Type Z, audio each 2/- One dozen, 23/- post free. Special prices for larger quantities.

OC44	OC45	OC70	OC71	OC72
3/6	7/6	6/6	6/6	5/-
OC73	OC75	OC76	OC81	OC28
18/-	8/-	8/-	7/6	19/6

OC81 7/6 (Matched Pair, 18/-)

EDISWAN MAZDA TRANSISTORS

The very latest types: XB/102 7/6; XB/103 7/6; XC/101 10/6; XA/101 12/6; XA/102 12/6.

SPECIAL OFFER. Set of 7 Ediswan Transistors: XA/101, XA/102, 2 XR/102, XB/103, 2 matched XC/101. Price 49/6.

CRYSTAL DIODES. General Purpose GEX00, each 1/- Per doz. 9/- All other types in stock.

"GOLTP" POWER TRANSISTORS

All types in stock. Example: V15/10P. Ideal for output stage of car radio, will give approx. 3 watts operating from 12 v. Each 15/- post free. Suitable Output Transformer for above, correct ratio, matched to 3 ohms, 9/6. Post 1/- Driver Transformer, 9/6. Post 1/-.

SUB-MIN COMPONENTS

As used in the smallest Japanese pocket transistor radios. Coils, Loudspeakers, I.F. transformers, Ganged Condensers, etc., in stock at lowest prices. Also all T.S.L. transistorised Miniature Units.

20 000 VALVES IN STOCK

Brand new surplus and imported, also full stocks of B.V.A. valves. List post free.

STOP PRESS

STUPENDOUS SURPLUS STEREO SCOOP

Brand new and unused in maker's cartons by a very well-known manufacturer, originally intended for record demonstrations. AC mains 195-250 v. Specification: Garrard 4 speed single record player (TA Mk. 2) complete with pick up, crystal stereo, cartridge and diamond stylus, twin 4 watt (8 watt monaural) amplifier, 3 valves, 2 ECL82 and EZ80 rectifier, vol. control, balance control, on/off switch fitted. Spring mounted on polished wood base 17in. x 14½in. x 8in. with plastic dust cover. Full data and circuit diagram supplied. Two specially matched Acousti-stereo loud speakers in cabinets, corner (floor or wall mounting). Dims.: 5ft. 3in. x 7½in.

LASKY'S **£12.19.6** complete PRICE Carr. & Ins. 25/- extra.

All units available separately, prices on request.

33 TOTTENHAM COURT ROAD, W.1.

207 EDGWARE ROAD, W.2.

2 mins. Oxford Street. Nearest Station, Gooch Street

MUSEum 2605

Few yards from Praed Street

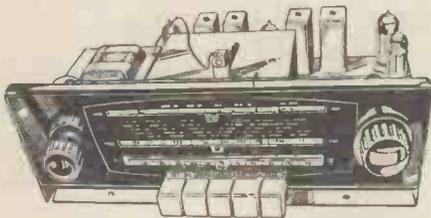
PADddington 3271/2

Both addresses open all day Saturday. Close 1 p.m. Thursday.

PLEASE ADDRESS ALL MAIL ORDERS TO DEPT. W. AT ABOVE EDGWARE ROAD ADDRESS.

SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO

BRAND NEW AM/FM (V.H.F.) RADIOGRAM CHASSIS AT £14 (Carriage Paid)

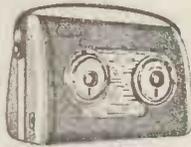


Tapped input 220-225 v. and 226-250 v. A.C. ONLY.
 Chassis size 15 x 8½ x 6½ in. high. New manufacture, 12 mths. guarantee.
 Dial 1½ x 4 in. in black and gold.
 Pick-up. Extension Speaker. Ae, E, hd Dipole Sockets. Five "piano" push buttons—O.P.F., L.W., M.W., F.M. and Gram. Aligned and tested.
 With all valves and O.P. Transformer. Tone Control Fitted.
 Covers 1,000—1,900 M.; 200-600 M.; 88-98 Mc/s.
 Valves E280 rect., ECH81, EF89, EABC80, EL84, ECC85.
 Speaker and Cabinet to fit chassis (table model), 47/6 (post 3/6).
 10 x 6 in. ELLIPTICAL SPEAKER, 20/-, to purchasers of this chassis.

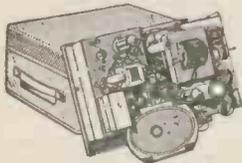
TERMS: (Chassis) £5 down and 5 Monthly Payments of £2, or with Cabinet and Speaker £5/10/- down and 6 Monthly Payments of £2.

This chassis is an ideal partner for the radiogram cabinet appearing on this page.

Fully Built and Guaranteed 6 Transistor Printed Circuit Radio. Originally £16/16/- OUR PRICE ONLY £10 carr. paid. 12 in. x 7½ in. high x 4½ in. at base, tapering to 2 in. at top. 5 in. Speaker—L.W. and M.W. Car AER Socket; Ferrite AER; covered in Beautiful Duracour Fabric. BRAND NEW.



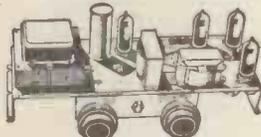
TAPE RECORDER FOR ONLY £17.17.0 (10/- carr.)



A QUALITY ARTICLE. Valves EZ80, EOC83, ECL82, DM70. Acos Crystal "mike," 850ft. Tape and extra spool. 3 in./sec. Mike and Radio inputs: Vol. on/off tone, Ext. L.S. and Monitor. Fast forward and reverse. Cannot be accidentally erased. Magic Eye Indicator. 6 x 4 in. Speaker. Cabinet 14 x 11½ x 7 in. Supplied completely built and in cabinet.

STEREO & MONO AMPLIFIERS £4.15.0 (3/- p. & p.)

Brand new. 200-250 A.C. Tone and volume controls each channel. EZ80, ECC83 and 2-EL84, giving 2 x 4W. Size 12 x 3½ x 3½ in. O.P. trans. for 2-3Ω speaker. Separate on-off switch to allow balancing to remain set. Monaural push-pull amplifier giving 8W same price.



TRANSISTORS

Packet of matched OC78 (2) Output and 1—OC78D Driver Stage for 20/- (ref. LFG3). Packet of one each of OC44, (mixer Osc. yellow spot); OC45 (1st I.F. orange spot) and OC45 and I.F. blue spot) for 20/- (ref. RFG3). The two packets of total of six Transistors will be supplied for 37/6, post paid.

LATEST COLLARO STUDIO TAPE TRANSCRIPTOR

Three motors, three speeds, 1, 3½ and 7 in. per sec. Takes 7 in. spool. Push button controls. £10/17/6 (10/- carr.). Tape and spool 30/- extra the pair.
 Latest B.S.R. MONARDECK. Single speed 3 in. per sec. Takes 5½ in. spools. Only 27/2/6 (plus 5/6 carr.). 850ft. first grade Tape, 5½ plastic spool, 16/- (post 1/-).



SELF-POWERED V.H.F. TUNER CHASSIS (200-240 V AC)

covering 88-95 Mc/s. Mullard permeability Tuner. Dims. 10½ in. x 4½ in. x 5 in. high. ECC85, EF91, EF91 and 2 Diodes. Metal Rectifier. Mains trans. Fully wired and tested. 27/14/- carr. paid.
 Room dipole 10/-, 300 ohm twin feeder 6d. yd. Without Power Pack 28/14/- carr. paid.

AUTOMATIC RECORD CHANGERS

4 sp. turnover crystal cartridge. Wired for stereo, fitted monaural cartridge. B.S.R. UA14 27/10/- Motor board to fit 3/6. Collaro C.60 27/15/- Carr. 5/- either type.

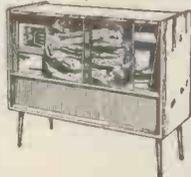
UNREPEATABLE OFFER OF AM-FM CHASSIS AT ONLY £9.9.0 carr. pd.

A small quantity of Printed Circuit chassis by famous manufacturer. Valves UY85, UCH81, UF89, UABC80, UL84 and UCC85. O.p. trans. for 2-3 ohm speaker. Chassis 14 x 7 x 7 in. Front controls concentric, left—Vol. and Tone; right—W/o and Tuning. "Gold" centre knobs provided. 2-dial bulbs. Sockets, AE, E; Ext. sp; P.U. Mains isolating provided free. Coverage: Long, Med., VHF (87-101 Mc/s). Unused, slightly tarnished, but not dirty; New Mullard Valves; not our manufacture, so no guarantee.

NEW LOUDSPEAKER BARGAINS. Good Makes.

2-8 ohms. 13 x 8 in. 35/- (4/-); 7 x 4 in. 14/6 (2/-); 6½ x 4 in. 12/6 (2/-); 10 x 6 in. 25/- (3/-); 5 in. 12/- (2/-); 4 in. tweeter 7/6 (2/-); 7 x 5 in. 17/6 (2/-); 9 x 6 in. 22/- (2/6). Postal charges bracketed.

SUPERB CONTEMPORARY CABINET



Fitted with 3 sliding doors providing room for Radio, Autochanger, 4 speakers, and record storage.

PRICE 15 Gns.

Free delivery in London area. 35/- carriage elsewhere.

GRAMOPHONE AMPLIFIER



with 5 in. SPEAKER. On Fabric-covered Baffle 12½ x 6 in. Mains and Output Transformers. EZ40 and EL41 Valves. Tone and Volume Controls. On/Off switch. Plenty of Volume. Fully guaranteed. Two Knobs supplied. Ready to play. Useful for Stereo. ONLY 57/- Post 3/-.

The "CANTATA" 6-transistor and diode Portable Kit

400 mW. push-pull output; Ferrite rod aerial; M.W. and L.W.; operates on two 4.5 v. cells; full working instructions; booklet of full assembly and alignment instructions; all parts sold separately, write for list, speaker. Price includes every item needed to assemble. Cabinet is supplied completely built. Cabinet size 9 in. x 6 in. x 3 in. Car aerial socket provided. 6 Mullard Transistors. Printed circuit 8 x 3 speaker; alignment service 17/6 incl. post.
 Fully built & aligned set £10.10.0 carr. pd. Full guarantee.



£7.19.6 Post 3/6

TAPE RECORDER CASE 55/-:

Size 17½ x 13½ x 8 in. Hinged lid. Plain Board Inside. Our 57/- Gramophone Amplifier fits this Case. Carr. 5/-.

BATTERY ELIMINATOR

For 4 Low Consumption Valves (96 range), 90 v. 15 mA. and 1.4 v. 125 mA. 42/6 (2/6 post). 200-250 v. A.C. Size 5½ x 3½ x 2 in. Also for 250 mA. 1.4 v. and 90 v. 15 mA. at same price.

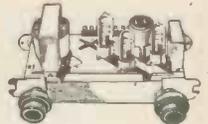


BEREC BATTERY RADIO

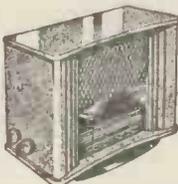
25-75 M. and M.W. or 41-120 M. and 16-49 M. Either type 25/4/- (2/6 p. & p.)

3-VALVE AMPLIFIER

4 watts. Valves: EZ80; ECC83; and ECL82. Tone and vol. controls, bass and treble. 13 in. x 4 in. x 5 in. over valves. Mains and O.P. Trans. and 6 in. x 4 in. Celestion speaker. Suitable for mfc. and guitar. 200-240 v. A.C. 67/- (P. & P. 4/-).



COMPLETE V.H.F./A.M. RADIO FOR £12/10/-



(carr. paid)
 Brand new set, in superb walnut cabinet (size 19 x 8½ x 14 in. high). Covering 80-100 Mc/s. 16-49 M. and 200-500 M. Mains trans. 200-250 v. with 2 tapplings. Ferrite rod aerial for A.M. Control: volume on/off, tone, tuning, v/change. Gram and ext. speaker position provided. Valves 12AT7, 12AH6, 6BJ6, EABC80, 6BW6 and metal rectifier. Fully guaranteed. Today's Value, £20.

Delivery by return. C.O.D. 2/- extra. Terms: Cash with order or one-third down and balance plus 12/6 (up to 27/10/-) in equal four monthly payments. Balance over 27/10/- add 2/- in £1 and pay in not more than 6 monthly payments. See special terms for A.M.-P.M. chassis. All new goods unless stated. Send 6d. for 20-page catalogue. SATISFACTION GUARANTEED. Posted orders to FARNBOROUGH.

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56 Stokes Croft, Bristol, 1 Tel. 27809

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Tel. 3371

247, New Road, Copnor, Portsmouth, Hants.

(Portsmouth and Bristol closed Wednesday.) (Farnborough closed Sat.)

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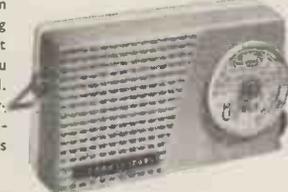
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NEW! NEW! THE "CLYMAX"

At last a 6-transistor pocket size superhet for
 Medium and Long
 Wave at a price you
 can afford.
 All required compo-
 nents



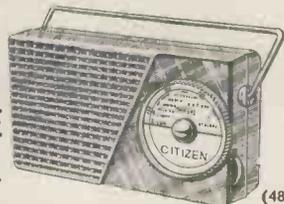
ONLY
£6.16.6

- ★ Plus 2/6 P. & P. Nothing more to buy!
 - ★ Completely self contained. No external aerial or earth required.
 - ★ Full medium wave coverage, plus switched Light programme on Long Wave.
 - ★ Push pull output—250 milliwatts.
 - ★ Matched set of latest type Mullard transistors.
 - ★ Genuine 3in. P.M. Speaker.
 - ★ High-Q Coils.
 - ★ Ferrite rod aerial with high selectivity.
 - ★ Size 5½ x 3½ x 1½in. Two tone cabinet.
 - ★ Precision etched printed circuit with component references clearly marked.
- Alignment service available. All parts available separately. Full assembly instructions and individually priced parts list, 2/-, post free.

THE "CITIZEN"

Our sensitive 5-stage (4 transistor plus diode) pocket
 transistor receiver for full Medium Wave reception—
 with the following outstanding features:—

NEW
 LOW
 PRICE
85/-



- ★ Completely self-contained — no external aerial or earth required.
- ★ Genuine 2½in. High Flux P.M. speaker.
- ★ Push-Pull output.
- ★ Genuine Mullard transistors.
- ★ Socket provided for personal listening.
- ★ Socket provided for connection to Car Aerial.
- ★ Volume control with on/off switch, condenser tuning.
- ★ Easy assembly on pre-tagged circuit board.
- ★ Attractive red polystyrene cabinet measures 5½ x 3 x 1½in., chrome handle, attractive dial.

All required components including full instructions, solder, etc., and battery, at special inclusive price of **ONLY 85/-** plus 2/6 P. & P.

Yes **EIGHTY-FIVE SHILLINGS ONLY!**
 Nothing more to spend

Suitable crystal dead-aid type miniature ear-piece fitted with miniature jack plug at **ONLY 7/6** extra, if required. All parts available separately—itemised list and full assembly instructions sent for 1/6 post free.

Hear this amazing little receiver at any of our branches

RADIO JACK (25)

Covers local medium wave stations variably tuned. Compact self-contained unit requiring only connection to aerial (no power supplies required) for first-class reception when used in conjunction with your tape recorder or high gain amplifier. All necessary parts available at special inclusive price of 19/6. P. & P. 1/6.



All parts available separately, but if purchased at one time, the whole will be supplied at a special inclusive price of

ONLY £10.19.6 Plus 4/- P. & P.

Individually priced Parts list and comprehensive instruction booklet 2/6 post free. (Deducted from cost if complete parcel purchased later.)

NEW! NEW! READY SHORTLY The "HIGHWAYMAN"

AT LAST A QUALITY CAR RADIO TO BUILD YOURSELF, AT AN ECONOMICAL PRICE.

Look at these features:

- ★ Attractive styling.
- ★ Three latest Mullard transistors plus valve types EBF83 and ECH83
- ★ No Buzz, High output and sensitivity.
- ★ Printed circuit (newest type).
- ★ 7 x 4in. High flux p.m. speaker and baffle.
- ★ FULL Medium and Long Wave Coverage.
- ★ Push Buttons for fingertip control.
- ★ Extremely low Battery consumption (less than ½ amp.).
- ★ Easy to fit, any make car. (Positive earth only.)
- ★ 12-volt operation.
- ★ Compact size measures only 7 x 7 x 2in. deep.
- ★ Easy assembly, supplied with dial and drive already mounted.

"WAVEMASTER" 7-TRANSISTOR LUXURY PORTABLE 400 MILLIWATTS OUTPUT NEW LOW PRICE £9.19.6 !!

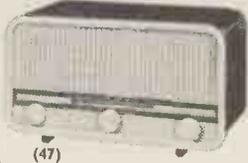
To build yourself, Medium and Long waves—Push-Pull Superhet A.V.C. Perfect Car Radio reception. Size 10in. x 6½in. x 4½in. at base tapering to 4in. at top. Very attractive two-tone grey Vynide covered cabinet with black and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings. Weight—complete with long-life 7½-volt battery—4½lb. Mullard high-grade transistors throughout. High-Flux 7in. x 4in. Elliptical Speaker. Slow motion tuning. Co-axial socket at rear for direct connection to Car Radio Aerial. Improved reception by use of five-section plated telescopic aerial disappearing into Cabinet when closed, 34in. above Cabinet: (43) when fully extended.



Construction simplified by Bakelite chassis board with the following components already mounted: I.F. Transformers (3). Oscillator Coil, Trimmer, Bank, Output Transformer, Interstage Transformer, Aerial Brackets and Earth Bar. **SPECIAL INCLUSIVE PRICE** for all required components, full assembly instructions—nothing more to buy—is **£9/19/6** plus 3/6 P. & P. Alignment service available. Full assembly instructions and Individually priced parts list, all of which are available separately, 2/6 post free.

NEW! "POPULAR FOUR" Improved appearance and performance

A new three-valve plus miniature contact cooled rectifier, mains T.R.F. Receiver is now available. New De Luxe Cabinet, polished walnut finish, cream trim, attractive horizontal dial (as illustrated). Quality 4in. P.M. speaker. Specially wound high gain super-sensitive Denco coils. Medium and Long Wavebands. Excellent Continental reception! Overall dimensions: 12in. x 6in. x 5in. A.C. 200/250 v. Simple construction with guaranteed results. Easy to follow practical and theoretical diagrams supplied. All necessary components down to the last nut and bolt, are offered at a **SPECIAL INCLUSIVE PRICE OF £5/5/-** plus 3/6 p. & p. Instruction book available separately 1/6, post free. The same circuit is available in attractive White or Brown Bakelite Cabinet with rectangular dial at 97/6 only. Plus 3/6 p. & p. **ALL PARTS AVAILABLE SEPARATELY.**



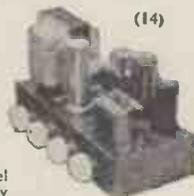
THE "MINI-4" SUPERHET!



4 latest type Mullard transistors, plus diode. Medium and Long Waves. High flux 2½in. P.M. Speaker. Ferrite slab aerial. Attractive dove grey plastic case with scarlet controls. Size only 5½ x 3½ x 1½in. Easy to assemble on eyeletted board. All required components at special inclusive price of **£5/10/-** plus 2/6 P. & P. Easy to follow assembly instructions and individually priced parts list, 1/6, post free.

THE R.C. 3/4 WATT AMPLIFIER

Compare the advantages. Treble bass AND middle controls. For crystal or magnetic pick-up. A.C. Mains 200/250v. Valve line-up: 6V6GT, 6G7 metal, 6X5GT. Negative feed-back. Built on stove enamelled steel chassis measuring only 8in. x 4in. x 1½in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams at **£4/5/-** only, plus 2/6 p. & p. or instruction Book fully illustrated for 1/- post free. This amplifier can be supplied assembled, tested and ready for use at **£5/5/-** plus p. & p.



HI-FI ENTHUSIASTS!

GRUNDIG TM 20, special version of TK 20, complete with pre-amplifier for recording and playback. Ready to connect. **BRAND NEW.** Full guarantee. Supplied complete with GCM3 microphone (listed 6 gns.) at special price of 35 gns. only, plus 15/- pkg. & carr. Also TM60 STEREO VERSION, complete but less microphone at 79 gns. plus pkg./carr. **H.P. AVAILABLE.**

VISIT OUR FULLY EQUIPPED HI-FI SHOWROOM AT TOTTENHAM COURT ROAD FOR DEMONSTRATIONS OF THE LATEST HI-FIDELITY EQUIPMENT BY ALL LEADING MANUFACTURERS

i.e., Leak, Quad, Armstrong, Dulci, Ferrograph, Reflectograph, Tandberg, Vortexion, Tannoy, Linear, Wharfedale, Grundig, Goodmans, W.B., Rogers, Garrard, Lenco, B.T.H., Pamphonic, Simon, Brenell, Collaro, Telefunken, Fi-Cord, etc., etc. A full range of high quality cabinets to suit all purposes is on show. Enquire about our interesting part-exchange scheme for personal callers. H.P. Available

RECORD PLAYERS

Full range at usual competitive prices. Interesting H.P. facilities. **E.M.I. MODEL 985 4-SPEED SINGLE RECORD UNIT.** Very latest type. Heavy 8 1/2 in. dia. turntable, low flutter performance. 200/250 v. with tap at 80 v. for operating amplifier valve filament if required. Complete with matching pick-up with mount and rest. Brand new and fully guaranteed. **ONLY 89/6**, plus 3/6 P. & P. Pick-up available separately, complete with mount and rest 25/-, plus 1/6 P. & P.

4-SPEED BATTERY OPERATED VERSION OF ABOVE 6 volt operation complete with pick-up £5/19/6 plus P. & P. 3/6.

TRANSISTOR AMPLIFIER now available for use with the above battery player. Compact size, 500 milliwatts output, printed circuit construction, tone and volume controls. Supplied complete with 8 in. x 2 in. 20 ohms matching quality speaker. Price only 89/6 plus 2/6 P. & P.

LATEST GARRARD MODEL 210. Four-speed manual or automatic. 10 in. and 12 in. records of same speed can be mixed in any order, wired for stereo, attractive white colour scheme. Price 10 1/2 gns., plus 3/6 P. & P.

JUST RELEASED! LATEST GARRARD 4-SPEED AUTO SLIM—Monaural, wired for stereo, £9/3/4. Plus 3/6 P. & P.

LATEST B.S.R. UA20. Small compact. 4 speed. For Stereo/Monaural use at £8/19/6. Plus 3/6 P. & P.

LATEST B.S.R. UA14. 4-speed. Attractive appearance. Wired for stereo. Fully guaranteed. £7/19/6 plus 3/6 P. & P.
B.S.R. UA14. Stereo/Monaural. Fully guaranteed. £8/19/6 plus 3/6 P. & P.

THE CRY (19) BABY ALARM



This highly efficient unit is simple to assemble, extremely sensitive and may be installed in a matter of minutes. Completely safe employing a double wound mains transformer. Attractively finished in Red and Grey (washable) "Lionide" with cream plastic escutcheon. Size only 7 1/2 in. x 6 1/2 in. Supplied in six form complete with mike at **ONLY 72/6** plus 2/6 p. & p. or assembled and tested 89/6 p. & p. 1/6. Suitable mike flex available at 1d. a yard. Instruction book and price list separately 1/- post free A.C. 200-250 v.

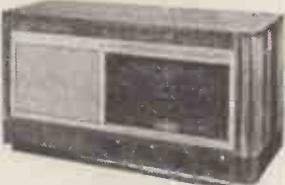


TWO CHASSIS BARGAINS! Not repeatable, limited quantity.



4 VALVE AC/DC SUPERHET (as illus.). Medium and long waves. Valve line-up UCH42, UAF42, UL41, UY41. Dial size 6 1/2 x 2 1/2 in. Overall chassis size 9 in. x 6 1/2 in. x 5 1/2 in. high. Complete with 5 in. quality speaker, ready to fit, at only £5/17/6 plus 5/- p. & p. Also, as above, but **FOUR STATION PRE-SET SUPERHET** chassis. Two controls only, volume on/off, and simple 4 station rotary selection switch. Set to Light, Home and Third programme, also Light programme on long waves. Frame aerial included, also 5 in. quality speaker mounted on chassis. Overall measurement 9 in. x 6 1/2 in. x 5 1/2 in. high. Only £4/17/6 plus 5/- p. & p.

FRUSTRATED EXPORT. Not repeatable! L., M. and S.W. **SUPERHET RECEIVER.** Manufactured by McCarthey for export. At present for operation on 6 volts. but conversion details supplied free.



Valve line-up: 6K8G, 6K7G, 6Q7C, 6F6G, 6X5G and 6 volt 4-pin non-synchronous vibrator. 8 in. P.M. Speaker, 4 watts output. P.U. socket. Ext. L.S. socket, etc. Tone control. Fitted in polished wood cabinet, size 21 1/2 in. x 10 1/2 in. x 10 1/2 in. These cabinets are slightly soiled owing to storage, but each is guaranteed unused, in serviceable condition, tested prior to despatch. Price £5/19/6 only plus P. & P. 7/6, plus 28/6 for A.C. Mains Conversion Components if required. **OUTSTANDING BUY!**

A.M. RADIOGRAM CHASSIS. Manufacturers' surplus. Brand new and fully guaranteed. Long, Medium and Short Waves, ECH81, EF89, EBC81, EL84, EZ80, slow motion tuning, tone control, ferrite rod aerial. Provision for gram, extension speaker, and tape play-back. Chassis size 11 in. deep by 8 1/2 in. wide.



Dial engraved on attractive brown and gold front panel size 16 1/2 in. x 9 in. which forms escutcheon for easy fixing. **LIMITED QUANTITY ONLY** at £8/19/6 plus 5/- P. & P. H.P. available.

NEW! TAPE RECORDER CONSTRUCTORS

LATEST COLLARO STUDIO TAPE TRANSCRPTOR. Latest type incorporating Record, Interlock, Lever, Button, 3 motors, 3 speeds, 1 1/2, 3 1/2, 7 1/2 i.p.s., takes 7 in. spools. Push-button controls. £12/19/6 plus 5/- P. & P. Usual H.P. facilities.

NEW! TAPE RECORDER AMPLIFIER TYPE 8311-V. Sub-assembled — anyone can build! Printed Circuit, all components mounted and dip soldered. Already tested. Each lead cut to length. All that is required to complete the tape recorder is for a few components to be mounted in the cabinet and the free ends of the leads soldered to terminals which are clearly marked. Everything supplied, all you need is solder iron, pliers and screwdriver. Valve line-up, EF66, ECC63, 2 x EL64, EZ81 and EM84 magic eye. Monitoring facilities, output socket for leading to high quality amplifier, can be used as "straight" amplifier for record reproduction. **EQUALISING ON TWO SPEEDS. OUTSTANDING VALUE AT £11/11/-** plus 2/6 P. & P. including all necessary instructions



ATTRACTIVE TWO-TONE PORTABLE CARRYING CASE. Suitable for above amplifier and Collaro Studio deck. Fitted with 9 in. x 5 in. High Flux P.M. speaker for high quality reproduction. Inclusive price £5/5/- Plus 5/- P. & P.

The above 3 items purchased at one time, **SUPPLIED CARRIAGE PAID N.B.** Any microphone listed hereunder is suitable for use with this recorder.

CRYSTAL MICROPHONE. Sensitive Miniature Lapel-type. Complete with clip and screened lead. Brand new. 17/6. Plus 6d. P. & P. (as illustrated). **MIC 45-1.** Acos latest flat pistol-grip crystal microphone. Attractive black and gold finish. OUR PRICE 29/6 plus 1/- P. & P. **ACOS MIC-39-1.** Crystal stick microphone. List price 6 gns. Our price 39/6 plus 1/6 P. & P. **MIC 40.** General-purpose crystal microphone with desk stand. Our price 22/6 only plus 1/6 P. & P. **100C.** Imported crystal, attractive streamlined polished metal case, incorporates muting switch. OUR PRICE 39/6 plus 1/- P. & P. (stand 8/6 extra). Large range of microphones in stock—ask for list.



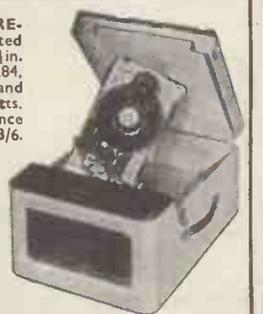
TELEPHONE PICK-UP COIL. Designed to feed into the microphone input of either a tape recorder or any high gain amplifier. Easily attached to telephone by rubber suction attachment. The coil is electrostatically shielded to minimise hum pick-up. When positioned on telephone this model is more than adequate for a fully modulated tape recording. Brand new complete with 5ft. shielded cable. **ONLY 14/-** P. & P. 1/6.

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PLASTIC TAPE SPOOLS. Best quality. 3 in. 1/6, 5 in. 2/-, 5 1/2 in. 2/3, 7 in. 2/6. **PLASTIC SPOOL CONTAINERS** for spool sizes 5 in. 1/6, 5 1/2 in. 2/-, 7 in. 2/3. Any single item plus 6d. P. & P. Orders over £1, post free.

LANGUAGE COURSES ON TAPE! Complete Elementary Course in French, Italian, German or Spanish. **PRICE ONLY 29/6** supplied. 5 in. long play tape, 55 minutes at 3 1/2 i.p.s. Price **ONLY 29/6** complete. Post Free! Trade Supplied.

EXTRA SPECIAL OFFER !! A small three-valve **PORTABLE RECORD PLAYER AMPLIFIER** mounted on baffle 12 x 7 in., with High Flux 6 1/2 in. Loudspeaker. Valve line-up UCC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. Ready for use, £5/12/6. P. & P. 3/6. **NEW STYLE CABINET** finished in two-tone Leatherette. Will accommodate above Amplifier and Baffle without modification, also most types of Ancillary Equipment. Overall size 18 x 13 1/2 x 8 1/2 in. Fitted with carrying handle, £3/9/6, plus 5/- P. & P. **NOTE.** If both items purchased together they will be supplied at a special inclusive price £8/7/6, plus 6/6 P. & P.



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We have been fortunate in obtaining a further limited supply of this fine and popular cabinet. Instantly recognised as being of leading High Quality manufacturer's stock, this trolley-type cabinet is finished in polished dark walnut. Can easily be adapted to accommodate tape recorder, amplifier, radiogram, loudspeaker enclosure, etc., etc. External measurements: 24½in. x 16in. x 29in. The whole is mounted upon "easy run" castors. Subject to being unsold £4/19/6 Plus 15/- C. & P.



ANOTHER PORTABLE CABINET BARGAIN! Ex leading manufacturer's battery portable attache type case. Attractive two-tone grey rexine finish. Size closed 13½in. x 9½in. x 3½in. Complete with fittings and handle. Including Medium and Long Wave frame aerial which fits in lid. On/off switch on lid stay. Limited quantity only at bargain price of 19/6 plus 2/- P. & P. Brand new.

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The well-known Brayhead **TRANS TRONIC "SUPER" 60" RADIO KIT**

A complete construction kit to make your own transistorised Transmitter and Receiver. No soldering reqd., 7 different circuits to build. Ideal Xmas Gift—beautifully presented in original manufacturer's coloured box with all necessary instructions. (As nationally advertised at £5/4/8.) Limited quantity only at 49/6. Plus P. & P. 4/-.



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As illustrated; new design in light oak. Two sizes available. For 6½in. or 8in. speaker at 22/6. For 10in. speaker at 25/- only. Each plus 2/6 P. & P. Suitable reconditioned 8in. P.M. unit at 13/6 only, plus 1/6 P. & P. Ask for speaker list.

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20,000 OHMS PER VOLT!!

MODEL 200H. Volt-ohm-Milliammeter RANGES:
A.C. VOLTAGE: 10, 50, 100, 500 and 1,000 volts (10,000 ohms per volt).
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RESISTANCE: 0-6k. 0-6 meg. (300 ohm and 30 k. at centre scale).
CAPACITANCE: 10 pf. to .001 mfd., .001 mfd. to .1 mfd.
DECIBELS: -20 to +22 db.

A fully guaranteed pocket size meter, knife edge pointer, top quality, supplied complete with test prods and full operating instructions at **£6.19.6** ONLY Post free.

JUST ARRIVED!! Model TE10. Identical in appearance and size with rotary type switch but 10,000 ohms per volt. Ranges: D.C. Voltages: 0-6-30-120-600-1,200 volts (10,000 ohms per volt). A.C. voltage: 0-6-30-120-600-1,200 volts (10,000 ohms per volt). D.C. current: 0-120 microamp., 0-3-300mA. Resistance: 0-30K, 0-3 Meg. (150 ohms and 15K at centre scale). Capacitance; 50pf to 0.01 mfd., 0.001 mfd. to 0.15 mfd. Decibels: **£5.19.6** Post free. -20 to +63 DB in 5 ranges. PRICE Bona-fide trade enquiries invited. Optional extra, attractive carrying case 15/- only. Leaflet available.

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SPECIALLY BUILT POWER PACK for TCS receivers, 230 volts A.C. mains, including 6X5GT valve, £3/10/-.

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FREQUENCY METER BC221 TECHNICAL MANUAL 22/6.

VIBRATOR UNIT. 12 v./160 v. 35 m/amps. Exceedingly well filtered and smoothed. Excellent for car radios. Including one 6X5G valve and vibrator 17/6. P. & P. 7/-.

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Instruction Manual for AR88D, £1.

FAMOUS RCA TRANSMITTER TYPES ET 4336, K. & L. Frequency 2 mc/s-20 mc/s. Power output: 350 w. telegraph, 250 w. telephone. Type of modulation—Class B high level. Audio input impedance 500 ohms. Power supply 190 to 250 v. Single phase 50-60 c. Tube complement: Crystal oscillators 807. Master oscillators 807. Intermediate amplifier 807. Power amplifier 813(2). Modulator 805(2). Rectifier 866A(4). Complete with Master oscillators, crystal multipliers, speech amplifiers, microphones, keys, instruction manual, etc. We guarantee full supply of all replacement parts for a minimum of 5 years after purchase. Price on application.

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Frequency range 2-22 mc/s. Keying speed up to 250 words per minute. Power supply requirements 230 v. 3 phase 50/60 cycles. Tube complement: Oscillator—807 (1). Doubler (1st) Amplifier—807 (1). Intermediate power (2nd) Amplifier—813 (4). Power (3rd) Amplifier—889-R (2). Plate rectifier—827A (6). Auxiliary Rectifier—872A (3). Bias Rectifier—872A (2). Keyer—807 (2). Price on application.

R209 RECEPTION SET. A 10-valve high-grade Super Heterodyne Receiver with facilities for Receiving R/T (A.M. or F.M.) and C.W. frequency 1 mc/s-20 mc/s. Hermetically sealed. Built on miniature valves and incorporating its own vibrator power supply unit driven by a 6 v. battery (2 point connector included). The set provides for reception from rod, open-wire or dipole aerial with built-in loudspeaker or phone output. Overall measurements: Length 12in., width 8in., depth 9in. Weight 23 lb. In as new, tested and guaranteed condition, £23/10/-, including special headphone and supply leads. Carriage £1.

AR 88's. Completely rebuilt with new PVC wiring. Type "D" £75; Type "LF" £70.

COMPLETE SET OF STRONG AMERICAN RODS (American). Screw-in type MP49, 50, 51, 52, 53, total length 15ft. 10in. Top diameter 0.185in. Bottom diameter 0.615in., together with matched aerial base. MP37 with ceramic insulator, ideal for car or roof insulation, £2/10/-, Post free.

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FAMOUS AMERICAN CARBON HAND MICROPHONE. Type T.17 £2/5/-.

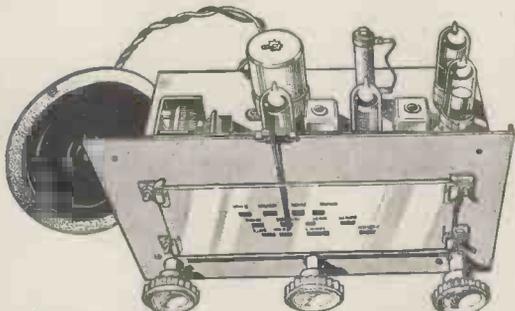
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A quality 4 valve AC/DC superhet chassis made by a world famous manufacturer. Long and Medium wave coverage. Fitted with a cord and drum reduction tuning drive and attractive illuminated glass dial (size 6½ x 2½ in.). Controls: Volume on/off, tuning and wave change. The receiver is self-powered, employing a mains dropper and a valve rectifier. Chassis dimensions 6½ x 9 x 5½ in. high. Supplied complete with a good quality 5-inch loudspeaker, valves (UCH42, UAF42, UL41, UY41), AC/DC mains input lead, ivory knobs, etc. **DON'T HESITATE, ORDER NOW!** This unbeatable bargain is bound to sell out quickly at only £4/19/6 plus 6/6 post and packing.

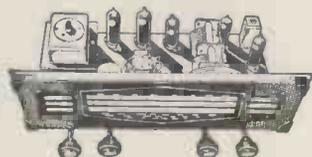
4 STATION PRESET CHASSIS with Speaker

ONLY £4.17.6
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A compact, 4 station pre-set mains transportable receiver for operation from AC/DC mains. Two simple controls, volume on/off and 4 position station selector. The latter is set to Light Programme (Long Wave), Third Programme, Home Service and Light Programme (Medium Wave) but may of course be adjusted to alternative selections if required. A frame aerial with throw-out extension is supplied, making this receiver ideal as a general purpose transportable set for the home. A fully smoothed power supply is provided from AC/DC mains input by a mains dropper and a valve rectifier. The good tonal qualities are assisted by the provision of a quality 5 in. speaker, which is ready-mounted on the chassis (this is easily detachable if alternative positioning is required). Valve line up: UCH42, UAF42, UL41, UY41. This chassis (size 9 x 6½ x 5½ in. high) is supplied complete with valves, knobs, mains lead, aerial, etc. It is beautifully made by a famous maker, and is a first-class buy at the rock bottom price of only £4/17/6, plus 6/6 post and packing.

A.M. RADIOGRAM CHASSIS



A chassis of distinction by a famous maker. Covering Long, Med. and Short Waves, plus gram position, this chassis (size 15½ x 7 x 6½ in. high), incorporates the latest circuitry, using fully delayed A.V.C. and negative feedback. Controls: Tone, Vol. On/Off, W/Change (L.M.S. and Gram), Tuning, Tapped input 200-250 v. A.C. only. An attractive brown and gold illuminated dial with matching knobs, make this one of the most handsome, in addition to being one of the best performing chassis yet offered. Complete with valves (ECH81, EF89, EBC81, EL84, EZ81), knobs, output transformer, leads, etc. **OUR PRICE £9.19.6** plus 4/6 post & packing.

E.M.I. 4-speed Player and P.U.



Heavy 8½ in. metal turntable. Low flutter performance. 200/250V. shaded motor with tap at 80V. for amplifier valve filament if required. Turnover LP/78 head. Price 89/6 plus 4/6 P. & P.

CONDENSER RESISTOR PARCEL
50 mixed P.F. Condensers and 50 mixed Resistors. An assortment of useful values. All popular sizes—all new—a must for the serviceman and constructor. **ONLY 10/-** P. & P. 1/-.

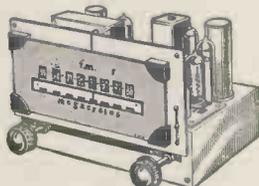
6 TRANSISTOR KIT

Less cabinet & speaker

Special offer. Limited quantity only of new ex-manufacturers parts to make a 6-transistor 2-waveband superhet chassis. Ideal for portable or table radio. All parts including transistors, ferrite aerial, printed circuit, etc., but EXCLUDING speaker and cabinet. Few only £4/19/6 plus 2/6 P. & P. Simple instructions 1/6 (free with kit).

A FEW ONLY £4.19.6 P. & P. 2/6

HARVERSON'S F.M. TUNER KIT



At last a quality F.M. Tuner Kit at a price you can afford. Just look at these fine features, which are usually associated with equipment at twice the price. ★ F.M. Tuning Head by famous maker. ★ Guaranteed Non-drift. ★ Permeability Tuning. ★ Frequency coverage 88-100 Mc/s. ★ OA81 Balanced Diode Output. ★ Two I.F. Stages and Discriminator. ★ Attractive maroon and gold dial (7 x 3 in. glass). ★ Self powered, using a good quality mains transformer and valve rectifier. ★ Valves used ECC85, two EF80s and EZ80 (rectifier). ★ Fully drilled chassis. ★ Everything supplied, down to the last nut and bolt. ★ Size of completed tuner 8 x 6 x 5½ in. ★ All parts sold separately.

£4.19.6 Plus 8/6 P.P. & Ins.

Circuit diagram and illustrations, 1/6, post free.

NOW AVAILABLE

A robust cabinet made from heavy gauge metal which has been specially designed to house the above F.M. tuner. Beautifully finished in a choice of glossy hammer green, or hammer grey enamel, or black crackle. The front panel (illustrated) has holes for control spindles and apertures for tuning dial and magic eye. **PRICE 25/-** P. & P. 1/9. (Front panel only 10/6 P. & P. 9d.)

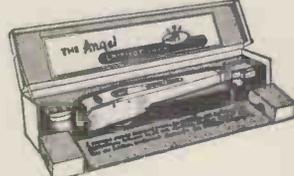


SUPER STEREO KIT MK. II

A kit of ready-built units only requiring inter-connection. Comprising two midget 3W amplifiers push button switch, transformer, control unit (bass, treble and vol.), power pack, two speakers, indicator light, valves (ECL82, EZ80 range), and comprehensive instructions. **£3.19.6** Plus 6/6 P. & P.

THE WORLD FAMOUS E.M.I. ANGEL TRANSCRIPTION P.U.

(Model 17A)



A Pick-up for the connoisseur originally priced at £17/10/-. The last remaining few offered at **£5/15/-** plus P. & P. 5/-.

TRANSISTOR AMPLIFIER KIT

A complete kit of parts to build a compact 4-transistor amplifier, with volume control and drilled panel. Two GT3 driver transistors, transformer coupled. 1 watt output from matched pair GT15. Supplied with output transformer and 2½ in. 3 ohm speaker. Ideal for record player, etc. **£9/6** Plus 4/6 P. & P.

SUPERHET CHASSIS

—less Valves & Cabinet

Modern AC/DC chassis with printed circuit and ferrite rod aerial. Although not completely built, the main components are mounted. L. & M. wave coverage. 4 valves (UBF89, UCL83, UCH81, UY85). Everything supplied except valves and cabinet. With speaker and simple instructions. **£3.3.6** Plus 3/6 P. & P.

BARGAIN MONTH FOR TRANSISTORS

POWER	TRANSISTOR	PRICE
OC44	GET15	9/-
OC45	GET15 (matched pr.)	16/6
OC71	GET102	7/6
OC75	XA103	8/6
OC76	PXA101	9/6
OC78	PXA102	9/6
OC78D	DIODE	
	OAB1	3/-

Please add 6d. postage for each transistor.

SWITCHED ATTENUATOR

Audio to V.H.F. in four steps of 20 dB ± 0.02 dB up to 300 Mc/s. Cost £5/10/-. **OUR PRICE £1.19.6** Plus 1/- P. & P.

83 HIGH ST., MERTON, S.W.19.

CHerrywood
3985/6

ENTHUSIAST'S 14 WATT AMPLIFIER KIT

A kit designed to meet the exacting requirements of the audio enthusiasts, yet remain within the price range of the average constructor. A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Superb reproduction of both music and speech (frequency response \pm 3db. c/s.-60 Kc/s. with negligible hum). Separate inputs for mike and gram allow records and announcements to follow each other, and make this amplifier ideal for small halls, youth clubs, etc. Fully shrouded ultra linear output transformer (to match 3-150 speaker), and fully shrouded mains transformer (these alone are worth over £3/10/-). Volume control, and separate bass and treble controls are provided, giving good lift and cut. Valve line up: 2 EL84s, ECC83, EF86, and EZ80 rectifier. All parts down to the last nut and bolt, including valves, heavy gauge metal chassis finished in glossy hammer green enamel (mains and output transformers finished to match).

P. & P. 6/6 (simple instruction booklet ONLY) **£6.19.6**
1/6. Free with Kit.

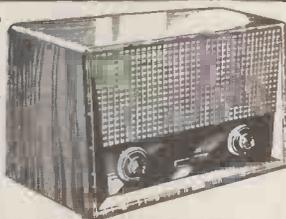
PRINTED CIRCUIT AMPLIFIER KIT

A top quality record player amplifier in kit form. This amplifier (which is used in a 29 gn. record player) has a printed circuit, and has an internal fully smoothed power supply (input A.C./D.C. mains) using a mains dropper and contact cooled rectifier. A flying panel is supplied, accommodating BASS, TREBLE, and VOL-ON/OFF controls. 2 valves (UL84 and UF89) and 1 linear output transformer give crisp reproduction from all records at 4 watts.

Our price for the complete kit of parts (including valves) ONLY **59/6**
Plus 6/6 P. & P. Simple instructions 1/6 (free with kit).

SUPERB WALNUT CABINET

A very fortunate purchase allows us to offer this quality table radio cabinet for only 16/6 (these cabinets cost the manufacturers 35/- each to make). The positions of the controls make it ideal for housing our 6 TRANSISTOR SUPERHET KIT described below. Beautifully finished in walnut and tygan. **OUR PRICE ONLY 18/6**
Plus 1/6 P. & P. and ins.



6 TRANSISTOR SUPERHET KIT

£6.19.6

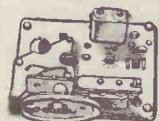
A first-class 2-wave-band transistor superhet in kit form.

- ★ Printed circuit board (size 8 1/2 x 2 1/2 in.).
- ★ 3 pre-aligned IF transformers.
- ★ Quality 5in. speaker.
- ★ G.E.C. first grade transistors.
- ★ Output transformer.
- ★ High gain ferrite rod aerial.
- ★ Push-pull output.
- ★ Car aerial input socket.

The complete kit of parts ONLY **£6.19.6** plus 2/6 P. & P. Simple instruction booklet 1/6 (free with kit). (Suitable cabinet if available 15/-)



F.M. TUNER HEAD



A permeability tuned tuner head by a famous maker, supplied without valve (ECC85) 18/6 plus 1/9 P. & P. Valve 8/6 extra.

TRANSISTOR SPEAKER

Western Electric. 3Ω or 80Ω. Size 2 1/2 x 1 1/2 in. deep. **12/6**
Plus 1/- P. & P.

SPECIAL OFFER! One doz. 6K7G **£1**, plus 2/6 P. & P.

COSSOR CRT SNIP

10in. 108K 18/6
10in. 75K 18/6
EITHER PLUS 6/6 P. & P.

OSCILLATOR COIL

Suitable for any tape deck. ONLY 5/6, plus 6d. P. & P.

REGUNNED T.V. TUBES

Any type, any size supplied.

G.E.C. FIRST GRADE TRANSISTORS

Set comprising one 874 mixer, two 873 I.F.s, one GET114 driver, two GET113 matched output and one diode. **34/6**
Post 1/-.

COLLARO STUDIO TAPE DECKS

We have a few only of the latest model at the Special price of

ONLY £10 Plus 5/6 post & insurance

CRYSTAL MICROPHONES

Ideal for tape recorders, use with amplifiers, intercom., etc.

T.S.L. stick mike **22/6**

ACOS latest model **18/6**

Postage 1/8 either model

THE HARVERSON COMPLETE F.M./V.H.F. RECEIVER KIT £6.19.6

AT LAST—A COMPLETE F.M. RECEIVER IN KIT FORM! Specially designed with the home constructor in mind, this kit enables the construction of a completely self-contained V.H.F. receiver at fraction of the normal cost of comparable equipment. This is basically a quality self-powered F.M. tuner plus 2 separate audio amplifier stages, with output transformer and speaker.

- ★ F.M. Tuning Head by famous maker.
 - ★ Guaranteed Non-drift.
 - ★ Permeability Tuning.
 - ★ Frequency coverage 88-100 Mc/s.
 - ★ OA81 Balanced Diode Output.
 - ★ Two I.F. Stages and Discriminator.
 - ★ Self powered using a good quality mains transformer and valve rectifier.
 - ★ Valves used ECC85, two EF80's, ECL82 and EZ80 (rectifier).
 - ★ Fully drilled chassis.
 - ★ Good quality speaker.
 - ★ Well designed output transformer.
 - ★ Attractive maroon and gold glass dial.
 - ★ Two output stages (using ECL82).
 - ★ Everything supplied, down to the last nut and bolt.
 - ★ Compact size.
 - ★ All parts sold separately.
- OUR PRICE **£6.19.6** Plus 4/6 P. & P.



Introducing HARVERSON'S Monaural Amplifier Kit

39/6

In response to numerous requests from delighted purchasers of our "SUPER STEREO KIT" we have produced a "MONAURAL AMPLIFIER" on similar lines.

★ A UCL82 valve provides a triode amplifying stage, and a pentode output stage (3 watts), enabling good amplification and sparkling reproduction to be combined with physical compactness (amplifier size, 7 x 3 1/2 x 6 1/2 in. high).

★ Modern circuitry design, good quality O.P. transformer (to match 3Ω) keep hum and distortion to a low level.

★ The controls, volume on/off and tone, are complete with attractive cream and gold knobs.

★ The amplifier has a built-in fully smoothed power supply, using a good quality mains transformer (A.C. mains only) and metal rectifier.

★ All you need is supplied including easy to follow instructions which guarantee good results for the beginner and expert. All components, leads, chassis, valve, knobs, etc., are first grade items by prominent manufacturers.

OUR PRICE **39/6** Plus 4/6 post and packing.

5in. LOUDSPEAKER TO SUIT, 14/6 EXTRA ALL PARTS SOLD SEPARATELY

VALVES

WE HAVE 20,000 IN STOCK AT LOWEST PRICES EVER!

Send for your requirements

TESTGEAR COMPONENTS (LONDON) LTD

2/4 Earham Street, London, W.C.2 (CAMBRIDGE CIRCUS) Tel: TEM 1189

A few minutes' walk from Leicester Square or Tottenham Court Road underground stations.

TRANSISTORS. We have purchased a manufacturer's stock of transistors and offer them at the following low prices:

G.E.C.: GET.572 10 amp. switch or audio. Price 12/6.
GOLTOP: V30/10PD 3 amp. switch or audio. Price 7/6.
MULLARD: OC.28, OC.35, OC.16. Price 15/-. OC.170. Price 10/-. OC.71. Price 4/6. OC.75. Price 5/-. OC.71, OC.72, OC.44 equivalents (white black and blue spots), 3/6 each.

U.S.A. P.O. TYPE RELAYS. Type APHC, 6,500 ohm, 12 v. 2 m/a., S.P.C.O. Price 2/6. Type APLC, 3,500 ohm, 6 m/a., S.P.C.O. Price 2/6.

A.P.N.I. RADIO ALTIMETER. A 420-460 Mc/s. Radar Set, complete with 14 valves and 3 relays. Price 25/-. 24 v. dynamotor 7/6 extra. Transmitter unit ex above, includes two 995 acorns and transducer, as used in "Wireless World" wobblator. Price 6/6. Receiver unit ex above, includes two 20004 acorns. Price 5/-. Audio amp., ex above, includes two 12SH7. Price 5/-.
RECTIFIERS. Contact cooled bridge rectifiers output 250 v. 120 m/a. Price 5/6. Transformer for same with 6.3 v. 3 a. winding. Price 8/6.

VALVES. We carry comprehensive stocks of all popular R/X and T/X tubes. TT21, TT22, 6146, etc. A few examples of our low prices: 6AG7, 5U4, 6AK5, QV04/7, 6AQ5, 6SL7, 6SN7, 12AX7, 12AU7. All 5/- each. 6J6, 6AM5, 6AM6, 6C4, 6F80, 6SK7, 1625. All 2/6 each. 807, 7/6 each. 12SH7, 6AC7, 12SJ7, 717A, 6F50, 6F54, 955, 9004. All 1/6 each. Hundreds of other types available at similar prices.

FT.241 CRYSTALS. Fresh stocks of all types have now arrived. Channels 0 to 41 and 56 to 79 are 5/- each. Channels 42 to 55 are 7/6 each. Channels 270 to 322 and 341 to 389 (except 360) are 2/6 each. Channels 323 to 340 are 7/6 each.

9 MC/S. CRYSTALS. Spot on crystals in 10XJ holders. Price 10/- each. Or within ± 5 Kc/s. of 9 Mc/s. Price 7/6 each. Sockets 9d. each.

10X AND 10XJ CRYSTALS. An even wider range than previously is now available. Send for our list with new supplement.

CRYSTAL FREQUENCY STANDARDS. 10X type. 500 K/c, 7/6; 100 K/c, 15/-; 1,000 K/c, 15/-.

50 MICROAMP METERS. Made by Sangamo Weston. Brand new. Type S.145. Size $3 \times 2\frac{1}{2}$ in. 850 ohms resistance. Four scales operated by lever "Set Zero," "0-3," "0-300." Easily coupled to rotary range switch by cord or lever. A gift at 20/-. Easily adjusted to 25-0-25 microamps.

RELAYS. As used in 1986, etc., series aircraft transmitters. Size $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$ in. 700 ohm coil, or 250 ohm coil. Operates on 12-24 v. Double pole changeover. Price 3/6. Aerial changeover relays. 12-24 v. operated 4 P.C.O. Price 3/6.

R.F. CHOKES. Type (1) 2.5 MH, 250 m/a. pie wound. Price 2/6. Type (2) 1.5 MH pie wound 50 m/a. Price 1/-.

B.C.221 FREQUENCY METERS. In perfect condition, complete with original calibration chart. £16.

TYPE 46 TRANSCEIVERS. The best bargain for many years. These fine Walkie Talkies are now available in new condition, complete with all accessories at a give-away price. Three-channel crystal controlled T/X and R/X, supplied complete with one pair crystals, coil box, rod aerial, leads and plugs, valves, balanced armature headset with throat mike. 1 watt output. Coverage 3.6-4.3 Mc/s. or 6.7-7.6 Mc/s. by means of plug-in coil box. Inland buyers supplied with crystals in 3.5 or 7 Mc/s band (state which required) other frequencies available for export. Requires only 150 v., 15 v., and 3 v. dry battery. Range over 10 miles. Full instructions and circuit supplied. These units have been "demobbed" by removal of the "Send Receive" switch. A replacement switch with fitting instructions is supplied. We offer this fine unit with all accessories as listed above at the ridiculous price of 30/- or two for 57/6. Batteries are available at 24/- per set.

TIME SWITCHES. Type (2) Venner 14-day clockwork time switches. One make and one break every 24 hours. Complete with key, 5 amp. contacts. Price 32/6. Type (3) mains driven time switches. By first rate manufacturer. 200/250 v. 50 c. 10 amp. contacts. Can be supplied with up to three "makes" and three "breaks" every 24 hours. Price with one pair of contacts £25/5-, each extra pair contacts, 4/-. Type (4), as above, but 20 amp. contacts. Price 69/6. Each extra pair contacts 4/-.

R.F. CABLES. $\frac{1}{4}$ in. diam. 52 ohm co-ax., 2/6 per yard. $\frac{1}{2}$ in. diam., ditto, 9d. per yard. 300 ohm ribbon, 6d. per yard. 80 ohm balanced feeder, 4d. per yard.

METERS. 2 in. square, flush, m/c., 0-50 m/a. Price 10/-. 2 $\frac{1}{2}$ in. scale, 3 $\frac{1}{2}$ in. diam. Flush 0-30 or 0-100 m/a., 10/-. Many others available.

I.F. TRANSFORMERS. Good quality iron-cored 465 Kc/s. transformers. Type (1) size $1 \times 1 \times 2$ in. Price 2/6. Type (2) size $2\frac{1}{2} \times 1\frac{1}{2} \times 1$ in. Price 2/6.

PLATE TRANSFORMERS. Type (66) 730-715-700-0-700-715-730 v. 330 m/a. D.C. and 280-0-280 v. 60 m/a. D.C. Size $6\frac{1}{2} \times 5\frac{3}{4} \times 7\frac{3}{4}$ in. H. price 47/6.

MAGSLIPS. Type (1) 50 v. 50 c. May be used as transmitter or receiver. 3 in. diam. Price 17/6. Type (2), as above, but 2 in. diam. Price 15/-.

VARIACS. 110 v. input, 0-130 v. output. 5 amps. Price £4.

CO-AX CONNECTORS. Telcon Miniature screw-on plugs and sockets. Price 1/6 per pair. F. and E. standard size screw on plugs and sockets. Price 1/6 per pair.

SILICON RECTIFIERS. Miniature silicon power diodes at new low prices. Made by one of England's greatest manufacturers. 250 m/a. D.C. output. Type (1) 400 P.I.V. Price 3/6. Type (2) 600 P.I.V. Price 5/6. Type (3) 800 P.I.V. Price 7/6. Type (4) 1,000 P.I.V. .45 a. Price 8/6.

OFFICE DICTATING MACHINES. An obsolete type but the biggest bargain ever. Contained in portable carrying case, wind-up double spring motor, 4 valve amplifier (B7G type valves), 6 minute play recording mechanism using magnetic plastic discs that may be reused indefinitely. Complete with crystal mike that doubles as playback speaker. Send for full details. Complete with 10 discs (extras 1/6). Price £33/3-. Batteries (2) 15/-.

MODULATOR UNITS. Type (1) Ex the 1985 Aircraft T/X. 7 watts Class B. Output crystal or low impedance input. Output matches TT15. Complete with valves 10/-. Type (2) Bendix MP28 unit, the modulator for the TA12 T/X. 50 watts audio from class "C", 807s. Complete with 4 relays (2 antenna type). 6F6, 6N7, two 807s. Price £33/3-, or less 28 v. dynamotor, £22/2-.

COLLINS ART-13 AUTOTUNE TRANSMITTER. An excellent T/X at a give-away price. Coverage: 2-18 Mc/s., 21 and 28 Mc/s. easily added. Autotune mechanism allows selection of any one of eleven (pre-selected) frequencies. Built in 200 Kc/s. crystal calibrator checks the typical Collins Super Stable V.F.O. Uses standard valves including PP811's modulating the 813 final. Size only 2 $\frac{1}{2}$ in. wide, 16 in. deep, 12 in. high. Requires power supply of 1,000 to 1,250 v., 250 m/a. (for 100-200 v. input). 400 v. 225 m/a. and L.T. for heaters and autotune mechanism. Supplied complete with valves, calibration charts, circuit, and full technical details, including 21 and 28 Mc/s. conversion and power supply information. Definitely no snags (except TVI). In fair condition, and less both meters, £10/10-.

Send for full details.

FT.243 CRYSTALS. In addition to our standard range we now offer 3.5, 3.540, 3.590, 3.640, 3.680, 3.720, 3.760, 3.800 Mc/s., and 100 other types previously unobtainable between 3.840 and 6.450 Mc/s. All at 5/- each.

BATTERY CHARGING APPARATUS. 4 amp. bidge rectifiers, 15/-. Transformers for same, tapped for 6 or 12 v. battery, 18/6. Ballast 1/6. 36 v. 10 amp. bridge rectifiers, 35/-. Transformer for same 55/-. 12 v. 7 amp. bridge rectifier 25/-. Transformer for same 35/-. 24 v. 2 a. bridge rectifier 8/6. Transformer 10/-.

UHF TUNERS. TN17 front end for APR4, 75-320 Mc/s. £10/10/- Modern front end 190-240 Mc/s., £5/5/-.

R.F. UNITS. RF.25 (brand new) 15/-. RF.27 (brand new) 20/-.

PLATE TRANSFORMERS. 1,100-0-1,100 v. 400 m/a. Price £3/5/-.

CRYSTALS FOR REGRINDING. We offer high grade crystals in 10X holders within 50 Kc/s. (lower of your specified frequency at the bargain price of 6 for 10/-). Limits 2-8.5 Mc/s.

VALVE HOLDERS. Best quality B7G, B9A, Octal. Price 6d. each. 813, price 3/6.

GARRARD TURNABLE WITH MAGNETIC PICKUP. Mains operated. 78 r.p.m. A gift at 17/6.

PICKUP HEADS AND CARTRIDGES. Collaro Studio "0," complete head, 15/-. Acos inserts, G.P. 59-1C, 10/-. HGP 39-1, 10/-. HGP 59-1C, 10/-. Decca XMS complete heads, 10/-.

OUTPUT TRANSFORMERS. Type (1) E.M.I. PP 7,500 to 3 ohms (50-1) handles 8 watts. Type (2) Plessey PP 10K ohms to 5 ohms or 6 K ohms to 3 ohms. 4 watts. Price 5/-. Type (3). As above but 10 watts, 10/-. Type (4) 6V6 to 3 ohms (45-1). Price 2/-.

MAINS TRANSFORMERS. Type (26) input 230 v. output 250 v. 60 m/a. (H.W.) and 80 v. at .1 a., 5/-. Type (16) 250 v. 65 m/a. (H.W.) and 6.3 v. 3 a., 6/6. Type (350/120), 350-0-350 v. 120 m/a., 6.3 v. 3.5 a., 5 v. at 2 a., 16/6. Type (350/300) 350-0-350 v. 300 m/a., 6.3 v. 8 a., 5 v. 2 a., 4 v. 2 a., 6.3 v. 2 a. Price 27/6. Type (5K), 230-0-330 v. 300 m/a., 5 v. 3 a. tapped at 4 v. 2 v. 2 a., 10 kV ins., 3) v. 1 a., 7.5 v. 1 a., 5 kV 5 m/a. Price 25/-. Type (4V) 280-0-280 v. 70 m/a., 6.3 v. 2 a., 4 v. 2 a. Price 9/-. Type (6V4A) 6.3 v. 4 a. Price 8/-.
T.C.C. BLOCK CONDENSERS. 4 mfd. 2 kvv. at 60 deg. C. Price 7/6

P.M. LOUDSPEAKERS, Shopped but perfect. 5 in. diam. Price 6/6 8 in. diam. Price 7/6

SELENIUM RECTIFIERS. 250v. 120 m/a. H.W., 2/6 400 v., 2 m/a., 1/6.

TOGGLE SWITCHES. Long dolly type. D.P.C.O. Price 1/6. 4 P.C.O. with centre off position, price 1/6.

ELECTROLYTIC CONDENSERS. Fresh stock. Wire ended. Insulated tubular case. 25 MF., 25 VW., 25, 50 or 100 mfd., all 50 VW. 10, 30, 40 or 50 mfd., all 150 VW. All 1/- each. 20+20 or 40+40 mfd., 150 VW. 1/6 each. 4, 8 or 16 mfd., all 450 VW., all 1/- each. 20, 32, 40, 80 mfd., 450 VW., all 1/6 each. 10+10, 20+20, 32+32, 40+40, all 450 VW. All 2/- each.

ILLUMINATION METERS. High grade meters by G.E.C., direct reading 0-1,000 LUX (0-100 foot candles). Price 17/6.

BARGAINS FOR CALLERS. A large range of bargains at attractive prices. ART. 13's from £8/8/- (also spares). Class D Mk. III wavemeters from 30/-. All units from the 1131 transmitter, in brand new condition at give-away prices, also the 1131 enclosed rack.

SOLDERING IRONS. Solon standard, extra light, straight pencil bit, 65 watt 80 v., 10/-; 230 v. 18/6.

POT CORES. Mullard Vinkor complete assembly type LA2509. Build your "Q" Multiplier with this and obtain a "Q" of over 4,000. Price 12/6.

2 METER R/X. Receiver portion of the SCR.522 TX/RX. Brand new with valves and conversion details for continuous tuning 144-46 Mc/s. Price 30/-. Or with relay, 37/6.

CRYSTAL CALIBRATORS. The well known Class "D" Mk. 3 calibrator. Used, but in perfect working order. Price 39/6.

CERAMIC WAVECHANGE SWITCHES. Type (1): Complete assembly as used in the AR.88. Price 8/6. Type (2): Wearite heavy duty 4-bank switches, each bank 2 poles 6 ways. Price 7/6. Type (3): 2 band 1 pole 11 ways. Price 7/6.

VEHICLE COMPASSES. The Sherill M.6. A superb compass originally designed for armoured cars. Complete with manual and deviation correction card. Further details on request. Cost over £40. Price £315/-.

I.F. AMPLIFIER STRIPS. Three stage I.F. amplifier strips ex the TR.1985/1986 series transmitters. Frequency 9.72 Mc/s. Widely used as an F.M. amplifier, etc. Price, complete with 6 valves, 10/-.

TOROIDAL CORES. 2in. diam. $\frac{3}{8} \times \frac{3}{8}$ in. 3/6.

FERROX-CUBE LA2/type 25 pot cores. 5/-.

POT CORES. $\frac{3}{8}$ in. diam., $\frac{3}{8}$ in. thick, adjustable slugs. 1/6 each.

CRYSTAL DIODES. Germanium general purpose, 6d. OA81 EQUW, 9d. Printed circuit board, fitted with 10 OA81's and several other components. Price 2/6. Type (2) as above but fitted with 10 OA71's, price 2/6.

POWER PACKS. Admiralty type 95. In attractive steel case, size 14 x 11 x 6. Rated output 400 v. (choke input) at 50 m/a. and 6.3 v. 1 a. but 100% overload O.K. Complete smoothing. Complete with all connector plugs. Price 50/-.

MODULATION TRANSFORMERS. Type (1) Collins T.C.S. P.P.807 to parallel 807's. Ratio 1-1, 25 w. audio. Price 12/6. Type (2) T.B.S. type 50 w. audio turns, ratio 1-1.65 CT. Price 18/6. Type (3) Ex 1131. 150 w. audio. Ratio 1.1 CT. Price 25/-.

C/R BRIDGES. Mullard type GM 4140. Price £4/15/-.

60-95 MC/S T/X R/X. Eddystone P40 single channel crystal controlled receivers, converted to F.M. Soiled but complete. Price 22/6. Matching transmitter 25/-.

CONSTANT VOLTAGE UNITS. Made by Pye. Standard mains input. 4 KVA output. Price £15. Send for full details.

SPECIAL PURPOSE VALVES. 931A, 27/6. 85A1, 10/-.

DL510, 7/6. GS10C, 17/6. EL81, 7/6. 58CV (miniature photocell), 5/-. EL36, 7/6. 6032 (infra-red tube), £3. CV2272 (C.R.T.) 30/-.

CV466, CV467, CV468, all 5/-.

4 METER MOBILE TX-RX. A few only B.44 Mk. II radio telephones. Coverage 60-95 mc/s. T/X and R/X single channel, crystal controlled. R/X is double superhet. T/X output 3 watts. Built in 12 volt power supply, draws 3 A. on receive, 4.5 A. on transmit. Provision for loud hailer operation (3 watts). Built in loudspeaker. Size 14 x 7 x 13in. Complete with all plugs, technical manual, service manual, moving coil mike. Unused, but may have minor faults due to long storage. All spares available. Price £4/4/-.

R/X crystal in 4 meter band (surplus) 5/-. T/X crystal (new) 37/6.

B.44 MK.I. An earlier version of the above, but an excellent basis for conversion to a fixed station. Output is nominally 4 watts but both final and modulator are QQZ04/15 double beam tetrodes capable of 14.5 w. output at highest frequency. Specification is otherwise similar to the Mk. II. A built in 12 v. power supply is fitted on a separate chassis. Substitution of the power supply by a 400 v. mains power pack plus the necessary circuit alterations will provide a base station capable of over 30 watts output. Price (complete TX/RX) with accessories as with Mk. II, £5/15/- or less case and power supply £3/5/-.

R/X crystal in 4 meter band (surplus) 5/-. T/X crystal (new) 37/6.

R/X UNIT TYPE R.114. An excellent basis for a 2 meter converter (See February S.W. mag.). Complete with valves and Jones plug and socket. Price 15/-, post paid. Extras if required, 7580 crystal 5/-.

I.F. trans. as specified (unconverted) 2/6.

MARCONI CR.150. In almost new condition. Less power supply. £21.

TOP BAND CRYSTALS. For grinding to 1.8-2 mc/s. we offer super quality extremely active 1,700 kc/s. crystals at 4 for 10/- including one (3-pin) socket.

H.F. CRYSTALS. Miniature, glass encapsulated, wire ended crystals. Six types each containing two quartz plates separated by 50 kc/s each. of six crystals are also separated by 50 kc/s. Lowest frequency is 19,887.5, highest 20,437.5. Ideal for "rubber" crystal VFO., etc. Price 3/6 each or 15/- for set of 6

CRYSTAL BARGAIN PACKAGE. We have large stocks of 10 x crystals surplus to our requirements. We offer 40 different crystals between 2 and 8.5 mc/s. at £1. For customers ordering more than £1 worth we will still supply completely different frequencies.

RECEIVER TYPE R1475. The well known "88" set. R.F. stage, two I.F. stages, BFO, extensive bandspread over 2-20 mc/s. 600 kc/s. (I.F. frequency) crystal calibrator. In excellent condition but untested. Price £7. Mains power pack £2. Several also available in poor condition (for callers only) from £3.

1,550 KC/S I.F. TRANSFORMERS. Size $1\frac{1}{2} \times 1\frac{1}{2} \times 2\frac{1}{2}$ in. Price 2/6 each.

SMOOTHING CHOKES. 75 H., 25 m/a., 1,500 ohms. 5/-.

150 MICROAMP METERS. Edgewise (horizontal) scale type Mirror scale type (1) 7in. scale calibrated, -150 to -200 deg. C. Price £3/10/-.

Type (2) 10in. scale calibrated, -130 to -200 deg. C. Price £4/15/-.

A.C. VOLT METERS. Weston flush mounting 4in. scale rectifier type. 0-100 volts, 50-2,500 C. Price 30/-.

MAGNETIC AMPLIFIERS. Brand new units by Elliot. Price 35/-.

Write for details.

COSSOR DOUBLE BEAM SCOPES. A few available for callers from £10.

TAYLOR VALVE TESTER TYPE 45B. In excellent condition. £14.

TRIPLETT TYPE 1632 SIG GEN. 100 kc/s.—120 mc/s. As new £15.

DECADE BOXES. 4 range. Ex Post Office. Price £2/10/-.

TAYLOR TYPE 30A SCOPE. $3\frac{1}{2}$ in. tube in excellent condition. £16/16/-.

PORTABLE STANDARD VOLTMETERS. 7in. mirror, scale 0-30 v. Price 30/-.

ATMOSPHERIC PRESSURE SWITCHES. Employ triple anod. Price £3. Associated relay system. Price £2.

WAYNE KERR TYPE CT34 SCOPE. Miniature portable scope, 24 v. D/C operated. As new. £18.

G.E.C. VTVM. 1.5-150 v. A.C./D.C. 8in. mirror scale with probe. £9/9/-.

MARCONI VTVM. Type TF 2488/1. 1.5-150 v. Price £14.

INSULATION TEST SETS. Contain a 5 kv. power supply. Metered. Price £4.

MARCONI SIGNAL GENERATORS. Type TF390G 16-150 Mc/s. Brand new with manual and all accessories. Price £8/10/-.

SPOT FREQUENCY CRYSTALS. 2 mc/s. 7/6. 5 mc/s. 5/-.

Both $\frac{3}{8}$ in. fitting.

MOVING IRON VOLT METERS. 4in. scale 0-300 V. 50 c. Flush mounting. Price 15/-.

100 WATT AUDIO OUTPUT TRANSFORMERS. Multi-ratio push pull. Price 25/-.

7 MC/S. CRYSTALS. 10XJ fitting. Every 1 k/c from 7000 k/c to 7010 inclusive. Price 5/- each.

"C" CORE TRANSFORMERS.

Type (2530). 250-0-250 v. 60 m/a. 6.3 v. 3 a. 5 v. 2.5 a. 6.3 v. 2 a. Price 17/6.

Type (OT9A). 500-0-500 v. 180 m/a. 5 v. 3 a. 6.3 v. 6 a. 6.3 v. 3 a. Price 35/-.

Type (OT2A). 350-300-0-300-350 v. 120 m/a. (Both tapings simultaneously). 5 v. 3 a. 6.3 v. 4 a. 6.3 v. 3 a. 5 v. 3 a. Price 35/-.

H.R.O. COILS. .9-2.05 mc/s. Price 17/6. Various long wave types for rewinding. Price 10/-.

D.C.-A.C. CONVERTERS. War surplus dynamotor type. Input 12 v. Output 230 v. 50 c. 100 V.A. with built in variable resistor and meter. £7/10/-.

ISENTHAL VARIABLE RESISTORS. Type (1) Graded. 24-3.5a. 5.7 ohms. Price 37/6. Type (2) 17-3.5a. 6.8 ohms, 32/6.

BATTERY CHARGERS. Will charge two 12 v. batteries at 6 amps in steel case fitted with volt and amp meters. Variable output (coarse and fine). Price £5/10/-.

TERMS OF BUSINESS. All prices include postage or carriage within 200 miles. Handling charge of 1/6 on orders under 10/-. Payment cash or C.O.D. over £1. Export orders welcomed.

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TESTGEAR COMPONENTS (LONDON) LTD

2/4 Earlham Street, London, W.C.2 (CAMBRIDGE CIRCUS) Tel: TEM 1189

A few minutes' walk from Leicester Square or Tottenham Court Road underground stations.

R.S.C. (M/c) LIVERPOOL MANCHESTER LEEDS BRADFORD

Personal Shoppers welcomed at
 73 Dale Street
 4 mins. from Exchange Station
 8 mins. from Lime St. Station

8-10 Brown Street
 (Market Street)

5-7 County
 (Mecca) Arcade,
 Briggate, Leeds, 1

56 Morley St.
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TERMS: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2. 3/3 extra under £5 unless carriage stated. Trade supplied. Post order to: Mail Order Dept., 29-31 Moorfield Road, Leeds, 12.

R.S.C. HI-FI TAPE RECORDER KIT

Build a high quality recorder in the £70 class for only

25½ GNS.

OR DEPOSIT £5/7/6 and 12 monthly payments of 42/-.
 Cash price if settled in 3 months.

Can be assembled in 1 hour.

INCORPORATING THE LATEST GOLLARO STUDIO TAPE TRANSCRIPTION THE LINEAR LT46X HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7 x 4in. LOUDSPEAKER. Reel of Best Quality TAPE, Spare Tape Spools, a Portable Cabinet, size approx. 16 x 13 x 9in., finished in durable and attractive du-tone Poliorone and frequency diagram for wiring amplifier to transistor.

FEATURES INCLUDE:

- ★ 3 SPEEDS ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZING FOR EACH SPEED ★ OUTPUT 4 WATTS ★ MAGIC EYE RECORDING LEVEL INDICATOR ★ 3 MOTORS Fast rewind ★ TAPE MEASURING AND CALIBRATING DEVICE ★ TAKES FULL 7in. DIAMETER REELS OF TAPE ★ NEGLIGIBLE HUM ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.

Full descriptive leaflet supplied on receipt of S.A.E.



HI-FI 10 WATT AMPLIFIERS

BRAND NEW CARTONED MANUFACTURERS DISCONTINUED £7.19.6

A REMARKABLE OPPORTUNITY. Carr. 7/6. Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs, for mike and gram. Separate bass and treble controls. High sensitivity. Output for 3 ohm or 15 ohm loudspeaker. Guaranteed, tested and in perfect working order. For 200-250 A.C. mains.

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (especially suitable for use with any of our Amplifiers). A Triode Heptode P/longer is used. Pentode I.F. and double Diode Second Detector delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram-rotation. Controls are Tuning, W. Ch. and Vol. Output will load most Amplifiers requiring 500 mV. input depending on A/c location. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9.6-7in. high. Send S.A.E. for Illustrated leaflet. Total building cost of £4/15/-. Point-to-Point wiring diagrams and instructions 2/6.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS

HF1012, 10 watts, 15 ohms (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4/12/9. Please state whether 3 ohm or 15 ohm required.

BASS REFLEX CABINET. Specially designed for above speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18x12x10in. Strongly made. Handsome appearance. Ensure superb reproduction for only £3/19/6.

EXTENSION SPEAKERS. Handsome walnut veneered cabinets. All standard 2-8 ohms. 6in. 29/9. 8in. 35/9.

MULTI-METERS

CABY A10 Basic meter, sensitivity 155 microamps. A.C. and D.C. ranges. £4/17/6.

CABY B20. Sensitivity up to 10,000 ohms per volt A.C. and D.C. £6/10/-.

ACOS HI-FI CRYSTAL 'MIKES'

Mic 40 Hand or Desk type
 27/9 (Listed 45/-)
 39-1 Stick type
 39/6 (Listed 45/-)
 Limited number.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagram 39/9 or ready for use 46/9.

Type BM2. Size 8 x 6½ x 2½in. Supplies 120 v., 90 v. and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp., fully smoothed. THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2 v. ACCUMULATOR! when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions. 49/9 or ready for use 59/6.

POWER PACK KITS. Only 19/11. Fully smoothed H.T. output of 250 v. 90 mA and L.T. supply of 6.3 v. 1.5 amp. Consisting of Double Wound Mains Transformer 230/250 v. 50 c.p.s. A.C. primary. Selenium Rectifier. Smoothing Choke, Double Electrolytic Condensers, Aluminium Chassis and Circuit.

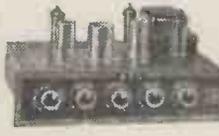


R.S.C. A12 STEREO AMPLIFIER KIT 4 GNS.

WITH TWIN 6in. SPEAKERS
 A complete kit of parts to construct a good quality 3 + 3 watt (total 6 watt) stereo amplifier providing really Hi-Fi-like reproduction. Suitable for use with all stereo pick-up heads at present available. Ganged volume and tone controls. Preset balance control. Outputs for matched 3-3 ohm speakers. For 200-250 v. A.C. mains.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT

Valves E23L, ECG 83, ECG83, EL84, EL84. Separate bass and treble controls giving "cut" and "boost". Sensitivity 50 mV. 5 watts high quality output on each channel. Can be used as straight 10 watt amplifier. Control Stereo/Monaural switch ganged volume, ganged treble, ganged bass, and balance. Outputs for 3 ohm speakers. Point-to-point wiring diagrams and instructions. Illustration full wiring details and priced parts list, 1/9. Assembled and tested 59/9 extra.



ACOS HGP 59 Hi-Fi Crystal Cartridges. (Turnover type with sapphire stylus). Standard replacement for Garrard and Collaro. Only 19/9. B.S.E. Pul-Pr 19/9. Acos Stereo/monaural 49/9.

R.S.C. MINIATURE 3 WATT GRAM AMPLIFIER KIT

All parts to construct a very compact, highly sensitive amplifier suitable for any type of single or autochange player. Size 12 x 2½ x 2½in. Chassis is isolated mains transformer. For 200-250 v. A.C. mains. Output for 3-3 ohm speaker. Volume and tone control with mains switch. ONLY 39/9

SELENIUM RECTIFIERS

L.T. Types	H.W.	H.T. Types	H.W.
2/8 v. 1 a. H.W.	1/9	120 v. 40 mA.	3/9
6/12 v. 1 a. H.W.	2/9	250 v. 50 mA.	3/11
Following F.W. (Bridge)		250 v. 60 mA.	4/11
6/12 v. 1 a.	3/11	250 v. 80 mA.	6/11
6/12 v. 2 a.	6/11	250 v. 250 mA.	12/9
6/12 v. 3 a.	9/9	Contact Cooled	
6/12 v. 4 a.	12/3	250 v. 80 mA.	6/11
6/12 v. 5 a.	14/6	250 v. 50 mA. F.W.	
6/12 v. 6 a.	15/6	250 v. 75 mA. F.W. (Bridge)	8/11
6/12 v. 10 a.	25/9	250 v. 75 mA. F.W. (Bridge)	10/11
6/12 v. 15 a.	35/9		

THE SKY FOUR T.R.F. RECEIVER



A design of a 3 valve 200-250 v. A.C. mains L. and M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, 6F81, 6X6 and is especially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-point wiring diagram, instructions and parts list 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

VARLEY 2 v. 14 A.H. ACCUMULATORS. New ex Govt. 5 x 3 x 1½in. 5/9 each, 3 for 15/-.

JASON F.M. TUNER. Type FMT1. All parts including Dial, Escutcheon, Punched Chassis & Valves. Power supply required 180 v. 25 mA and 6.3 v. 1.5 a.£6/19/6

SMOOTHING CHOKES
 60 mA. 10 h. 400 ohms 3/11
 80 mA. 20 h. 900 ohms 5/11
 100 mA. 5 h. 100 ohms 3/11
 100 mA. 10 h. 100 ohms 6/9
 150 mA. 10 h. 100 ohms 10/11
 120 mA. 12 h. 100 ohms 9/9
 200 mA. 5-10 h. 100 ohms 11/9
 250 mA. 5 h. 50 ohms 10/9

MICRO-AMMETERS

0-50 micro-amp. Diameter 2½in. approx. Sealed 0-100. Flush mounting, 29/6.

EX GOVT. MAINS TRANSFORMERS

Primary 0-110-200-230-250 v. 275-0-275 v. 100 mA. 6.3 v. 7, 5, 3 a. 22/9
 Input 200-250 v. 50 c.p.s. 250 v. 60 mA. 6.3 v. 2 a. 11/9
 Primary 200-250 v. Sec. 12 v. 20 a. (Carr. 7/6.) 49/9
 Primary 200-240 v. Sec. 3,500 v. 5 mA. 2 v. 2 a. 39/9
 50 watts, 0-100/120-230/250 v. 8/11

Battery Chargers and Kits for 200-230-250 v. 50 c/s. A/C. Mains

BATTERY CHARGER KITS

Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grommets, panels and circuit. Carr. 2/9 extra.

- 6 v. or 12 v. 1 amp. 24/9
- As above, with ammeter... 32/9
- 6 v. 2 amps. 25/9
- 6 v. or 12 v. 2 amps. 31/6
- 6 v. or 12 v. 2 amps. 42/9 (inclusive of ammeter)
- 6/12 v. 4 amps. 49/9
- 6 v. or 12 v. 4 amps., with variable charge rate selector and ammeter 59/9

ASSEMBLED CHARGERS

- 6 v. 2 a. 29/9. 6/12 v. 2 a. 38/9.
- 6/12 v. 4 a. 59/9.

ASSEMBLED CHARGER

6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only Carr. 3/9. 49/9
 6/12 v. 3 amp. with variable charge rate selector and ammeter. 59/9.

ASSEMBLED 6 v. or 12 v. 4/5 amps.



Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well-ventilated steel case with blue hammer finish. Ready for use with mains and output leads. Carr. 5/- or Deposit 13/3 and 5 monthly payments of 13/3.

As above, but for 6 amp. charging. 4 GNS. Carr. 5/-. Or Deposit 16/- and 5 monthly payments of 16/-.

D.C. SUPPLY KITS. Suitable for electric trains. Consist of mains trans. 200-250 v. 50 c.p.s. 12 v. 1 amp. selenium rect. (F.W. Bridge), 2 fuseholders, 2 fuses, change direction switch, variable speed regulator, partially drilled steel case and circuit. Very limited number, 33/9.

HEAVY DUTY EX GOVT. SELENIUM RECTIFIERS

With large square aluminium cooling fins, 12 v. 15 amp. F.W. (Bridge). Limited number. 19/6.

VALVES: Full range at really competitive prices.

EX GOVT. CASES

Well ventilated, black crackle finished, undrilled cover. Size 14 x 10 x 8½in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE. COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post.

RELAYS: Carpenter Type Polarised, 2 x 9,500 turns at 1,850 ohms. 13/9. Miniature type G.E.C. 670 M1092 sealed wire ends 4/covers platinum, 12/9.

R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC83, 807, 807, 6X254. Tone Control. Pre-Amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolt minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc. can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 I. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy to follow wiring diagrams.



Or Factory built using latest EL84 output valves and with 12 months' guarantee. **14 GNS. TERMS ON ASSEMBLED UNITS.** Carr. 10/- **11 gns.** DEPOSIT 33/3 and 9 monthly payments of 33/3.

Protective Cover 19/9. Type 807 output valves are used with High Quality Sectionally Wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B. 20-30,000 c/s. Tone Controls ± 12 D.B. at 50 c/s. ± 12 D.B. to ± 6 D.B. at 12,000 c/s. hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12x9x9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS, SUCH AS STRING BASS, ELECTRIC ORGAN, GUITAR, etc. POE DANCE BANDS, GARRISON THEATRES, etc. etc.** We supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers. **EXPORT ENQUIRIES INVITED.**

FULL RANGE OF LINEAR HIGH FIDELITY AMPLIFIERS ALWAYS IN STOCK - GL5A MINIATURE 3 WATT GRAM AMPLIFIERS

For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11x21x24in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changer unit. Output for 2-3 ohm speaker. Guaranteed 12 months. Only 59/6.

R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER
A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads in addition to all other types of pick-ups and practically all makes Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is negligible being 71 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 A. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with biseptate) with the blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-** assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.

P.M. SPEAKERS. 2-3 ohms 2 1/2in. Perdio 21/9. 5in. Goodmans 17/9. 7x4in. R.A. Elliptical 19/9. 6 1/2in. Rola 19/9. 8in. Rola 19/9. 8in. Goodmans 25/9. 8x6in. Elac with high flux magnet 25/9. 9in. R.A. 25/9. 10x6in. Elphical Goodmans 29/9. 12in. R.A. 29/11. 12in. R.A. 3 or 15 ohms 10 watts, 12,000 lines, 59/6.

TWEETERS. 4in. Plessey, 3 ohms 18/9. R.A. 15 ohms 25/9.

R.S.C. TRANSFORMERS Fully Guaranteed. Interleaved & Impregnated.

MAINS TRANSFORMERS. Primaries 200-250-250 v. 50 c/s.	
FULLY SHROUDED. UPRIGHT MOUNTING.	
250 0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a. 2 1/2-3 1/2in.	17/11
250 0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	27/11
250 0-250 v. 100 mA., 6.3 v. 2 a., 5 v. 3 a.	27/11
350 0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	27/11
350 0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/11
425 0-425 v. 200 mA., 6.3 v. 4 a., ct. 5 v. 3 a.	49/9
450 0-450 v. 200 mA., 6.3 v. 5 a., 5 v. 3 a.	59/9
TOP SHROUDED DROP-THROUGH TYPE	
200 0-200 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	17/9
250 0-250 v. 100 mA., 6.3 v. 3 a.	19/9
250 0-250 v. 100 mA., 6.3 v. 2 a., 5 v. 3 a.	21/9
350 0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	18/11
250 0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	26/9
300 0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	28/9
300 0-300 v. 130 mA., 6.3 v. 4 a., ct. 6.3 v. 1 a., suitable for Mullard 10 Amplifier	29/9
350 0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
300 0-350 v. 130 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9
425 0-425 v. 200 mA., 6.3 v. 4 a., 5 v. 3 a.	47/9
MIDGET CLAMPED TYPE. Primaries 200-250 v.	
250 0-250 v. 60 mA., 6.3 v. 2 a., 2 1/2 x 2 1/2 in.	12/9
250 v. 60 mA., 6.3 v. 2 a. Size 2 1/2 x 2 1/2 in.	11/9
FILAMENT TRANSFORMERS	
6.3 v. 1.5 a.	5/9
12 v. 1 a.	7/9
6.3 v. 3 a.	7/6
12 v. 3 a.	8/11
0.4-6.3 v. 2 a.	7/9
12 v. 3 a. or 24v. 1.5a.	17/9
AUTO (Step Up/Step Down) TRANSFORMERS	
50-80 watts 110-120 v./230-250 v.	11/9
150 watts 110-120 v./200-250 v.	27/9

LINEAR PRE-AMP/TREMOLO UNIT
Suitable for use with any Guitar Amplifier. Controls Volume, Frequency, Amplitude and switches. Valves: EF86 and EF80. Inputs for Guitar Pick-up or Mike, and Radio or Gram. Power required only **5 GNS.**

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram, as in A.10 High sensitivity. Includes 5 valves: ECC83, ECC83, EL84, EL84, 5Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE "LIFT" and "Cut."** Frequency response ± 3 D.B. 30-30,000 c/s. 8% negative feedback loops. Hum level 60 D.B. down. **ONLY 25 millivolts INPUT required for FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. **FOR STANDARD OR LONG PLAYING RECORDS. FOR MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v. 30 mA. and 6.3 v. 1.5 A. For supply of a RADIO FEEDER UNIT. Size approx. 12 x 9 x 7in. For A.C. mains 200-250 v. 60 c/s. Output for 3 and 15 ohm speakers. Kit is complete to last out. Chassis is fully punched. Full instructions and point-to-point wiring. **8 Gns.** Car. diagrams supplied. (Or factory built 51/- extra). **ONLY 19/-** If required lined metal cover with 2 carrying handles can be supplied for 18/9. **TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9 and 9 monthly payments of 24/9.** Send S.A.E. for illustrated leaflet detailing ready-to-assemble Cabinets, Speakers, Microphones, etc with cash and credit terms.**

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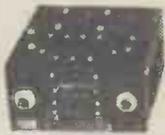
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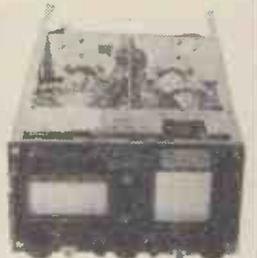
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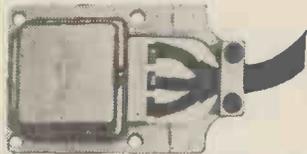
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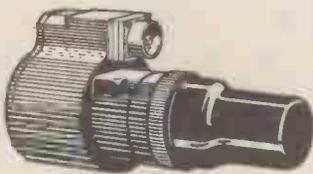


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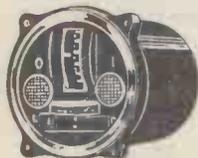


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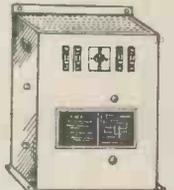
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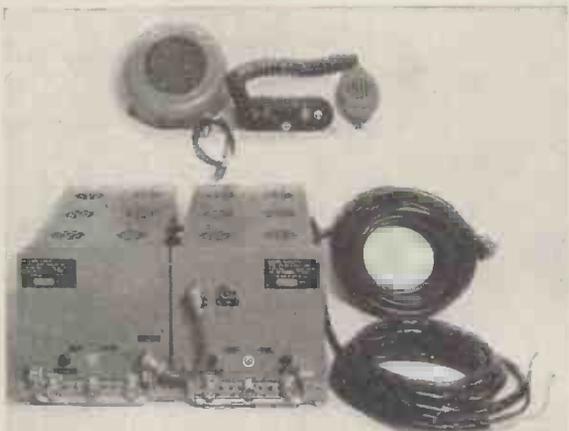
OA2 17/8	6B8 5/6	6SN7GT 5/6	19A Q5 10/6	900Q 37/8	D196 8/6	ECP82 10/6	EL81 17/-	KT88 24/-	PY81 .. 8/8	U301 23/10	UY41 7/6	Transistor
OB2 17/8	6BA6 7/6	6XJ7GT 9/-	19H1 10/-	150B2 18/-	D1810 10/6	ECP86 20/5	EL83 .. 20/5	KT101 34/-	PY82 .. 7/-	U329 .. 14/-	UY85 7/-	and Diodes
OZAGT 5/6	6BE6 5/6	6U4GT 12/6	20D1 15/8	150C2 17/6	DM70 7/6	ECH21 .. 23/10	EL84 .. 7/6	KTW61 6/6	PY83 .. 8/6	U339 .. 17/-	VM84B 15/-	GD3,4,5,
1A07 12/6	6BH6 8/-	6U5G 7/6	20P2 27/2	185BT 34/-	E80F 80/-	ECH35 6/6	EL85 .. 14/3	KTW62 7/6	PY88 .. 13/8	U403 17/-	VP4 .. 15/-	6, P
1C3 12/6	6BQ7A 15/-	6V6G 7/-	20L1 27/2	304 .. 10/6	E83F 30/-	ECH42 9/-	EL86 .. 17/8	KTW63 6/6	PZ30 .. 20/5	U404 .. 8/6	VP4B 23/10	OA70 3/-
1G8 17/8	6BR7 12/6	6X4 5/-	20P3 23/10	307 .. 7/6	E850 2/-	ECH49 9/-	EL91 .. 5/-	KTZ41 8/-	QP21 .. 14/-	U801 30/7	VP23 .. 6/6	OA73 8/-
1H3GT 10/6	6BR8 19/1	6X5GT 6/-	20P4 27/2	4033L 12/6	E876 9/6	ECH83 14/3	EL95 .. 10/6	KTZ63 7/6	QP25 .. 7/6	U4020 19/1	VP41 .. 6/-	OA79 3/-
1L4 .. 3/6	6BS7 25/-	630L2 10/-	20P5 23/10	5763 12/6	EABC80 9/6	ECL80 9/-	EL90 .. 9/6	L83 .. 6/-	Q8150/15	UABC80 9/-	VR105 8/-	OAS1 3/-
1LD5 5/-	6BW6 8/8	7B7 .. 8/6	25A5G 10/6	ACGPEN 7/6	EAC91 4/6	ECL82 10/6	EL821 27/2	MU14 7/8	R16 .. 10/6	UB41 12/-	VT61 5/-	OA91 3/6
1LN5 5/-	6BW7 6/6	7C5 .. 8/6	25LQGT 10/-	ATP4 3/6	EAF42 9/-	ECL83 19/9	EL822 19/6	N37 23/10	R18 .. 14/-	UBC41 8/6	VT61A 5/-	OA95 3/6
1NGT 10/6	6C4 .. 8/6	7C8 .. 8/6	25ZAG 9/6	AZ31 10/-	EBC34 2/6	ECL86 17/-	EM34 9/6	N78 20/5	R19 .. 20/5	UBC81 11/6	VU39 8/-	OA210 11/-
1R4 .. 9/6	6C5 .. 9/6	7E7 .. 9/6	25Z5 9/6	AZ41 14/3	E841 3/6	EP9 23/10	EM71 23/10	N108 23/10	RG1 240A	UBF80 9/-	W76 .. 5/6	OA211 20/-
1R5 .. 6/6	6C8G 9/-	7Y4 .. 7/6	275U 20/5	BL63 7/6	E831 4/-	EP22 14/-	EM80 9/-	N303 21/1	54/-	UBF89 9/6	W77 .. 4/8	OC16 48/-
1T4 .. 3/6	6D5 12/6	9BW6 15/8	28D7 7/6	CBL31 .. 23/10	EBC33 5/-	EP36 4/-	EM81 9/-	N339 15/-	RK34 7/6	UC84 .. 14/11	X41 .. 15/-	OC22 28/-
1U4 12/6	6F1 .. 27/2	10C1 13/6	30C1 8/-	COH35 .. 23/10	EBC41 8/6	EP39 .. 5/6	EM85 17/8	PC85 9/6	8P41 3/6	UC85 9/6	X61 .. 12/6	OC23 27/-
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3D6 5/-	6J5 .. 5/6	12AC6 15/8	30PL1 10/6	D15 10/6	EBL31 .. 23/10	EPF55 23/10	EZ80 .. 7/-	PCF87 10/-	U12/14 8/6	UCF83 19/9	XD(1.5) 6/6	OC66 25/-
3Q4 7/6	6J6 .. 5/6	12AD6 17/8	30PL1313/6	DAF91 6/-	ECS2 5/6	EPF73 10/6	EZ81 .. 7/-	PCF88 10/6	U18 20/5	UCF84 12/6	XFY12 9/6	OC71 6/6
3Q5GT 9/6	6J7G .. 6/-	12AEG 14/3	35A5 21/9	DAF96 8/6	ECS4 6/6	EPF85 6/6	EZ82 .. 7/6	PCF89 17/-	U19 48/-	UF80 10/6	XFY34 18/-	OC72 8/-
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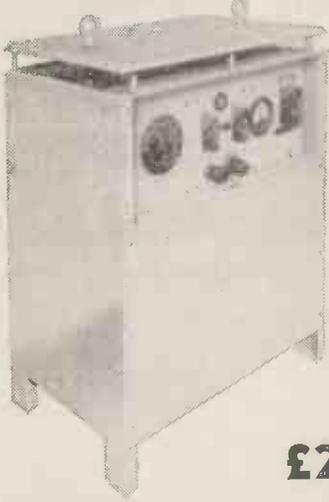
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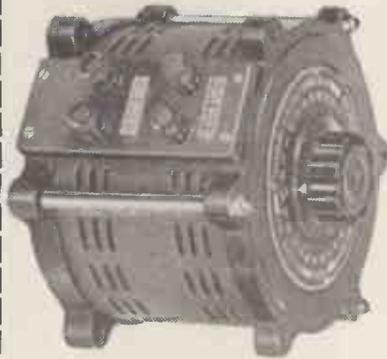
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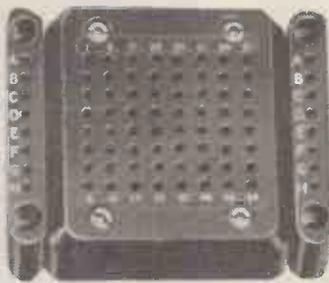
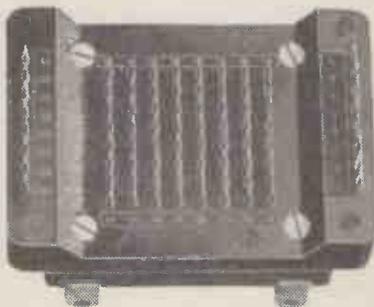
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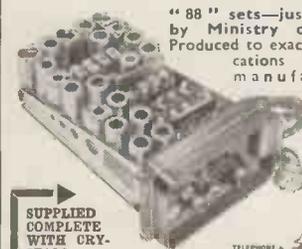
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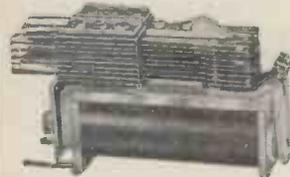
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WESTALITE BATTERY CHARGERS. Made by Westinghouse (type BC14-6/40). Input 200/250 v. A.C. will charge 6-volt or 12-volt batteries at 0/40 amps. Coarse control switch with eight positions and fine control switch with four positions including "off." Built-in 0/50 ammeter. Fused A.C. and D.C., grey enamel finish, dimensions 24in. x 14in. x 13in. £45 each. Carriage 20/-.

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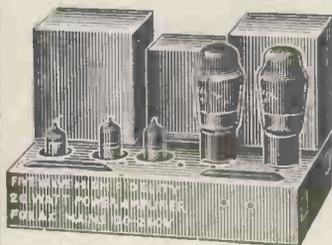
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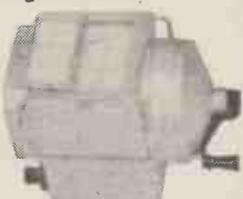
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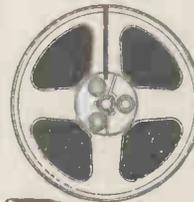
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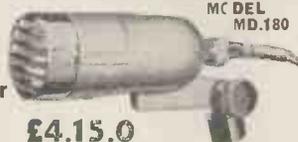
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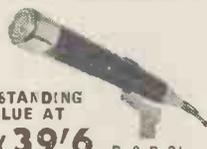
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Suitable for hand or stand use.
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Three-way mike for hand, desk or floor stand use. Response 100-8,000 c/s. Sensitivity -62dB. Length 7in. Head dia. 1½in. Supplied with neck band, lead and standard jack plug.
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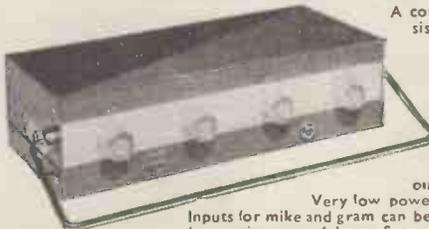
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A truly High Fidelity Ultra-Linear Amplifier with a push-pull output of 10 watts and incorporating negative feedback. Provision for Tuner, also, bass and treble control and 5-position selector switch for Microphone, Tape and L.P. and Standard Recordings. Finished in an attractive grey/green stove enamel. Brand new, fully guaranteed. Original cost 23 gns. **£14.19.6** P. & P. 2/6.

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external X 1/2 and CRT Brightness Modulation. A.C. mains 200/250 v. £15/15/- plus P. & P. 8/- or 30/- deposit, plus P. & P. 8/- and 12 monthly payments of 28/6. FULL 12 MONTHS' GUARANTEE INCLUDING VALVES AND TUBE.

ALIGNMENT ANALYSER TYPE MC12

A.C. MAINS 200/250 volts. Provides:— "WOBBULATOR" SWEPT FREQUENCY OPERATION, for FM/TV alignment linear frequency sweep up to 12 Mc/s. From 400 Kc/s—80 Mc/s. CAPACITANCE MEASUREMENT. Two ranges provided 0-60 pf. and 0-120 pf. SPECIAL FACILITY enables true resonant frequency of any tuned circuit I.F. transformer, etc., to be rapidly determined. Cash price £6/19/6 and 5/6 P. & P. H.P. terms 25/- deposit and 5/6 P. & P. and 6 monthly payments of £1/6.



5-TRANSISTOR POCKET RADIO

COMPLETELY PORTABLE. NO AERIAL OR EARTH REQUIRED

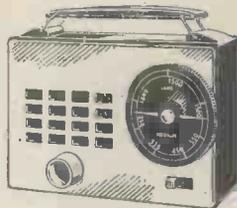
Size 4 1/4 x 3 1/4 x 1 1/4 in. Output 200 mW. 5 first quality transistors. Push-pull output.

Fitted 2 1/2 in. high-flux moving coil speaker.

Medium and Long wave.

Internal high gain ferrox aerial Twin-coloured case in red and black.

All parts available separately. Circuit-diagram 1/6. Free with kit.



Price £2.19.6

plus 3/6 post & Pkg.

SIGNAL GENERATOR



£6/19/6

Covering 100 Kc/s-100 Mc/s. on fundamentals and 100 Mc/s to 200 Mc/s. on harmonics. Metal case 10in. x 6 1/2in. x 5 1/2in. grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C. Mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F. output continuously variable 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%. Or 25/- deposit and 6 monthly payments of £1/6. Post & Packing 5/6 extra.

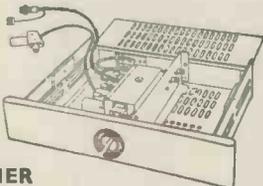
CHANNEL TUNER

Will tune to all Band I and Band III stations. BRAND NEW by famous manufacturer. Complete with P.C.C. 84 and P.C.F. 80 valves (in series). I.F. 16-19 or 33-38. Also can be modified as an aerial converter (instructions supplied). Complete with knobs.

32/6 Plus 4/- P. & P.

HEATER TRANSFORMER

To suit the above, 200-250 v. 6/- plus 2/- P. & P.



SIGNAL GENERATOR

Coverage: 120 Kc/s-230 Kc/s. 300 Kc/s-900 Kc/s. 900 Kc/s-2.75 Mc/s. 2.75 Mc/s-8.5 Mc/s. 8 Mc/s-28 Mc/s. 16 Mc/s-56 Mc/s. 24 Mc/s. 84 Mc/s. Metal case 10in. x 6 1/2in. x 4 1/2in. Size of scale 6 1/2in. x 3 1/2in. 2 valves and rectifier. A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent. modulated or unmodulated R.F. Output continuously variable. 100 millivolts C.W. and mod. switch variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%.



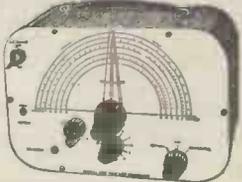
£4 : 19 : 6

P. & P. 5/6 extra.

SIGNAL & PATTERN GENERATOR

£6/19/6 P. & P. 5/6.

Or 25/- deposit. P. & P. 5/6 and 6 monthly payments of £1/6. Coverage 7 1/2 Mc/s-210 Mc/s. In five bands, all on fundamentals slow motion tuning audio output. 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ± 1% A.C. mains 200-250 v.



B.S.R. MONARCH UA8 with FUL-FI HEAD



4-speed plays 10 records 12in., 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Internals 7in., 10in. and 12in. records of the same speed. Has manual play position; colour brown. Dimensions: 12 1/2in. x 10 1/2in. Space required above baseboard 4 1/2in., below baseboard 2 1/2in. Fitted with Ful-Fi turnover crystal head. £6/19/6. Plus 5/6 P. & P.

STEREO HEAD £7/19/6 Plus 5/6 P. & P.

LINE E.H.T. TRANSFORMER

With built-in line and width control. 14 KV Bean Coil, 90in. deflection, on ferrite yokes. Frame O.P. transformer 500 pf. 18 KV. smoothing condenser. Can be used for 14in., 17in. or 21in. tubes.

Complete with circuit diagram

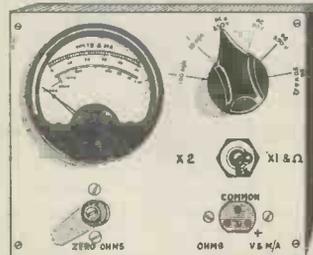
29/6 Plus 4/6 P. & P.

As above, but for 625 lines

£2.10 Plus 4/6 P. & P.

FOCUS MAGNET suitable for the above (state tube), 10/-, 3/- P. & P.

A.C./D.C. POCKET MULTI-METER KIT



2in. moving coil meter, scale calibrated in A.C./D.C. volts, ohms and milliamps. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500. Milliamps 0-10, 0-100. Ohms range 0-10,000. Front panel, range switch, wirewound pot (for ohms zero setting), toggle switch, resistor and rectifier. 19/6. P. & P. 2/-. Wiring diagram 1/-. FREE with kit.

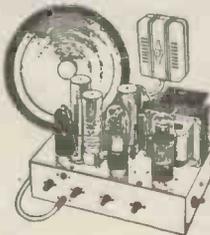
MAINS TRANSFORMER

All with tapped primaries

350-0-350, 70 m/a., 6.3 v. 1 amp., 6.3 v. 2 amp., 10/6, 250-0-250, 70 m/a., 6.3 v., 2 amp., 10/6. Postage and packing on the above 3/6.

280-0-280, 70 m/a., 6.3 v. 2 amp., 6.3 v. 1 amp., 10/6. P. & P. 3/6. 280-0-280, 120 m/a., 6.3 v. 2 amp., 6.3 v. 3 amp., 17/6. P. & P. 8/6.

5-VALVE AMPLIFIER IDEAL FOR SMALL HALLS



High power—high quality. 200/250 v. A.C. 2 inputs, mike and gram, bass and treble lifts. For use with Standard/L.P. Records. Two would be suitable for stereophonic. Ideal P.A. system, £3/19/6. P. & P. 7/-. CRYSTAL MIKE to suit, 15/-. P. & P. 2/-. 8in. P.M. SPEAKER to suit, 12/6. P. & P. 2/-.

PORTABLE AMPLIFIER

On printed circuit for A.C. Mains 200/250 v. Size 4in. x 3in. with tone and volume control. Complete with valves: ECL82 and EZ80. Output 2 watts, 39/6. P. & P. 3/-.

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Incorporating 45 r.p.m. "Starr" motor, "Acos" crystal pick up, 3 transistor push-pull, amplifier complete with transistors. Output 600 milliwatts, 49/6 plus 4/- P. & P.

NOW PROVED WITHOUT DOUBT TO BE THE GREATEST MULTI-METER IN THE COUNTRY !



MODEL E.P. 10k. 10,000 o.p.v. on both A.C. & D.C.

A complete wired and tested instrument (not a kit) incorporating extra large 3½in. meter face and unique slide range switch. Can be conveniently carried in the pocket and features unusually sensitive 10,000 ohms per volt A.C.-D.C. meter, 1 per cent precision resistors, and largest meter ever placed on an instrument this size. Single, easy to use range selector switch, can be appreciated by the novice and engineer alike. Complete with colour coded test leads and battery.

Size: 4½ x 3¼ x 1in. Model EP-10K. **ONLY £5.19.6** Post Free!

Everybody should possess one of these meters !

FULL SCALE RANGES:

D.C. VOLTS: 0-6-30-120-600-1,200 v.
 A.C. VOLTS: 0-6-30-120-600-1,200 v.
 D.C. CURRENT: 0-120µ A, 0-12-300 mA.
 RESISTANCE: 0-20K, 0-2 Meg. (150 ohm, 15K at centre scale).
 CAPACITANCE: 0.005 to 0.15 µF (at A.C. 6 v.).
 DECIBELS: -20 to +63db (600 ohms, 1mW 0dbm = 0.775 v.
 ACCURACY: D.C. voltages and current ±2% f.s. A.C. voltage ±4% f.s. Resistance ±3% of total scale length.

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World coverage on these famous Communication Receivers. They are the simplest type to use yet bring in stations that will amaze you. The ideal domestic receiver for medium wave during the day with Amateur stations at night. All have been converted to 230 v. A.C. mains and are guaranteed to work immediately. Incorporate Wave Switch, Audio gain aerial trimmer, high and low tone control, station locking device, aerial and earth inputs, speaker output sockets, etc. Size 17 x 8 x 9½in. Black crackle finish front panel. On demonstration at 87, Tottenham Court Road.

P.C.R.2. Medium and long waves and 6-23 Mc/s. Less speaker. **ONLY**

P.C.R. Medium and long waves and 6-18 Mc/s. With speaker **£8.19.6**

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Carriage 10/6 each.

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Mounts vertically—mounts horizontally—mounts on wall—sits on desk! Designed for use with transistor radios, valve radios, car radios, amplifiers, auxiliary speakers in Hi-Fi and numerous other applications where quality reproduction of sound is required.

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MODEL TS. 30 57'6

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All Transistor 2-STATION INTERCOM Model TI.302

- ★ Here is an Intercom system for both calling and conversing which uses the highest quality transistors and is operated from a single battery so that it may be used for multi-purpose applications, especially where there is no local electric supply and also where voltage fluctuations are severe.
- ★ The Master station incorporates individual volume control to ensure perfect speech reproduction.
- ★ The Sub-station incorporates a unique "buzzing" call system which ensures maximum efficiency.
- ★ Specially suited for use in offices, manufacturing plants, hotels, restaurants, residences and wherever conversation is required between two or more locations.

SPECIFICATION:

Circuit: 3 Transistors. Output Power: 200 mW. Battery: Standard 9 volt. Speaker: Built-in 2½in. permanent dynamic. Wiring: External 2-way wire. Calling: Internal "buzzer" system. Controls: Volume, Call, Stand-by/listen/talk. Dimensions: Main station: 3½in. x 1½in. x 3.7/16in. Sub-station: 3½in. x 1½in. x 3.7/16in. Colours: Black or Ivory cabinets.

Model TI.302 12 GNS.

Each Intercom is supplied complete with battery, 60ft. of wire and is individually cartoned in a magnificent fitted gift box.



TI.302

SF.20 RADIO HEADPHONES

Hi-impedance—2,000 ohms—general use headset. Black and Ivory plastic cased electro-magnetic units with adjustable head-band for comfortable fit. Individual listening for all types of applications. Individually packed, with flexible cord attached. 14/6, post paid.



AMERICAN LIGHTWEIGHT HEAD SET They're High and Low Impedance!

These H.S.30 phones are the smallest used by U.S. Air Force, 250Ω imp. using soft rubber miniature ear moulds for maximum music and voice reproduction of the finest quality. Supplied free is a small transformer unit with cord and plug which steps impedance up to 4,000Ω. Only 15/-. P. & P. 2/6



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CRYSTAL MICROPHONE INSERTS MODEL MC.1. Precision disc type crystal microphone cartridge. Output 53db. Response 100-6000 c.p.s. ONLY 6/6.



Complete HEADPHONE AND MICROPHONE ASSEMBLY. A must for every Constructor and "Ham." consists of moving coil, padded headphones and "press to talk" microphone. 10/-. P. & P. 3/6.



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LEAD ACID ACCUMULATORS (unspillable), 2 volts 16 A.H. Ideal for 6 volts and 12 volts supply. Brand new, original cartons. Size 4in. x 6in. x 2in., 5/6 each. P. & P. 1/6. 3 for 15/-. P. & P. 3/6. 6 for 27/6. P. & P. 5/-.



HOOVER ROTARY TRANSFORMERS. 12 v. input, 500 v. output at 65 mA. or 6 v. input, 250 output at 75 mA. ONLY 10/6 each. P. & P. 2/-

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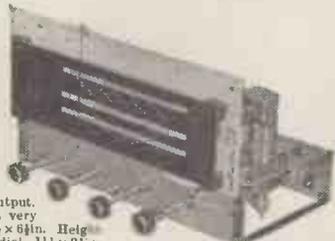


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Valve Line-up: ECC85, ECH81, EF89, EABC80, EL84, EM81, EZ80.

Three Waveband and Switched Gram positions Med. 200-500 mm., Long 1,000-2,000 m., VEF/FM 88-95 Mc/s. Philips Continental Tuning Insert with permeability tuning on FM and combined AM/FM IF transformers, 460 Kc/s. and 107 Mc/s. Dust core tuning all coils. Latest circuitry including AVC and Neg. Feedback. Three watt output. Sensitivity and reproduction of a very high standard. Chassis size 13 1/2 x 6 1/2 in. Height 7 1/2 in. Edge Illuminated glass dial 11 1/2 x 3 1/2 in. Vertical pointer. Horizontal station names. Gold on brown background. A.O. 200/250 v. operation. Magic-eye tuning. Aligned and tested ready for use. £13.10.0 Carr. & Ins. 5/-.

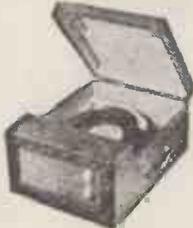


RECORD PLAYER BARGAINS Latest 4-speed models

NEW RELEASE by E.M.L.—4-speed Single Player Unit fitted with latest stereo and monaural Xtal cartridge and dual spindle stylus. Auto stop and start. A fidelity unit and bargain buy at only £6/19/6, carr. & ins. 4/6. SINGLE PLAYERS B.S.R. (TU9), 79/6; COLLARO JUNIOR studio P.U., 75/-; AUTOCHANGERS, B.S.R. (UA8), £6/19/6; UA9 STEREO, £7/10/-; B.S.R. (UA14), latest model, £7/15/-; COLLARO "C80" Latest Model, £7/15/- Carr. & Ins. 5/-.

RECORD PLAYER CABINETS

Cabinet Price £3.3.0 Carr. and Ins. 5/-



Contemporary style, resin covered cabinet in mottled red and white polka dot. Size 18 1/2 x 13 1/2 x 8 1/2 in., fitted with all accessories including huffic board and anodised metal fret. Space available for all modern amplifiers and auto-changers, etc. Uncut record player mounting board 14 x 13 in. supplied.

2-VALVE 2-WATT AMPLIFIER Twin stage ECI.82 with vol. and neg. feedback Tone control. AC 200/250 v. with knobs, etc., ready wired to fit above cabinet. £2/17/6. P. & P. 3/6. 6in. Spkr. & trans., 22/- P. & P. 2/-.

TRANSISTOR COMPONENTS

Midget I.F.—465 Kc/s 1/2 in. diam. 5/6
Osc. Coil M. & L.W. 5/9
Midget Driver Trans. 3.5:1 6/9
Midget Push-Pull Trans.—3 ohms 6/9
Elect. Condensers—Midget Type 1 mfd-50mfd. ea. 1/9. 100 mfd. 2/-, 6V/12V wks.
Condensers 150v. working: .05mfd., .03mfd. 9d. .05mfd., 1mfd. 1/-
.25mfd. 1/3; 5mfd. 1/6 etc.
Vol Controls—Midget Type with edge Control Knob. 5K, 47K, 1 M/ohm, ea. 2/6.
Speakers P.M.—2 1/2 in. EMI 3 ohms 17/6. 7in. x 4in. Plessey 35 ohms 23/6.
Ear Plug Phones—Min. Continental type, 3ft. lead, jack plug and socket. High Imp. 8/-; Low Imp. 7/6.

VALVE HOLDERS—Paxolin; Int. Occ. EF50, 6d. Moulded; Int. Occ. Mazda Octal. 7d.; B12A (CRT), 1/3; B8G, 9d. each; Nylon or Moulded, Ceramic: B7G, B9A unskirted, 9d. each; B7G, B9A skirted, 1/- each; B7G with Can. 1/6 each; B9A with Can, 1/9 each; EF50, B7G, 1/- each; B9A ditto, 1/3 each.

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"POCKET 6" TRANSISTOR RADIO KIT—Med & L/W size

5 1/2 x 3 1/2 x 1 1/2 in. Osmor Ferrite Ae 10/-, Osc. Coil & 3 I/F's 22/6. Driver & O/P Trans. 22/-, Tuning Gang 10/6. 2 1/2 in. PM Speaker 17/6. Set 6 Transistors & Diode 45/-, Printed Circuit 8/6. Vol. Control 8/-, W/C Sw. 3/6. Cabinet & Dial 8/-, Resistor Set 5/-, Condenser Set 15/-, Handbook, full details 1/6. REDUCED Complete Kit PRICE £8/10/0 Carr. 2/6

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Midget Type—2 pole 2 way, 1 pole 6 way, 2/6 each; 1 pole 12 way, 2 pole 6 way, 3 pole 4 way, 4 pole 2 way, 4 pole 3 way, 3/6 each.

METAL RECTIFIERS, STC

Types—RM1, 4/9; RM2, 5/6; RM3, 7/6; RM4, 16/-; RM5, 21/-; RM4B, 17/6.

WESTINGHOUSE—Contact Cooled

Types—FC116, 250V, 60mA, 11/9; FC101, 250V, 200mA, 21/-; FC31, 250V, 300mA, 26/6.

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Types—250V, 50mA, 7/6; 250V, 85mA, 10/-; 250V, 125mA, 15/-; 250V, 300mA, 26/6.

"6 plus 1" TRANSISTOR RADIO KIT

BEST EVER VALUE! Using 3 latest type Surface Barrier Transistors. MAJOR BARGAINERS SURPLUS BARGAIN OFFER. —Further kit supplies now available. Original purchase of this popular kit were rapidly sold out. This kit is a modern, sensitive quality Receiver Unit with all the latest features. Six BVA transistors and 1 diode, printed circuit med. and long waves. Ferrite aerial, car radio input 500 mW. push-pull output into 3 ohm speaker, calibrated dial and slow-motion tuning, etc. Size approx. 8 1/2 x 2 1/2 in. Cabinet size 9in. x 6 1/2 in. x 3 1/2 in. KIT of Parts including 5 gns. BARGAIN OFFER! £6/19/6 Complete Kit less speaker SET of 6 Transistors and 1 Diode, 45/- Carr. 2/6. 3 ohm Speaker 7in. x 3 1/2 in.—ONLY 15/6, carr. 1/6. Send 3d. stamp for full details. Circuit and Instructions 1/6. Cabinets now available 25/- extra.



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SINGLE PLAYERS: Model 48P £8/17/6. Carr. 4/6. Model 1A Mk. 2 £7/19/6. Carr. 4/6. Model 4HP. £17/19/6. Carr. 4/6. AUTOCHANGERS: Model RC 210 with plug-in GC8 head, 10 gns. Carr. 5/-. Model A Transcription Auto Changer—just released. £18/19/6. Carr. 7/6. Comprehensive range in stock.

COAX 80 ohm CABLE

High grade low loss Cellular Air Spaced Polythene—10in. diam. Stranded Cond. Now only 6d. a yard

BARGAIN PRICES—SPECIAL LENGTHS 20 yds 9/- P. & P. 1/6. Coax. Plugs 1/- 40 yds 17/6. P. & P. 2/-. Sockets, 2/- 60 yds. 25/- P. & P. 3/-. Couplers, 1/3.

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Electrolytics All Types New Stock TUBULAR | CAN TYPES 25/25 v. 50/12 v. 1/3 8+8/450 v. 4/6 50/50 v. 100/25v. 2/- 32+22/275 v. 4/6 8/450 v. 4/350 v. 2/3 50+50/350 v. 6/6 18+16/450 v. 5/6 60+35+275 v. 12/6 32+32/450 v. 9/6 100+200/275 v. 12/6 Transistor Midget Types—all values 1 mfd. to 50 mfd. 1/9 ea. 100 mfd. 2/- 6v/12v.

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Latest 5-valve circuit based on Mullard's design. Magic eye and tone controls. Printed circuit already wired. A sensitive quality recorder. B.S.R. Amp. Kit 95/- B.S.R. Tape Deck £9/10/- Collaro Amp. Kit £6/5/- Collaro Tape Deck £12/10/- Set of 5 valves 45/- Special Unit Kit Prices—Send stamp for detailed list. Handbook (full constructional and circuit details) 2/6.



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Auto Changer Kit. Comprising three units. Contemp. styled cabinet size 17 1/4 x 8 1/2 in. 2 valve 2 watt amp. and 7 x 4 in. quality speaker. Variable tone and volume controls with feedback circuit and B.S.R. 4-speed 10 record mixer auto. changer unit. Single Player Kit. Similar spec. to auto. changer kit except player is 4-speed B.S.R. T.U.9 single record player unit. Attractive contemp. styled cabinet. Size 13 1/2 x 13 1/2 in. with splendid volume and reproduction. All units ready wired, simple screwdriver assembly only FULL SATISFACTION REFUND GUAR. SEND FOR DETAILED LEAFLET 3d. STAMP

Terms: C.W.O. or C.O.D., post and packing up to 1/6. 7d. 1lb. 1/1; 3lb. 1/6; 5lb. 2/-; 10lb. 2/9.

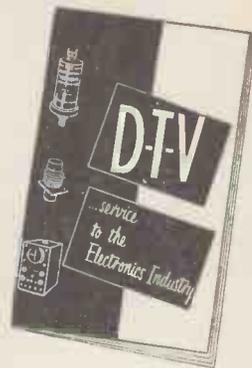


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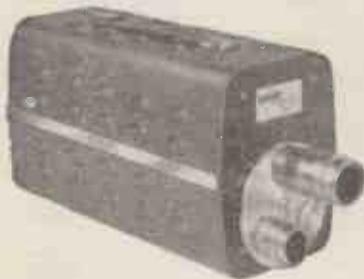
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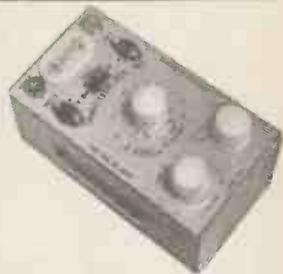
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T.V.4X	RM.4	4 1/2	250	280	18/4
T.V.5	RM.5	5 1/8	250	325	26/3
T.V.7	LW.7	3 5/16	240	300	26/3
T.V.9	LW.9	3 1/2	270	300	28/3
T.V.15	LW.15	2 1/8	240	300	29/6
T.V.86	14 A86	3 1/8	240	200	21/10
T.V.97	14 A97	3 1/8	240	200	26/-
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T.V.124	14 A124	3 1/8	295	200	31/6
T.V.989	13 B989	6 1/8	250	400	36/6
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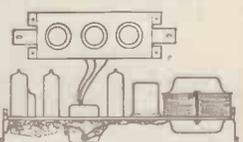
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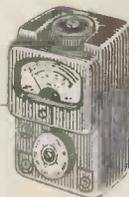
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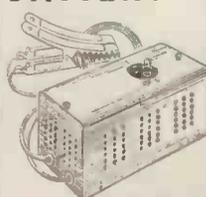
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Whiteleys 1012	5	2	20/6
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Elac 4 speaker HPI/2	10	15	3
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Wharfedale W2	29	10	0
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Garrard 301 Strobe	25	14	10
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" 4 HF Mono	19	13	2
" TA Mk. II Mono	9	3	36/9
" 4 HF Stereo	20	17	2
" TA Mk. II Stereo	10	12	10
" 210 Mono	13	7	2
Decca FFS3 Pickup	21	10	0
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Rogers HG 88	38	10	0
Leak Stereo 20 and Vari Stereo	55	9	0
Quad 22 and 2 Amps.	70	0	0
Jason 32 10	40	19	0
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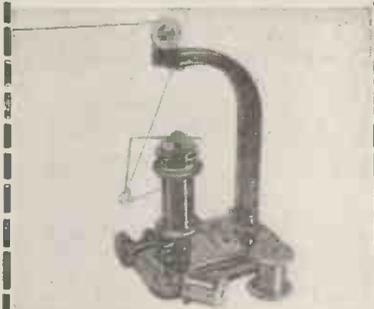
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Type PCR has a self contained speaker and covers 850 to 2,000, 200 to 550, and 16 to 50 metres.

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One of the finest communications receivers ever made. Those we offer are in superlative condition, thoroughly checked and tested as regards calibration, alignment and sensitivity.

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THE GOOD COMPANION

At last we are satisfied that a first-class transistor receiver with a performance at least equal to the best commercial receivers can be easily constructed. Come and hear one. The printed circuit technique, pre-aligned oscillator and I.F. transformers, American Philco R.F. transistors and Q.P.P. output of 750 mW from Mullard OC 82s ensure success. All the parts including 6 transistors, 2 diodes (all first grade), cabinet, 5in. speaker and comprehensive instructions cost £9/19/6. Uses PP9 battery, 3/6 extra.

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The new version consists of 4 transistors and 1 diode. Uses printed circuit and ferrite rod aerial. All the parts with comprehensive instructions (DLR 5 speaker) cost 52/6, post 2/6.

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AVO Capacity 5 pfd. to 50 mfd. Resistance 5 ohms to 50 Megohms. Inductance can be measured against external standard. Balance is indicated on a meter which can be used as a valve voltmeter from 0.1 to 15 v. Leakage test and Power Factor scale. AC mains operation. Tested and guaranteed and in superlative condition. £9/10/- plus 5/- P. & P.

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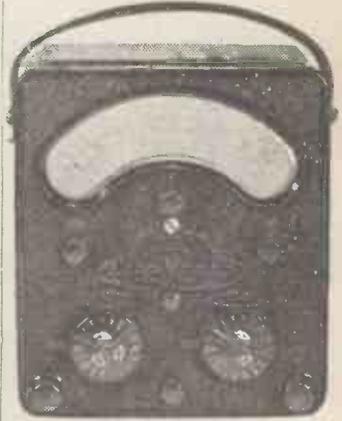
Contains 100 1/2 and 1 watt resistors, 50 HI Stub resistors, wire wound resistors, carbon and W/V pots, 100 capacitors (mica, paper, Sprague, bias, variable, etc.), valveholders, tag strips, metal rectifiers, sleeving, etc. All components are unused. **GUARANTEED VALUE, 25/- plus 2/6 post.**

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59/6

TRANSISTOR PRICES DOWN!

NEW PUSH-PULL SIX DESIGN

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2 RF stages. Attractive 2-tone case. Take it anywhere. No aerial required (except for car suitable areas) 3in. top grade full

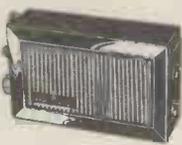
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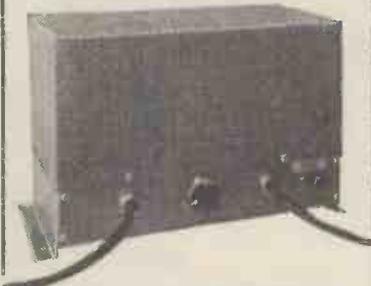
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10 watt push-pull ultra linear Hi-Fi amplifier with pre-amp. control unit. Amplifier: Valves EF86, ECC83, 2-EL84, E281 Sensitivity 40 M/V for 10 watts output Impedance, 4, 8 and 16 ohms, spare supply for tuner, 200/250 v., A.C.

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MK II AMPLIFIER, POWER AMP. AS ABOVE

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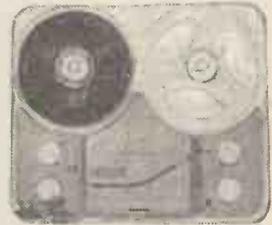
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Using 6 guaranteed first-grade transistors, sensitive diode, p/pull output, medium and long wave bands, printed circuit, high Q ferrite rod aerial, 6 x 4 high flux speaker. Provision for car aerial. Attractive 2-tone cabinet, overall size 9 x 7 x 3 1/2in. Easy to follow



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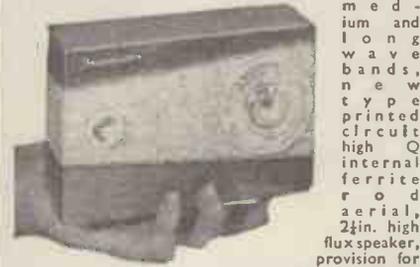
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Applicants must be experienced and possess sound technical knowledge. Good wages are offered plus Bonus and Staff Pension Scheme. Half-day on Saturday.

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CANADA'S largest electronics specialists have vacancies for **RADIO AND ELECTRONICS TECHNICIANS** for duties in remote areas of Canada. Salary \$7,500 per annum.

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Interviews for selected applicants will be arranged in London during January 1962.

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for consideration against positions which are and will be available after training in London, the Home Counties, West Country, Midlands and the North West and others which involve travel both in this country and abroad. The Company is prepared to assist in any housing problem that may arise.

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are manufacturers of all types of telecommunications equipment from SHF micro-wave radio to audio line systems. We are expanding our Engineering Department and require:—

ELECTRONIC ENGINEERS

capable of producing prototype manufacturing information from laboratory schematic sketches.

Training:

We are prepared to offer a period of up to 6 months' training so that successful applicants can familiarise themselves with our current range of telecommunications equipment.

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A generous starting salary will be paid and this will be reviewed at the end of the training period and thereafter twice a year.

Apply:

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The Staff Officer

THE GENERAL ELECTRIC CO. LTD.

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TS-173 Heterodyne Crystal Controlled Frequency Meters range 90 to 450 Mc/s. Individual Calibration Books with numerous crystal check points. Accuracy .005% nominal and .01% interpolation. Power required: dry batteries 6 V. and 130 V. PRICE, fully overhauled and guaranteed £120 0 0

TS-175 Heterodyne Crystal Controlled Frequency Meters, range 80 to 1,000 Mc/s., otherwise as above. PRICE fully overhauled and guaranteed £150 0 0

GENERAL RADIO LR.2 COMBINED HETERODYNE FREQUENCY METER AND CALIBRATOR EQUIPMENT

Frequency range 160 kc.-60 mc. and 0-5,500 c/s. In the latter range, the instrument will also work as audio oscillator with an output of 3V into 600 ohms Precision 100 kcs. crystal accurate to ±1 cycle drives a multiplier providing check-points at 100, 20 and 10 kcs. Direct reading interpolator indicating the difference frequency between the measured signal and the wavemeter setting. Power supplies 120 V. A.C. Price £150 Packing and Carr. £8

MARCONI TYPE TF-783 PRECISION HETERODYNE WAVEMETER. Range 3 to 15 Mc/s. on fundamentals, extendible to at least 30 Mc/s. by using harmonics. Accuracy better than .005%. Crystal Reference Oscillator giving check points every 20 and 200 kc/s. Direct calibration with linear interpolation. Power supplies 230 V. mains. PRICE £75 0 0

ALSO BC-221 and LM-14 FREQUENCY METERS. Prices and details on application.

POWER UNITS

WESTINGHOUSE SELENIUM RECTIFIER POWER UNIT

Input 115-230 V. Fully smoothed and fused. Output adjustable from 80-140 V. D.C. by means of tap switch in the transformer secondary winding. Maximum continuous current 400 mA. Dimensions 17 1/2 in. x 10 1/2 in. x 3 1/2 in. Price £40/- P.P. 7/6.

RECEIVER POWER UNIT DRAWER

Input 115-230 V. A.C. Output 6.3 V at 6 A.C., and 250 V. H.T. at 60 mA. Fully smoothed and fused. Built-in cooling blower. Dimensions 6 1/2 in. high x 13 1/2 in. wide x 17 1/2 in. deep. Weight 32 lbs. Price, complete with connectors and fully guaranteed £25 P.P. 20/-.

TRANSMITTER POWER UNIT DRAWER

Input 115-230 V. A.C. Output 6.3 V. A.C. at 10 A.; 24 V. D.C. at 60 mA. smoothed to ripple peak of 1%; 24 V. D.C. at 240 mA. for control circuits etc.; fixed bias of minus 8 V.; adjustable bias from zero to minus 30 V.; two independent outputs of 300 V. at 136 mA. with peak ripple of 1% and 300 V. H.T. at 215 mA. with peak ripple of 6%. Built-in cooling blower. Dimensions 8 1/2 in. high x 13 1/2 in. wide x 19 1/2 in. deep. Weight 60 lbs. Price £10/10/- P.P. 26/-

SPECIAL RECEIVERS

R-1859; frequency range 130-820 Mc/s. In two bands. Tuned coaxial line input circuit, crystal mixer, CV-62 local oscillator, four IF stages at 13.5 Mc/s. and bandwidth of 3.5 Mc/s. and 420 kc/s., detector, Video Amplifier and Cathode Follower Stages, Beat Frequency Oscillator, Video or Audio output. Sensitivity approx. 10µV. for 6db S/N ratio. External mains power supply unit. Fully overhauled and guaranteed, complete with power supply unit for 230 V. mains operation. £95 0 0

R-1294; frequency range 500 to 3,000 Mc/s. Tuned coaxial line input circuit, crystal mixer, CV-62 local oscillator, four IF stages at 13.5 Mc/s. and bandwidth of 3.5 Mc/s. Detector and two LF stages. Separate power supply unit is required. Fully overhauled and guaranteed, without power supply unit £95 0 0

External power supply unit can be supplied at extra charge.

HALLICRAFTER S-276; AM/FM reception in the range of 130 to 210 Mc/s. in one band. 117 V. A.C. operation. Fully overhauled and guaranteed £90 0 0

TELEFUNKEN RS1-20/AM/FM Receiver, 400-900 Mc/s. I.F. 2.25 Mc/s.; R.F. sensitivity at 450 Mc/s.-10µV for S/N of 10 db; Mixer-Oscillator-Pour I.F. stages and two A.F. stages. Power supplies 230 V. A.C. £110 0 0

AN/APR-4. The receiver unit is essentially an I.F. Amplifier with the associated audio and video stages and mains (115 V. A.C.) power supply unit. L.F. 30 Mc/s.; bandwidth 4 Mc/s. and 8 Mc/s. I.F. sensitivity from 33 to 66µV. Different frequency ranges are obtained by means of interchangeable plug-in tuning units containing mixer and local oscillator stages. These units are available for the following ranges: 35-95 Mc/s.; 75-220 Mc/s.; 300-1,000 Mc/s.; and 1,000-2,000 Mc/s. Prices or application—please specify the ranges required.

PANORAMIC ADAPTORS TYPE RDO, for use with AN/APR4 Equipment. 30 Mc/s. input frequency with sweep width of 10 Mc/s. Sensitivity at least 25µV for beam deflection of 2in. Mains operation. Price on application.

COMMUNICATIONS RECEIVERS

Fully overhauled to original specification and suitable for use in laboratories.

MARCONI CR-100, 40 kc/s to 30 Mc/s. ... £42 0 0

Ditto with Noise Limiter £48 0 0

MARCONI CR-100, 2-60 Mc/s.; Dual Superheterodyne with Signal Strength Meter and Electrical Breadboard. Complete with separate Mains Power Supply Unit £75 0 0

R.C.A. TYPE AR-88D, 540 kc/s to 32 Mc/s. £85 0 0

The above receivers are also available on Hire Purchase Terms. Please write for details and charges.

MARCONI TYPE TF-888A CIRCUIT MAGNIFICATION METER. Frequency Range 15 to 170 Mc/s. in four ranges ±2%. Magnification Range 60 to 1,200 in three ranges. Tuning Capacitor 12 to 80µµF with Vernier Tuning Dial. P.P. 20/- £130 0 0

MARCONI TYPE TF948 FM/AM SIGNAL GENERATOR

Frequency range 20 to 80 Mc/s. in two ranges. Built-in Crystal Calibrator with audible beat indicator. Output 1µV to 1mV into 75Ω and fixed high output of 1 V. Internal pulse. AM and FM modulation at 300, 1000, 1600 and 3000 c/s. Max FM deviation 600 kc/s. Provision for external modulation. Power supplies 100/180 V. and 200/250 V. Fully overhauled and guaranteed £200 0 0

METERS

50µA D.C. MC 2 1/2 in. Rd. Proj. Mtd. 45/-

200µA D.C. MC 2 1/2 in. Rd. Fl. Mtd.: Calibrated 0-200µA 35/-

Calibrated 0-30µA, sealed 35/-

500µA D.C. MC 2 in. Rd. Fl. Mtd., Ferranti or Elliott, with Ring Nut fixing, FGX4 30/-

500µA D.C. MC 2 in. Rd. Fl. Mtd. Victoria 30/-

500-600-500µA D.C. MC 3 1/2 in. Rd. Fl. Mtd., Calibrated 50-0-50 vds./sec. 30/-

750-0-750µA D.C. MC 2 in. Rd. Plug-in, uncalibrated, with Centre zero and FED marks 25/-

1 mA. D.C. MC 2 1/2 in. Rd. Fl. Mtd., calibrated 0-30-0-100 sealed 30/-

1-0-1 mA D.C. MC 2 1/2 in. Rd. Fl. Mtd., calibrated 100-200-400 with centre zero, sealed 22/6

15-0-15/30-0-30 mA. D.C. MC 2 1/2 in. Rd. Fl. Mtd. Dual range with three terminals. Turner model 508, FGX4 25/-

75mA D.C. MC 2 1/2 in. Rd. Plug-in, FGX4 15/-

150mA D.C. MC 2 in. Rd. Panel Mtd., FGX4 15/-

200mA D.C. MC 2 in. Rd. Fl. Mtd. 20/-

1 Amp. D.C. MC 2 1/2 in. Rd. Fl. Mtd. 25/-

1 amp. R.F. Thermocouple, 2in. Rd. Panel Mtd. 15/-

2 amps. D.C. MC 2 1/2 in. Rd. Fl. Mtd. 20/-

5 amps. D.C. MC 2 1/2 in. Rd. Fl. Mtd. 25/-

5 amps. A.C. MI 2 1/2 in. Rd. Fl. Mtd., calibrated 0-80 amps. 0-200 amps. 15/-

10 amps. D.C. MC 2 1/2 in. Rd. Fl. Mtd. 25/-

40 amps. D.C. MC 2 in. Rd. Proj. Mtd. 10/-

100 amps. A.C. MI 2 1/2 in. Rd. Fl. Mtd. 17/-

30-0-30 volts D.C. MC 2 1/2 in. Rd. Fl. Mtd. 17/6

36 v D.C. MC 2 in. Rd. Fl. Mtd., suppressed zero; zero deflection read. 18 1/2 sealed 20/-

150 v. A.C. MI 2 in. Rd. Fl. Mtd. 20/-

150 v. A.C. MI 2 1/2 in. Rd. Fl. Mtd. 20/-

300 v. A.C. MI 2 1/2 in. Rd. Fl. Mtd. 25/-

300 v. A.C. MI 2 in. Rd. Fl. Mtd., Turner 32 50/-

500 v. A.C. MI 2 1/2 in. Rd. Panel Mtd., Ferranti, Water-resist. proof, P8D-250µV; complete with external resistance; movement, 200µV 20/-

Signal strength meters, 2in. Rd. Panel Mtd. Basic movement 1 mA. D.C. Translucent scale with provision for internal illumination, calibrated from 0-20 "8" units at half scale, and from 0-40 db above 20 "8" units 35/- 1 1/2 in. Rd. P.M. miniature meters made by G.E.C., complete with fixing clips. These are available at the following ranges: 1 mA. at 25/-; and 25, 75, 100 and 150 mA. at 20/-

When ordering please add 2/6 in £ for packing and post.

PEN RECORDERS

ELLIOTT SINGLE PEN SWITCHBOARD PATTERN RECORDING MILLIAMMETER OR VOLTMETER. 4in. Strip chart; Clockwork chart drive (8-day) at 1in. per hour. This recorder is available for range of 15V. D.C. or higher or 5 mA. or higher. Fully overhauled and guaranteed £35 0 0

ELLIOTT OR EVERSHED SINGLE PEN SWITCHBOARD PATTERN RECORDING MILLIAMMETERS. Range 5 mA. D.C. or 2.0-2.0 mA. D.C.; 250 v Chart drive at 3in. per minute. 6in. Strip Chart. Fully overhauled and guaranteed £50 0 0

Ditto with range of 1 mA. D.C. £53 15 0

EVERSHED TWIN PEN SWITCHBOARD PATTERN RECORDING MILLIAMMETERS. Electric Chart Drive at 4in. per minute. Strip Chart 6in. wide. Fully overhauled and guaranteed, complete with two charts, two gravity pens, two siphon pens with trough, bottle of ink and dashpot oil. £65 0 0

Range 5 mA. D.C. £72 10 0

Range 1 mA. D.C. £72 10 0

Packing and carriage £1 per recorder.

SPECIAL OFFER OF CATHODE RAY TUBES

5CP1-5in. electrostatic Tube, medium persistence, suitable for Oscilloscopes; Anode voltages 1st 875 v., 2nd 2,000 v., 3rd 4,000 v., 1st-pin base ... £11/10-5PPT-5in. Tube, long persistence, electrostatic focus, electromagnetic deflection. Anode voltages: 1st 250 v., 2nd 7,000 v. Octal base, 5/ Postage and Packing 5/- per tube.

ONLY LIMITED QUANTITY AVAILABLE V.H.F. RECEIVER UNITS BC-624

4 Crystal controlled channel. 100-150 Mc/s. (3.0-1.93 metres). Valves 9003 R.F. stage, 9003 Mixer, Three I.F. stages 128G7; 12A7VC/Audio 12C8; Second Audio 12A3GT. Oscillator 2A7GT, Harmonic Generator 9002; Harmonic Amplifier 9003; Audio Squid-ether section of 12A7-GT. High and Low Impedance output. PRICE, with squelch relay removed, otherwise complete, without valves, with circuit diagram ... 7/6 p.p. 3/6. For valves see list below.



HEADPHONES

D.I.R. (low resistance), brand new; can be used as sound power microphones ... 10/- CHB (high resistance) ... 15/- HS-30 American Lightweight Headphones, Low Impedance ... 15/- Ditto with High-to-Low Impedance Transformer incorporated in the cord ... 17/6



RATCHET MOTORS 12v.

1 Amp. (Impulse Motors), 5.75 ohms ... 3/6 each Packing and postage 1/6.

VENNER 8-DAY TIME SWITCHES

For plug-in mounting. 1 make and 1 break every 24 hours. 24-hour dial with night and day marking. Contacts capacity 1A. at 250 v. Complete with key, Second-hand, guaranteed. ... 27/6. P.P. 3/6.

ROTARY TRANSFORMERS TYP 106

(Ex. TR-1520-Series) 24/28 v. D.C. input; Output 250 v. R.T. up to 200 mA, fully smoothed and grid bias supplies of -50 v. Complete with smoothing units. Perfect condition and guaranteed, 12/6. P.P. 5/-.

MAINS TRANSFORMER 100-250 v. input; 275-0-275 v. output @ 80mA; 6.3 v. @ 2.5A and 6.3 v. @ .5A, 15/- P.P. 3/6.

VARIABLE RESISTANCES

Precision Ganged Wire Wound Colvern Pot., 2 x 50,000 Ohm, 3 1/2 Watts, 4/- P.P. 2/- Adjustable Slider Wire Wound Resistor, 6 Ohm @ 5 Amps, with mounting feet, suitable for battery chargers, 2/6. P.P. 2/-.

PLUG-IN I.F. UNIT ZA30039.

One 465 kc/s. I.F. stage using 174 valve. 1/6 less valve or 5/- complete. P.P. 1/9.

E.H.T. METAL TUBULAR RECTIFIERS

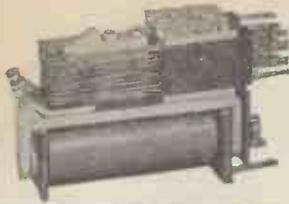
Half Wave; Max. r.m.s. volts 1220V. at 2 MA. Screw Terminals ... 7/6 Solder Terminals ... 5/- P.P. 9d. per rectifier.

RELAYS

SIGMA 4C1 or ALLIED "G," High Speed ... 5/6 SIEMENS HIGH SPEED 2x145Q, 1 CO. ... 8/6 SIEMENS HIGH SPEED 2x500Q, 1 CO. ... 9/- WESTINGHOUSE POLARIZED RELAY, 1 CO., speed of operation 500 per minute or more; twin 145Q coil plus soaking winding of 45Q. Complete with mounting socket ... 25/- Packing and postage 9d. per relay.

Table of vacuum tube types and prices, including 6X4, 6X5, 6X6, 6X8, 6X9, 6X10, 6X11, 6X12, 6X13, 6X14, 6X15, 6X16, 6X17, 6X18, 6X19, 6X20, 6X21, 6X22, 6X23, 6X24, 6X25, 6X26, 6X27, 6X28, 6X29, 6X30, 6X31, 6X32, 6X33, 6X34, 6X35, 6X36, 6X37, 6X38, 6X39, 6X40, 6X41, 6X42, 6X43, 6X44, 6X45, 6X46, 6X47, 6X48, 6X49, 6X50, 6X51, 6X52, 6X53, 6X54, 6X55, 6X56, 6X57, 6X58, 6X59, 6X60, 6X61, 6X62, 6X63, 6X64, 6X65, 6X66, 6X67, 6X68, 6X69, 6X70, 6X71, 6X72, 6X73, 6X74, 6X75, 6X76, 6X77, 6X78, 6X79, 6X80, 6X81, 6X82, 6X83, 6X84, 6X85, 6X86, 6X87, 6X88, 6X89, 6X90, 6X91, 6X92, 6X93, 6X94, 6X95, 6X96, 6X97, 6X98, 6X99, 6X100, 6X101, 6X102, 6X103, 6X104, 6X105, 6X106, 6X107, 6X108, 6X109, 6X110, 6X111, 6X112, 6X113, 6X114, 6X115, 6X116, 6X117, 6X118, 6X119, 6X120, 6X121, 6X122, 6X123, 6X124, 6X125, 6X126, 6X127, 6X128, 6X129, 6X130, 6X131, 6X132, 6X133, 6X134, 6X135, 6X136, 6X137, 6X138, 6X139, 6X140, 6X141, 6X142, 6X143, 6X144, 6X145, 6X146, 6X147, 6X148, 6X149, 6X150, 6X151, 6X152, 6X153, 6X154, 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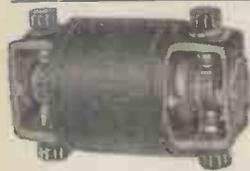
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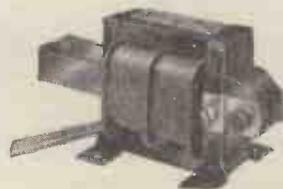
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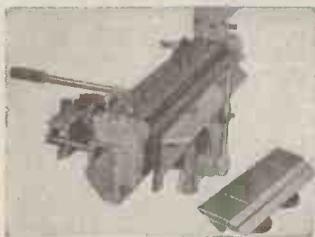
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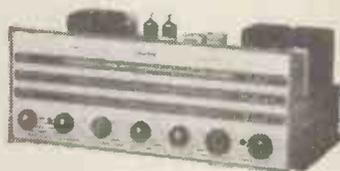
A PPLY in writing to: Clarke & Smith Mfg. Co. Ltd., Hanworth Air Park, Feltham, Middlesex. [9787]

T ESTERS, E. K. Cole, Ltd., Southend-on-Sea, have vacancies for radio and television testers and fault finders.—Apply Personnel Manager. [9731]



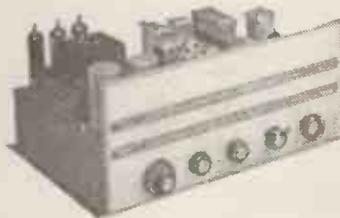
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FURTHER particulars and forms of application may be obtained from the Registrar (Department O), Bradford Institute of Technology, Bradford 7.

HENRY PATTEN, Clerk to the Governors. [9789]

KINGSTON UPON HULL EDUCATION COMMITTEE.

COLLEGE of Technology. PRINCIPAL, Emlyn Jones, M.Sc., F.R.I.C. REQUIRED, for 1st January, 1962. Assistant (Grade B) in the Electrical Engineering Department to teach in Marine Radar (maintenance) courses. Applicants should hold the Ministry of Transport Radar Maintenance Certificate with, preferably, seagoing radar and radio experience.

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FURTHER particulars and application forms, to be returned within 14 days of the date of this issue, may be obtained from the Chief Education Officer, Guildhall, Kingston upon Hull. [9776]

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8-ΩHM P.M. SPEAKERS. In good working order, 8in., 8/6; 6in. 7/6; 5in. 9/6.
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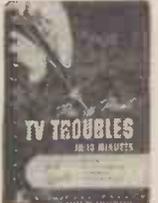
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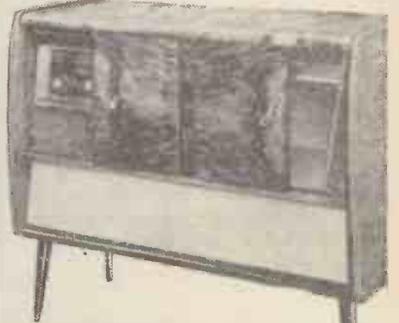
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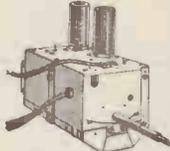
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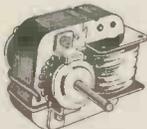
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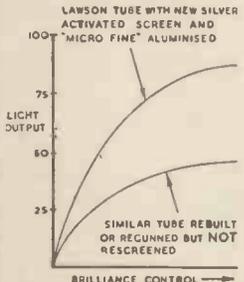
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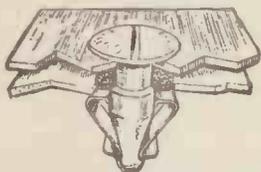
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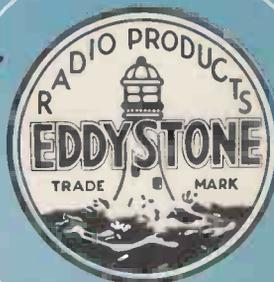
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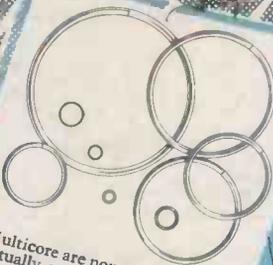
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