RADIO and ELECTRICAL Review

TELEVISION - COMMUNICATIONS - SERVICE - SOUND

Are You Looking for "Radio & Electronics" ?

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MAY 1st, 1954

VOL. 9, NO. 3

When valves are out of date

BRIMARIZE - no need to wait!

TYPE 76 and its octal based equivalent type 6P5G are general purpose triodes used as oscillators and amplifiers in radio receivers and test gear.

Type 6J5G will replace type 6P5G directly with change of bias resistor if necessary, whilst replacement of type 76 will involve a change of socket.

For oscillator applications the slight differences in inter-electrode capacitancies may necessitate re-trimming. When used in paraphase amplifiers the increased gain of type 6J5G will involve re-balancing of the inputs to the push-pull valves.

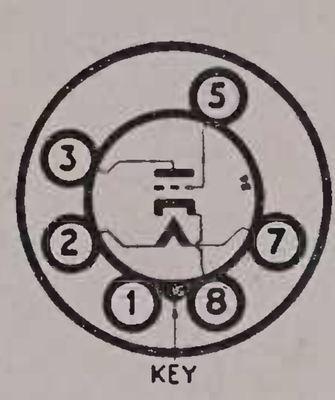
CHARACTERISTICS

	TYPES 76, 6P5G	TYPE 6J5G
Heater Voltage	6.3	6.3 volts
Heater Current	0.3	0.3 amp.
Anode Voltage	250	250 volts
Anode Current	5.0	9.0 mA.
Bias Resistor	2500	1000 ohms.
Mutual Conductance	1.5	2.6 mA/V
Amp. Factor	14	20

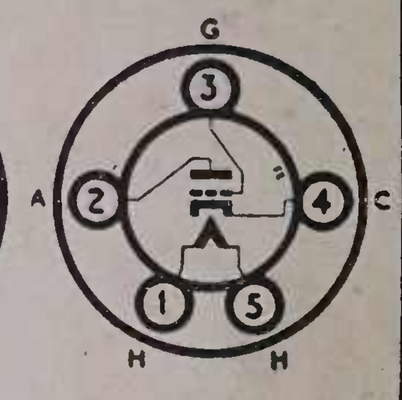
RESISTANCE COUPLED OPERATION

(Supply Voltage 250 volts)

Anode Load Resistor	0.05	0.1	0.05	0.1	meg.
Cathode Bias Resistor	3000	7500	2000	4000	ohms.
Voltage Gain	9	10	15	16	



TYPES 6J5G, 6P5G



TYPE 76

CHANGE VALVE FROM	CHANGE VALVE TO	CHANGE SOCKET FROM	CHANGE SOCKET TO	CHANGE CONNECTIONS FROM OLD SOCKET	CHANGE CONNECTIONS TO NEW SOCKET	OTHER WORK NECESSARY	PERFORMANCE CHANGE
76	6J5G	U.X. 5 Pin	International Octal	Pin 1 " 2 " 3 " 4 " 5	Pin 2 " 3 " 5 " 8 " 7	1. Change Bias Resistor in accordance with table above. 2. Re-trim receiver if necessary.	Increased oscillation or gain depending on the application.
6P5G	6J5G	International Octal NO CHANGE		NO CHANGE		AS ABOVE	

BRIMAR

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TELETUBES

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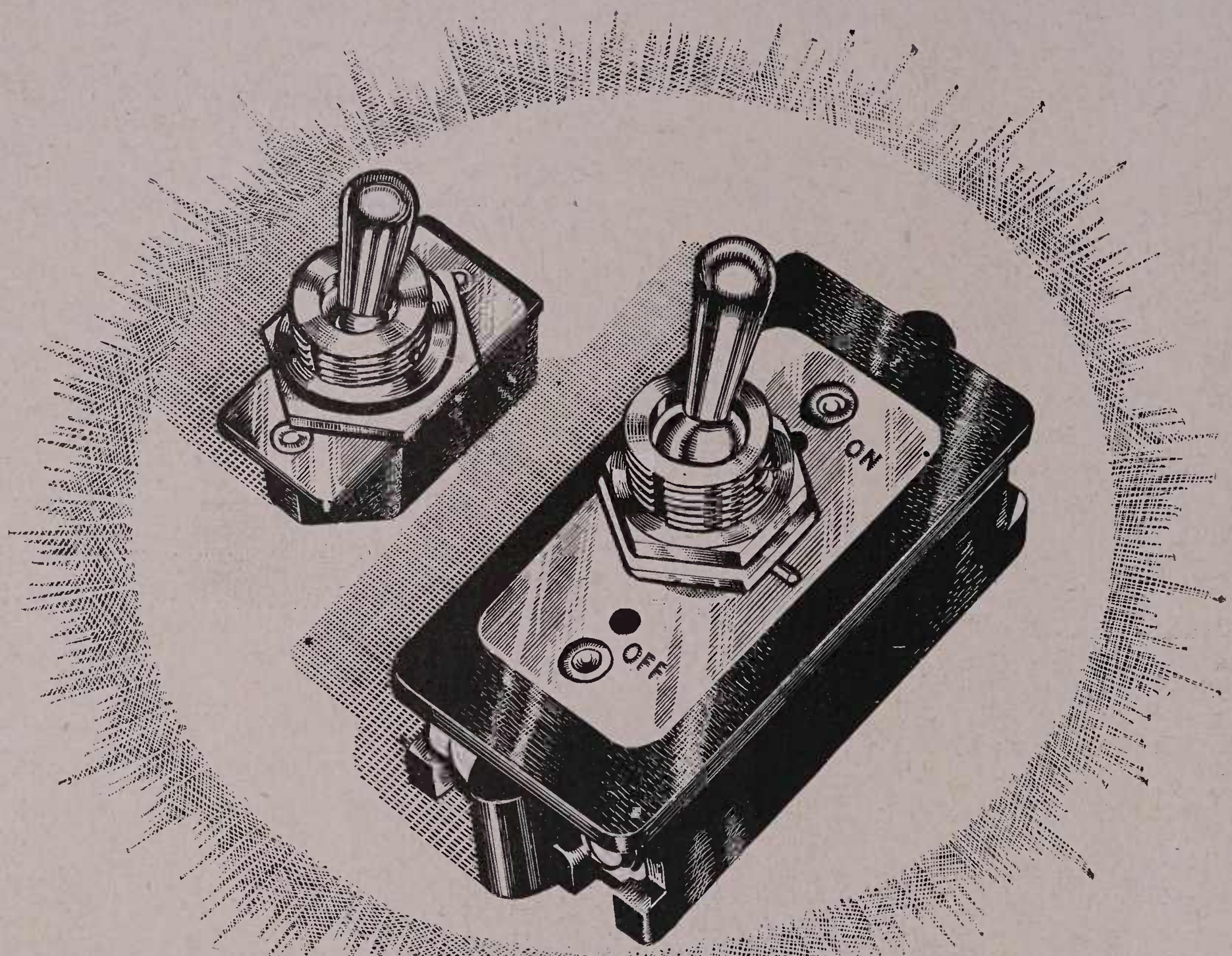

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1U5	6BE6	6L6G	7S7	35L6GT
3Q4	6B8G	6N7GT	7Y4	35W4
3S4	6B8GT	6Q7G	12AH8	35Z3
3V4	6BG6G	6Q7GT	12AT6	35Z4GT
5U4G	6BW6	6R7G	12AU6	50C5
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6AQ5	6J7GT	7B7	14H7	

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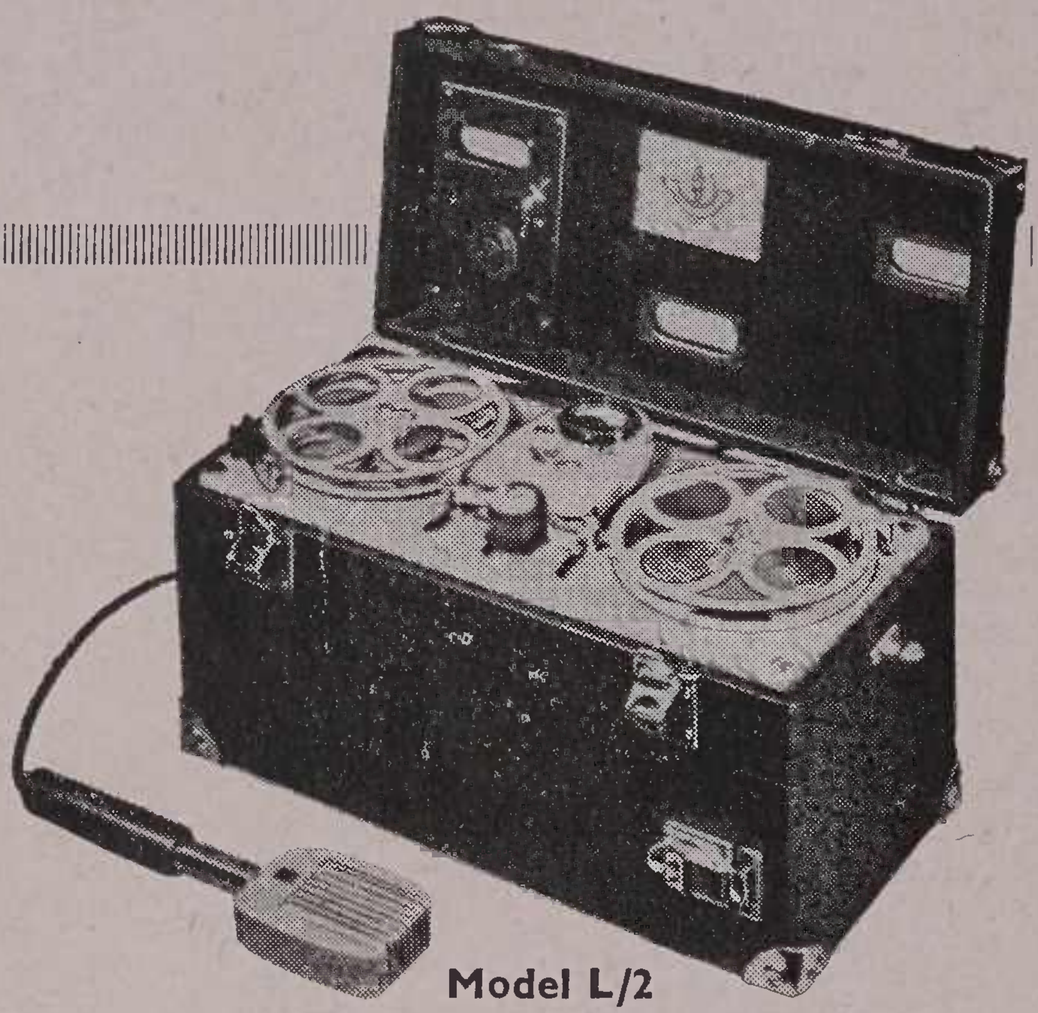

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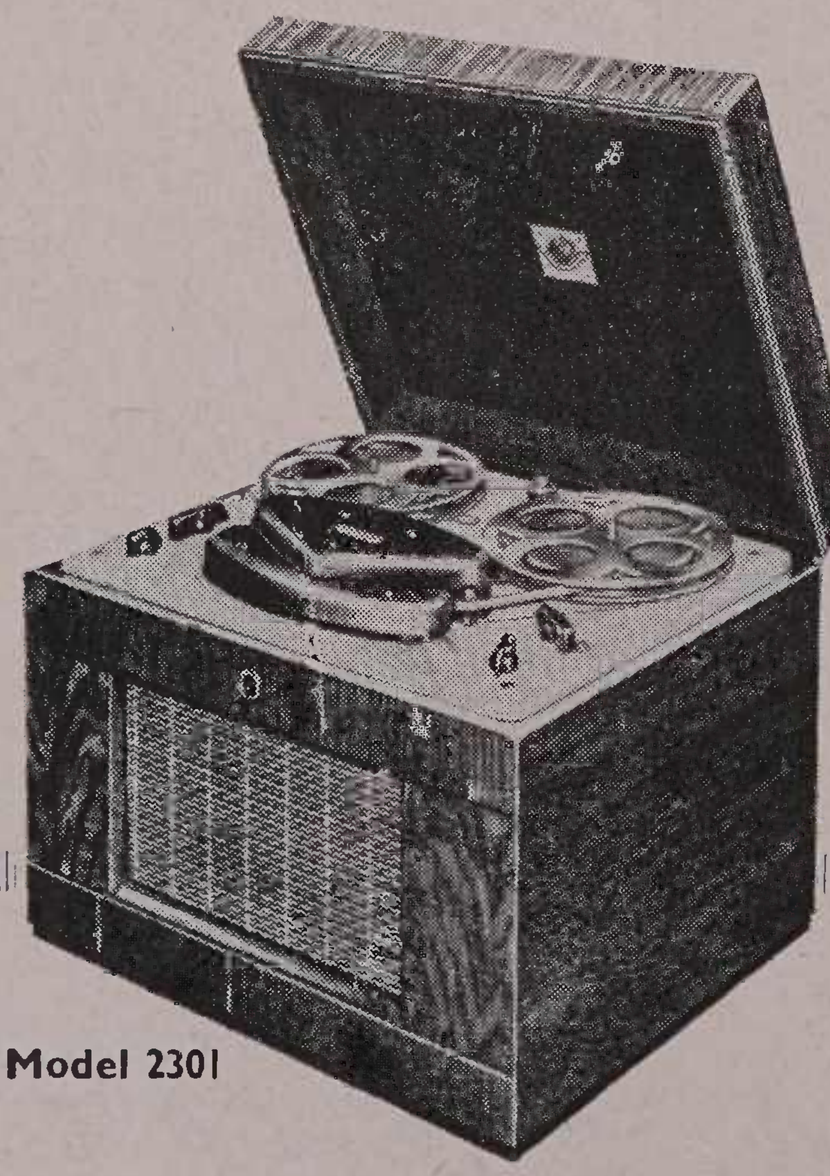
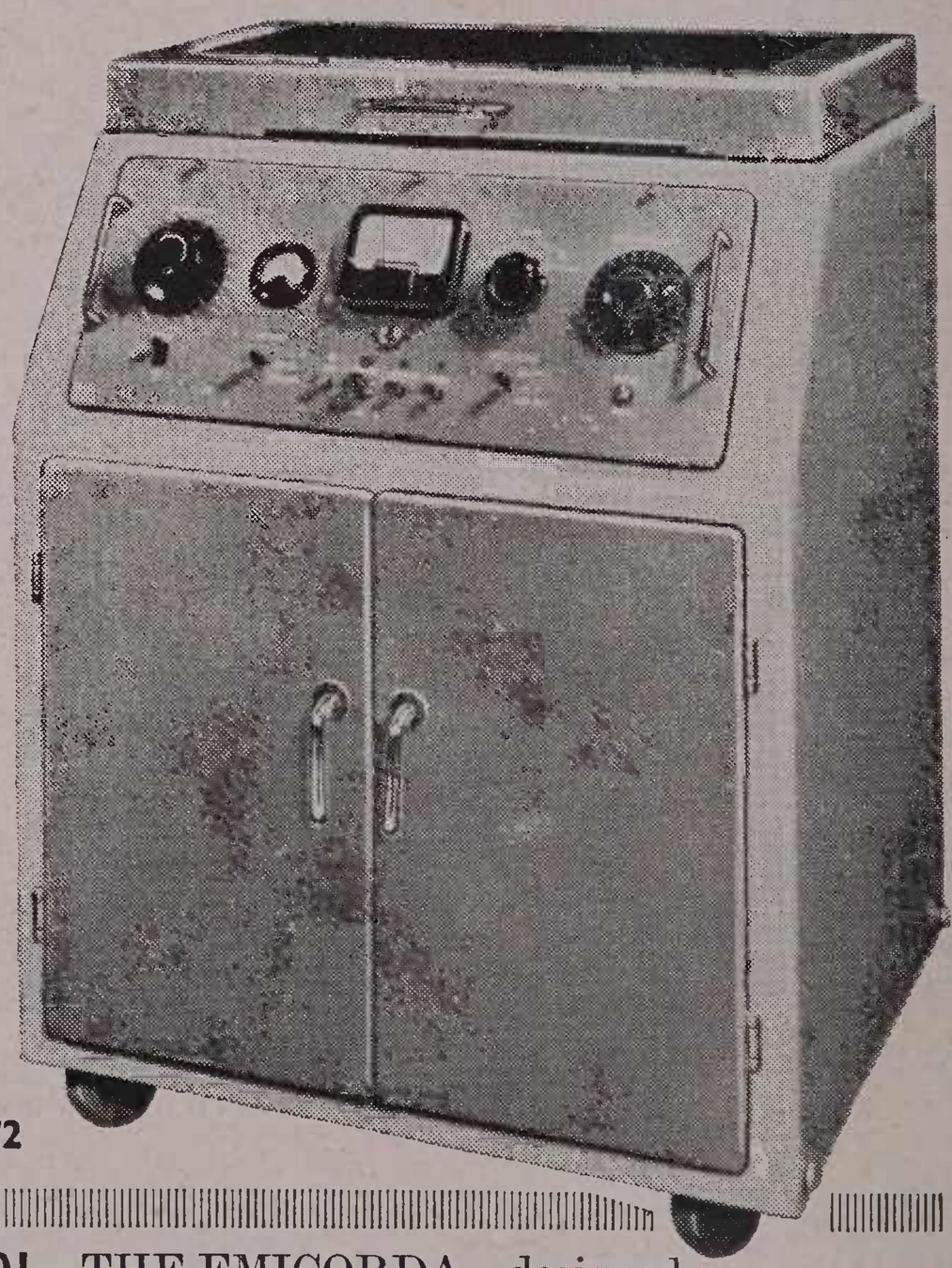


Model 2301



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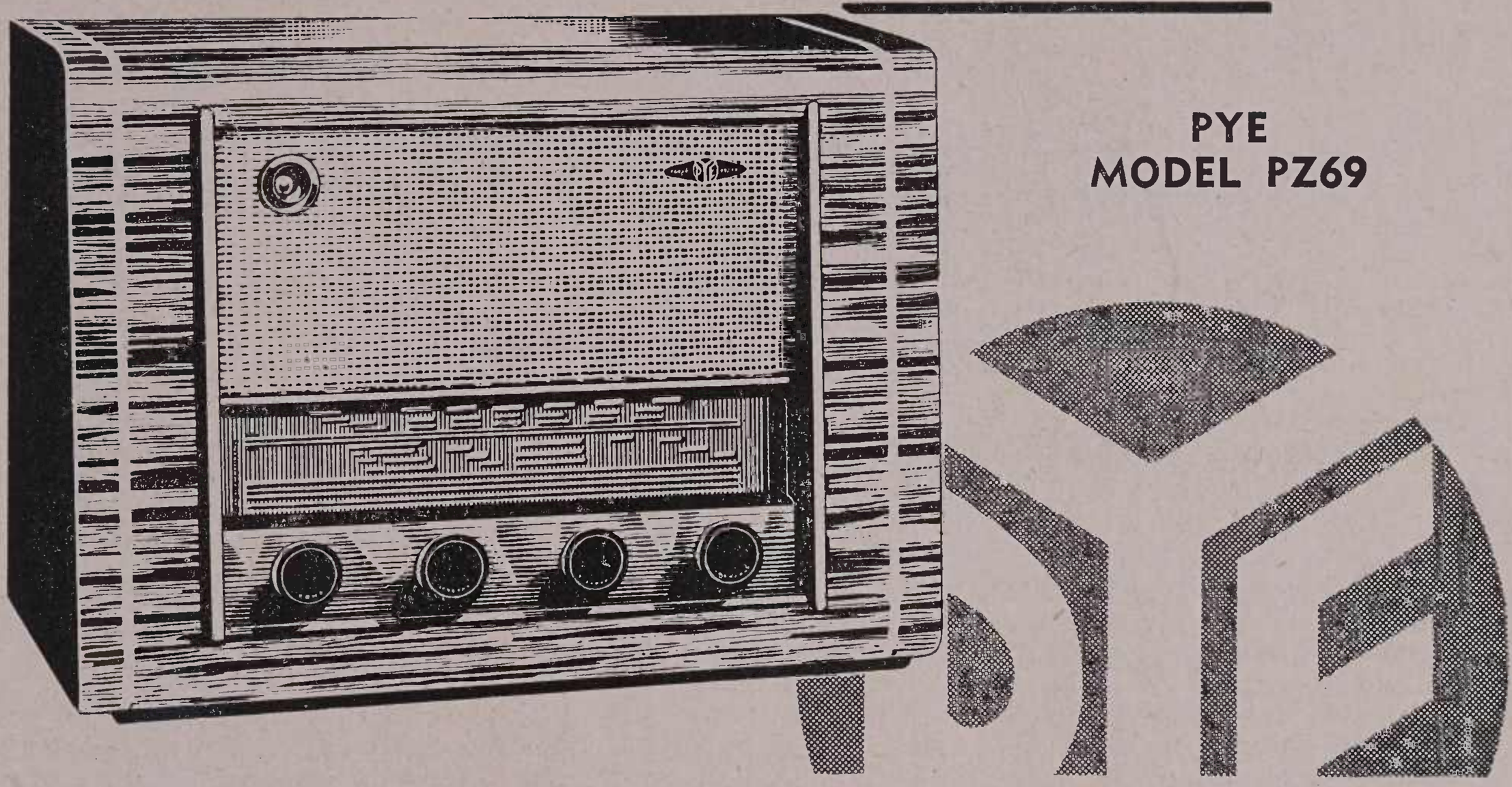

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No. 16

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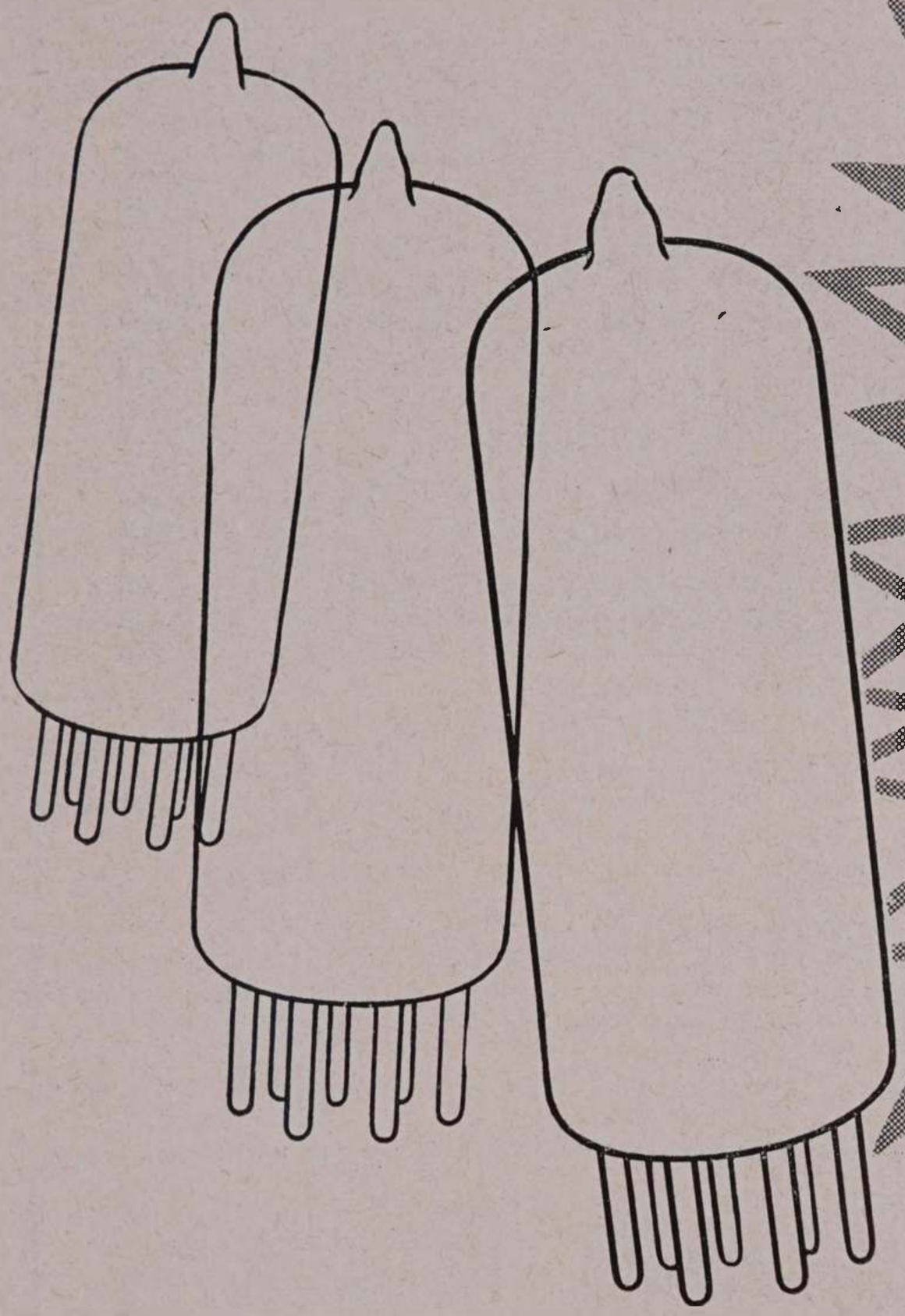

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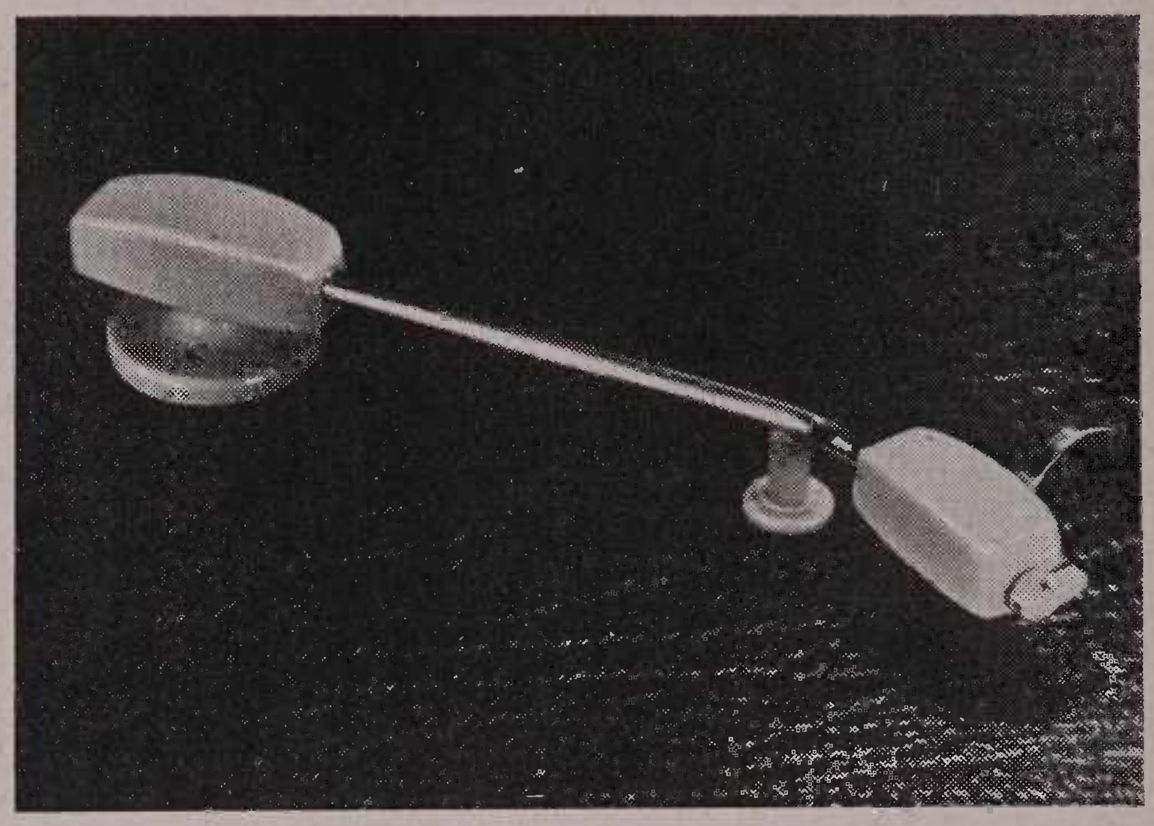

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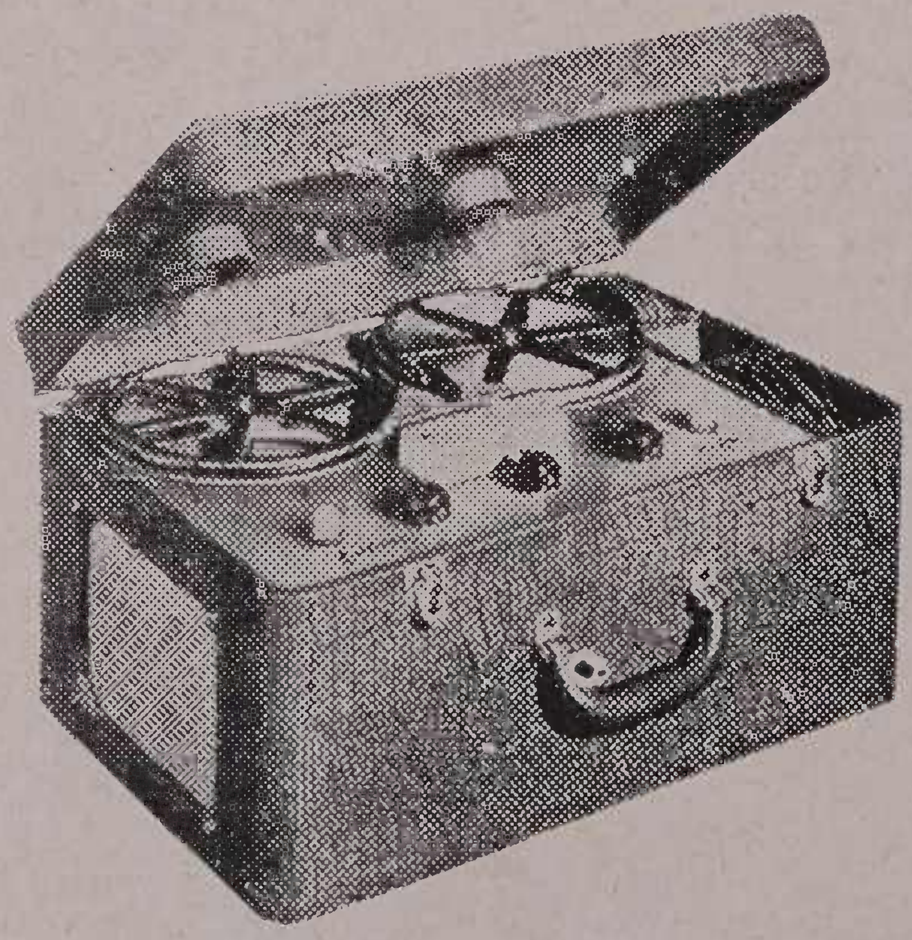

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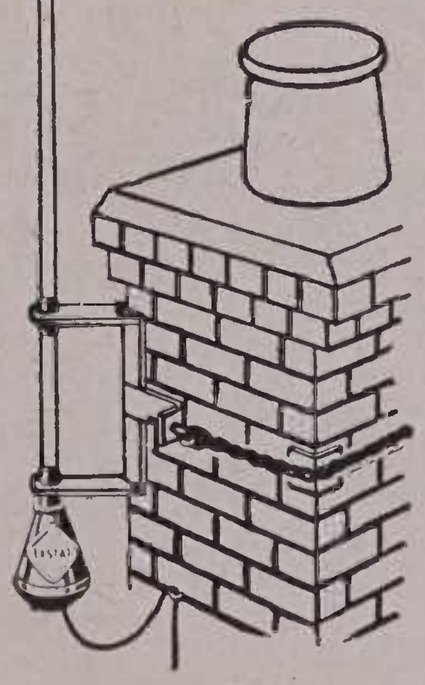

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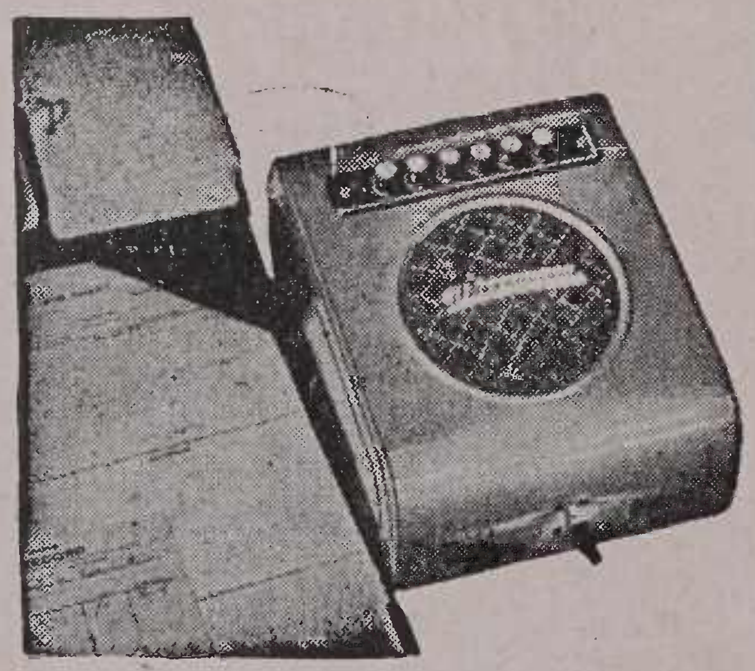

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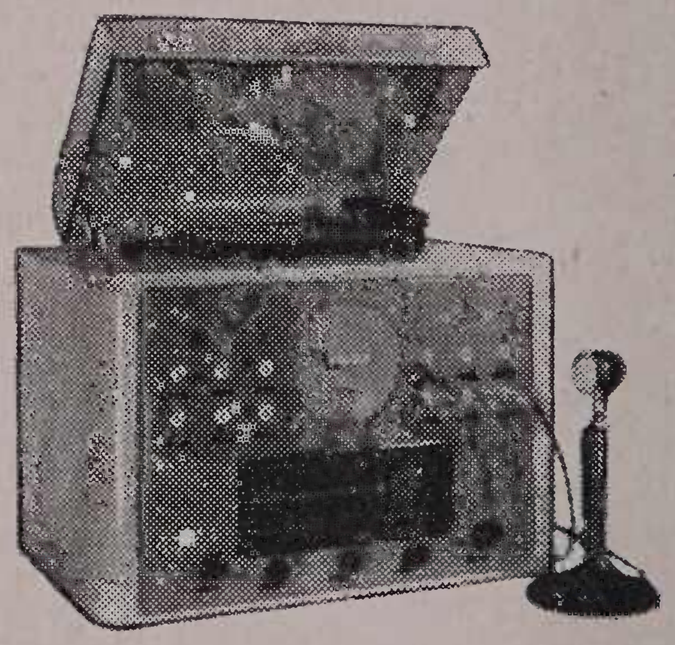

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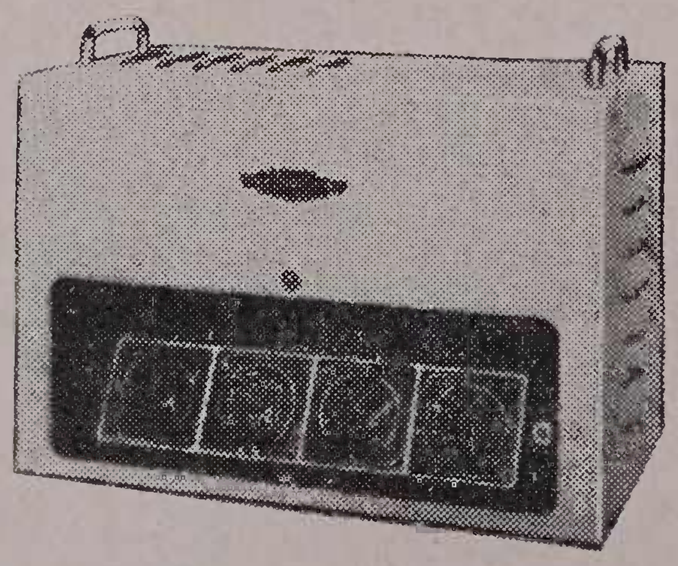

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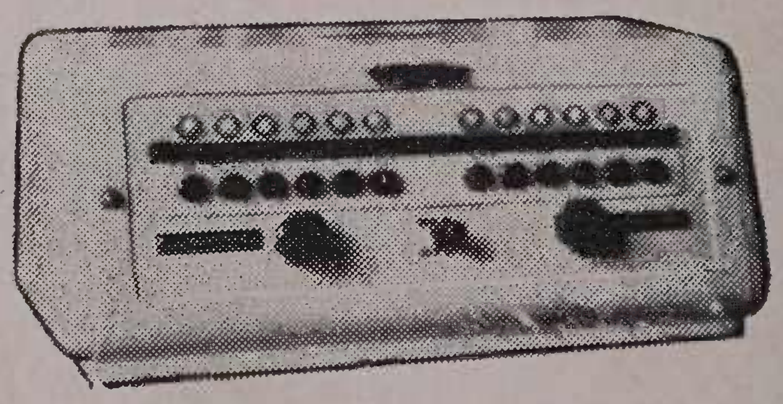

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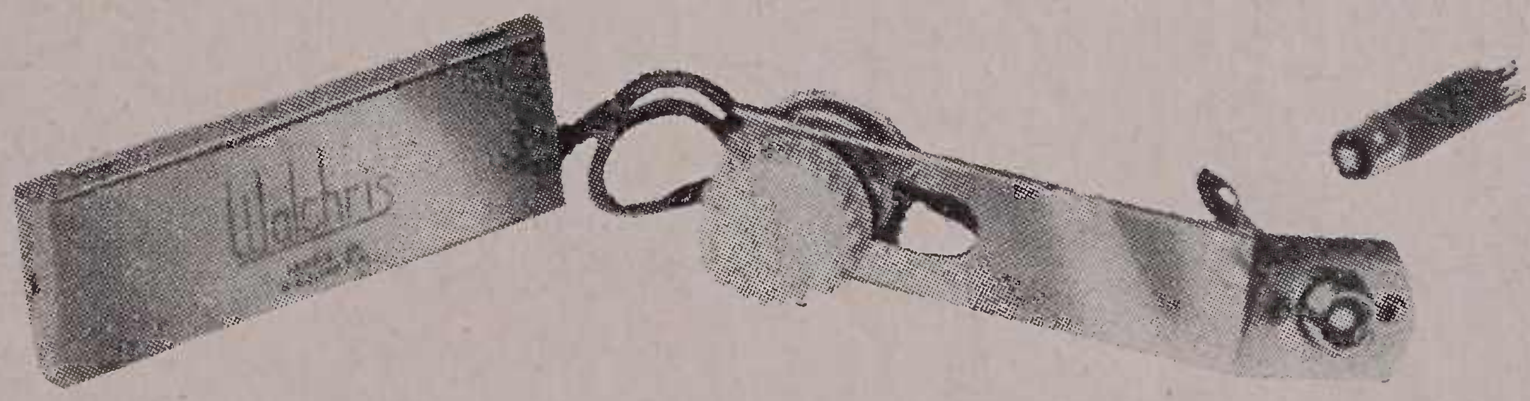

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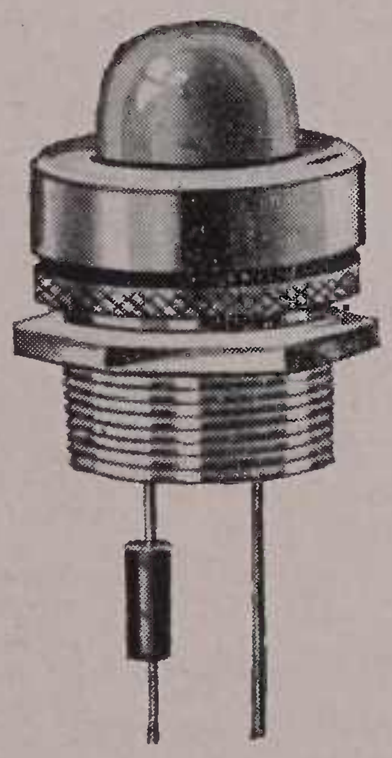

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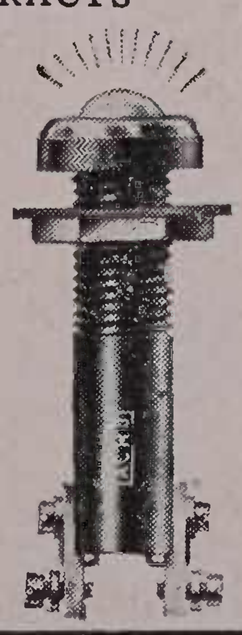

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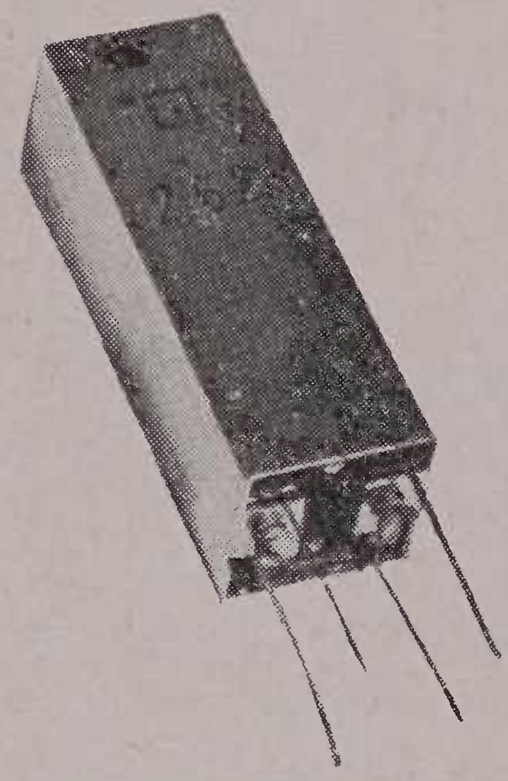

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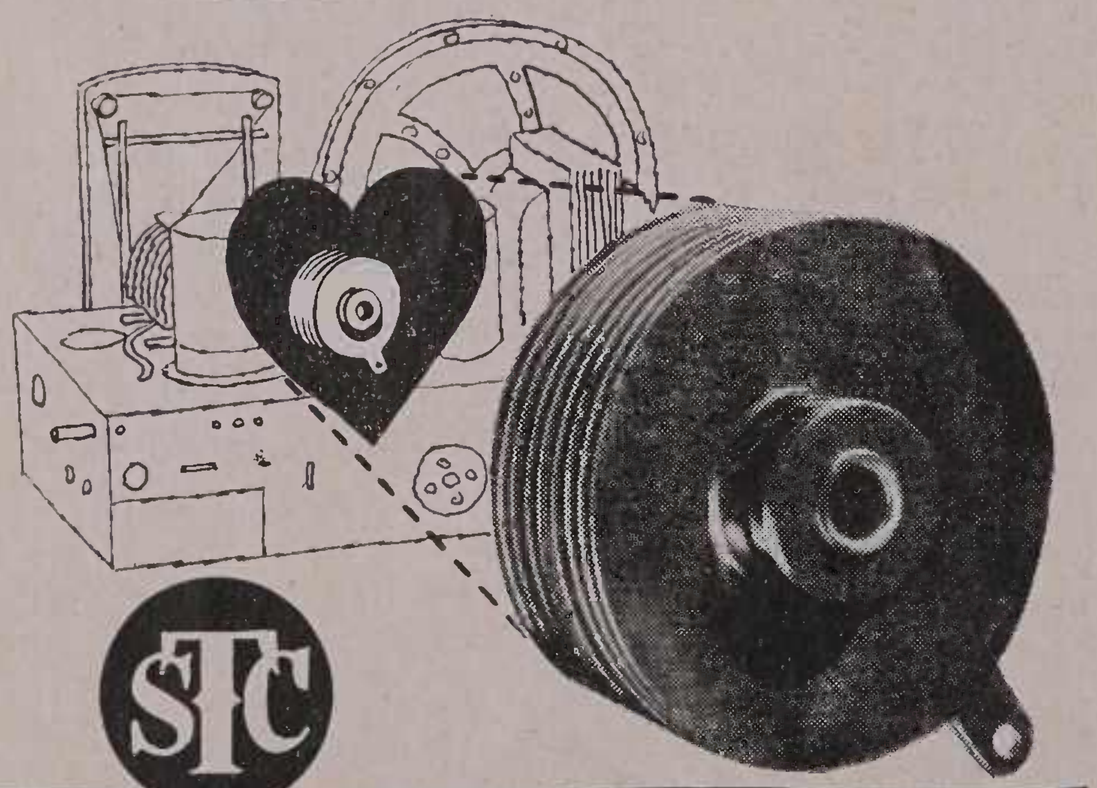

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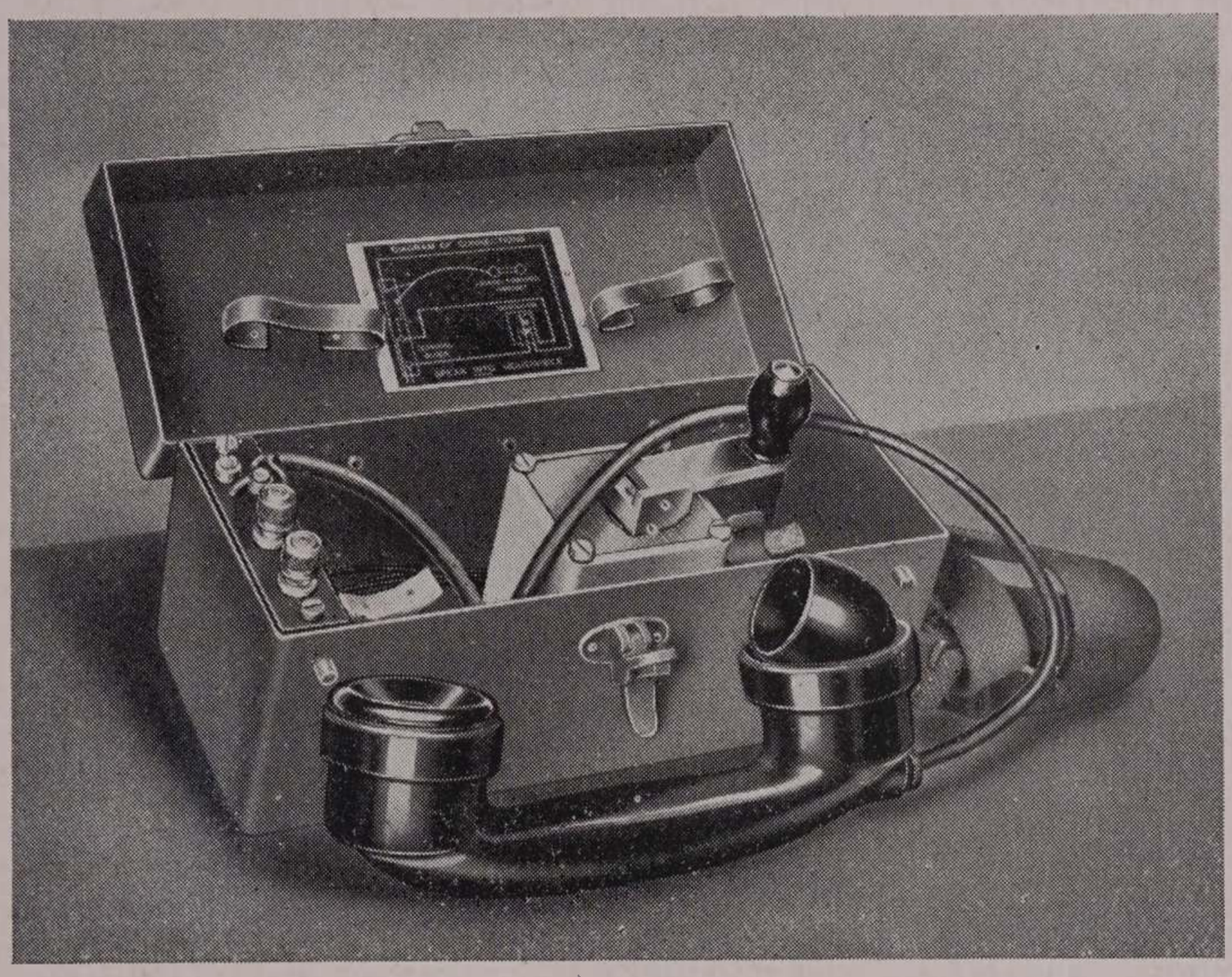
Battery-Less Portable Telephone type L51



The Battery-less Portable Telephone consists of a battery-less handset and high-frequency generator for "howler" calling, both contained in a sheet-metal case, fitted complete with webbing and carrying strap. No batteries are required for speaking or ringing. This instrument requires two-core cable for connection, and is ideal for positions which only require temporary communication.

Manufactured by
TELEPHONE MANUFACTURING CO.
London, England

New Zealand Representatives:
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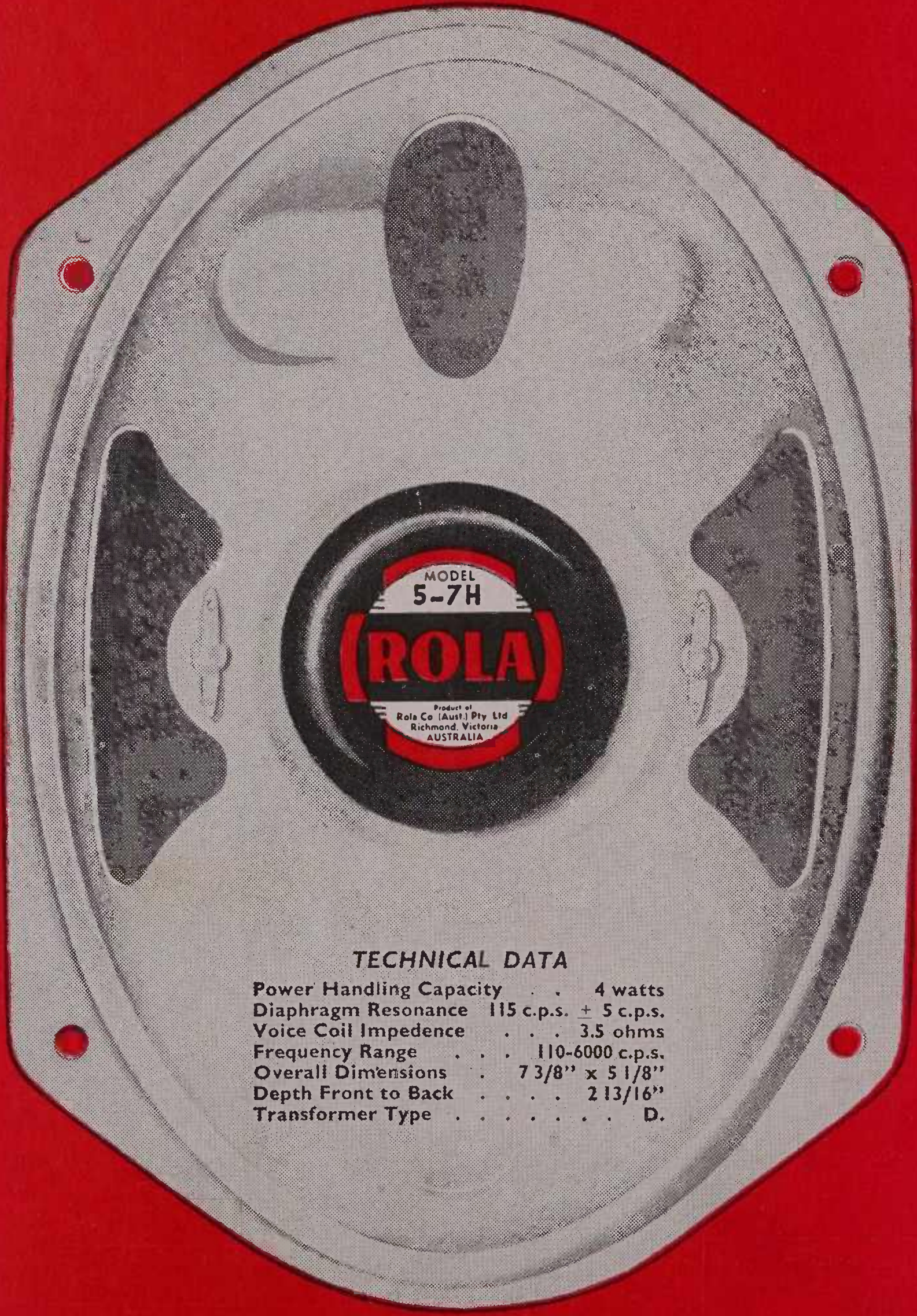
FOR BIG SET PERFORMANCE IN MIDGET SETS



TECHNICAL DATA

Power Handling Capacity . .	4 watts
Diaphragm Resonance	115 c.p.s. ± 5 c.p.s.
Voice Coil Impedence . . .	3.5 ohms
Frequency Range . . .	110-6000 c.p.s.
Overall Dimensions .	7 3/8" x 5 1/8"
Depth Front to Back	2 13/16"
Transformer Type	D.

Home Recording and the Law

In the December issue of our British contemporary, *Wireless World,* there appears an editorial article dealing with this topic. It is one which is of as much interest in this country as at Home, since it springs from the vast increase in the amount of amateur recording which has been brought about by the development and use of domestic tape recording.

It illustrates quite well one social aspect of technological advances—namely, the way in which these can cause legal difficulties by bringing about situations which were either impossible or very unlikely at the time certain legislation was drafted. The main question is whether a person who uses a recording machine on such things as broadcast programmes or gramophone records is infringing the laws of copyright, particularly when the recordings thus made are played back. It appears that the B.B.C. was under the erroneous impression that the use of recorders to take copies of their broadcasts was illegal, and went to the trouble of reminding listeners, through the pages of the *Radio Times* that this was the case. For those who like arguing from the layman's angle about points of law, there would appear to be many tit-bits here. For instance, even if the B.B.C. were correct, they could not prosecute without being able to prove that the recording complained of was in fact taken from one of their broadcasts. In many cases they would find great difficulty in proving it, provided the recorder had taken the precaution of excising any announcements and just had the bare music on his tape. As one correspondent to *Wireless World* put it, who is to say that the music was not synthesized from the outputs of a number of oscillators? And if the item recorded is some classical work, copyright on which has long ceased to exist, how could anyone prove which of some thousands of possible performances is the one recorded?

Luckily, however, such knotty points are rather unlikely ever to be thrashed out in court, nor is any inoffensive user of a tape recorder likely to be taken to court, even by the manufacturer of a gramophone record, unless he uses his copy for public performance. Should he do so, we must warn him that he *is* liable to catch it in the neck, but expert advice which we have sought has expressed the opinion that, provided a recorder is not used for public performance, the user is within the law, in this country at least. Naturally, it all depends on what is meant by "public performance," as Dr. Joad would have said. It can be taken, however, that as long as the recorder is used in one's home, for the edification of one's family and friends, and without charge, then the performance is not a public one. It may be that the same recording, played to the members of a society, such as a musical society or club, might be on somewhat thinner ice, but it is not thought that this, either, would constitute a public performance provided that any non-members of the society who might be present at the performance were there by invitation of the members.

It looks, then, as though we have little need to fear that our use of recorders will be restricted by the owners of copyrights or performing rights, as long as we do not try to cash-in on the recording. For example, a modern street musician who played copyright music from a tape recorder and then took round the hat would obviously be asking for trouble! However, he might quite well get away with playing Beethoven symphonies to music-hungry pedestrians provided no one could prove that his tape was made from a copyright gramophone record!

There is one point, however, which our legal adviser may have overlooked. Few radio men will not remember the old licences, which had on the back a long screed which stated, among other things, that anything heard on the air was to be regarded as secret and confidential and could not be divulged to anyone! Should the regulation on which this was based still be in force, the use of a tape recorder will be as illegal as the felonious copying down in pen and ink of "messages" picked up at one's "receiving station." At the same time, anyone who asks you whether you heard such-and-such a joke on last Saturday's "Take it from Here" must be equally culpable! It does seem that such a regulation, if still in force, should be repealed, or we will be in danger of seeing something very like one of A.P.H.'s "Misleading Cases" in real life.

Sets for Constructors—New Series

A FOUR-VALVE DUAL-WAVE SET

WITH 5-TUBE PERFORMANCE

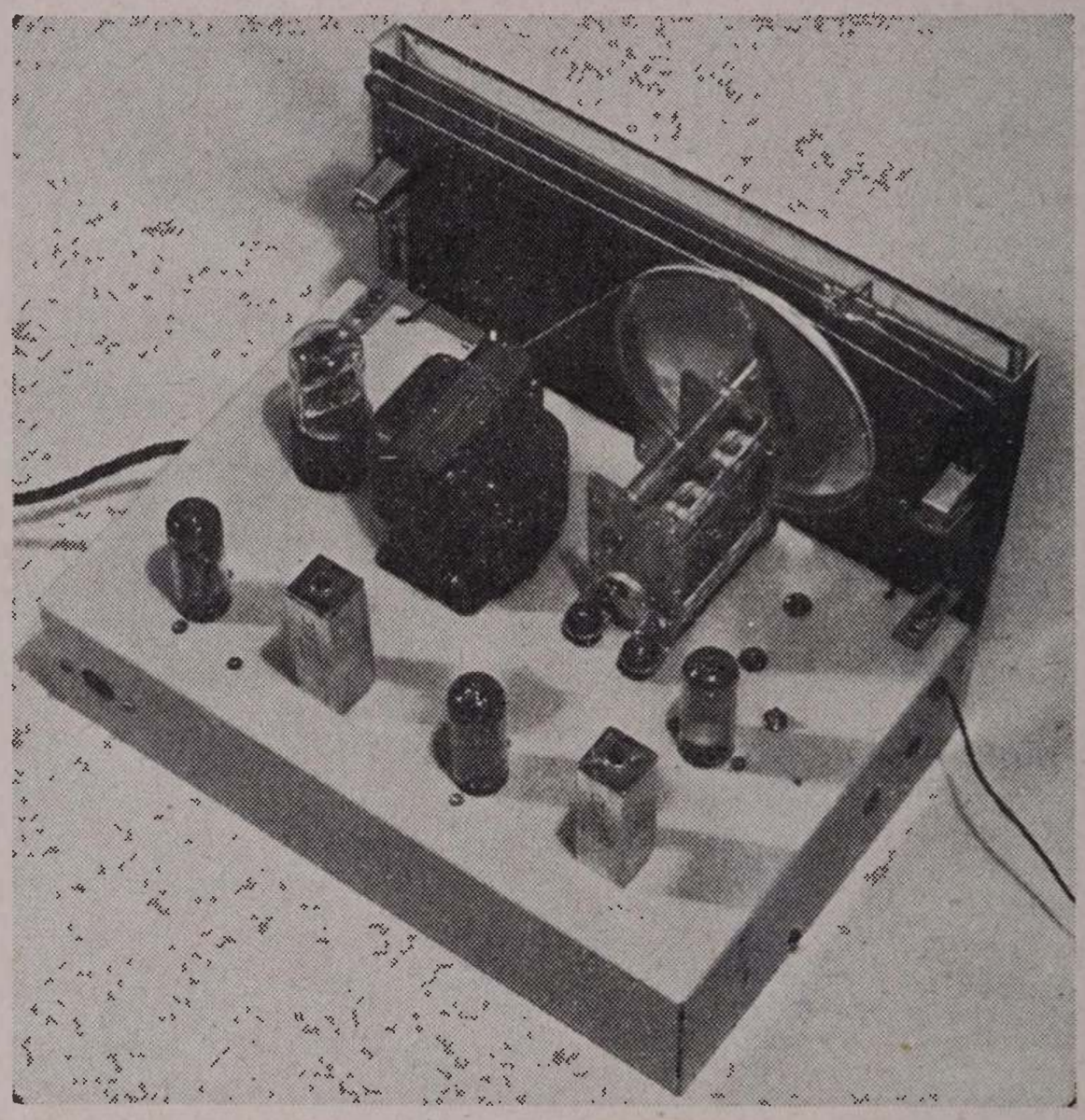
INTRODUCTION

We have never ceased to be surprised at the popularity of many of the sets that were designed and originally published in "Radio and Electronics" in the very early stages of its existence. Indeed, almost every week we hear of someone who is building receivers, amplifiers, etc., which appeared in our pages as long as seven or eight years ago. Now that we have entered upon our ninth year of publication, and have at the same time changed our title from "Radio and Electronics" to "Radio and Electrical Review," we feel that the time is opportune for presenting a completely new series of receivers, designed specially for amateur constructors, and using the most modern valves, and where applicable, the latest circuit techniques. We think that readers will find the performance of these sets really excellent, and it is our hope that they will turn out to be as popular as the older designs which they can now usefully replace.

DUAL-WAVE WITH ONLY FOUR TUBES

At the outset, we would like to point out that the little set which forms the first of the new series is really a "hot" performer. At one time—not so far distant—it would not have been possible to make a four-valve receiver which had adequate sensitivity on the short-wave band, but thanks to some of the latest valves, this is now entirely possible, and the sensitivity of this set is just as high as that of a conventional five-valver, not only on broadcast, but on short-wave too. The secret is quite simple once it has been pointed out. It lies in the use of the new nine-pin miniature series of valves, ECH81, EBF80, and ECL80, which together with the normal full-wave rectifier, for which we have used the old faithful 6X5, give a complement of only four valves and yet enable the circuit to be almost identical with that of a conventional five-valver.

The ECH81 is a modern high-gain oscillator mixer tube, with a very low noise level for valves of this general kind. This helps the short-wave performance considerably, especially in a set of this kind, which does not use a stage of R.F. amplification. The EBF80 is a remote-cut-off R.F. pentode with two diodes in the same envelope, so that it can be used as I.F. amplifier, detector diode, and A.V.C. diode. The ECL80, however, is somthing rather new in conception. Primarily designed for use in television receivers, it contains a small triode together with an output pentode. In our set it is used as audio voltage amplifier and output tube. Previous to the advent of this tube, a receiver with three working valves could not use a stage of audio amplification, but the ECL80, in making this possible, gives just that additional sensitivity that is needed in order to make short-wave operation a practical possibility. The only thing about this set that is different from the corresponding five-valver is that the power output is rather smaller than can be obtained from the average output pentode such as 6V6, EL33, EL41, etc. In many ways this smaller power output is a virtue in disguise. We have all become so used to the average set having a nominal power output of three to four watts, that we have almost forgotten the possibility of anything else. It is a fact, however, that a good deal less power than this is quite satisfactory, for filling even a medium-sized living room. Unbelievers please note the output power available in portables!



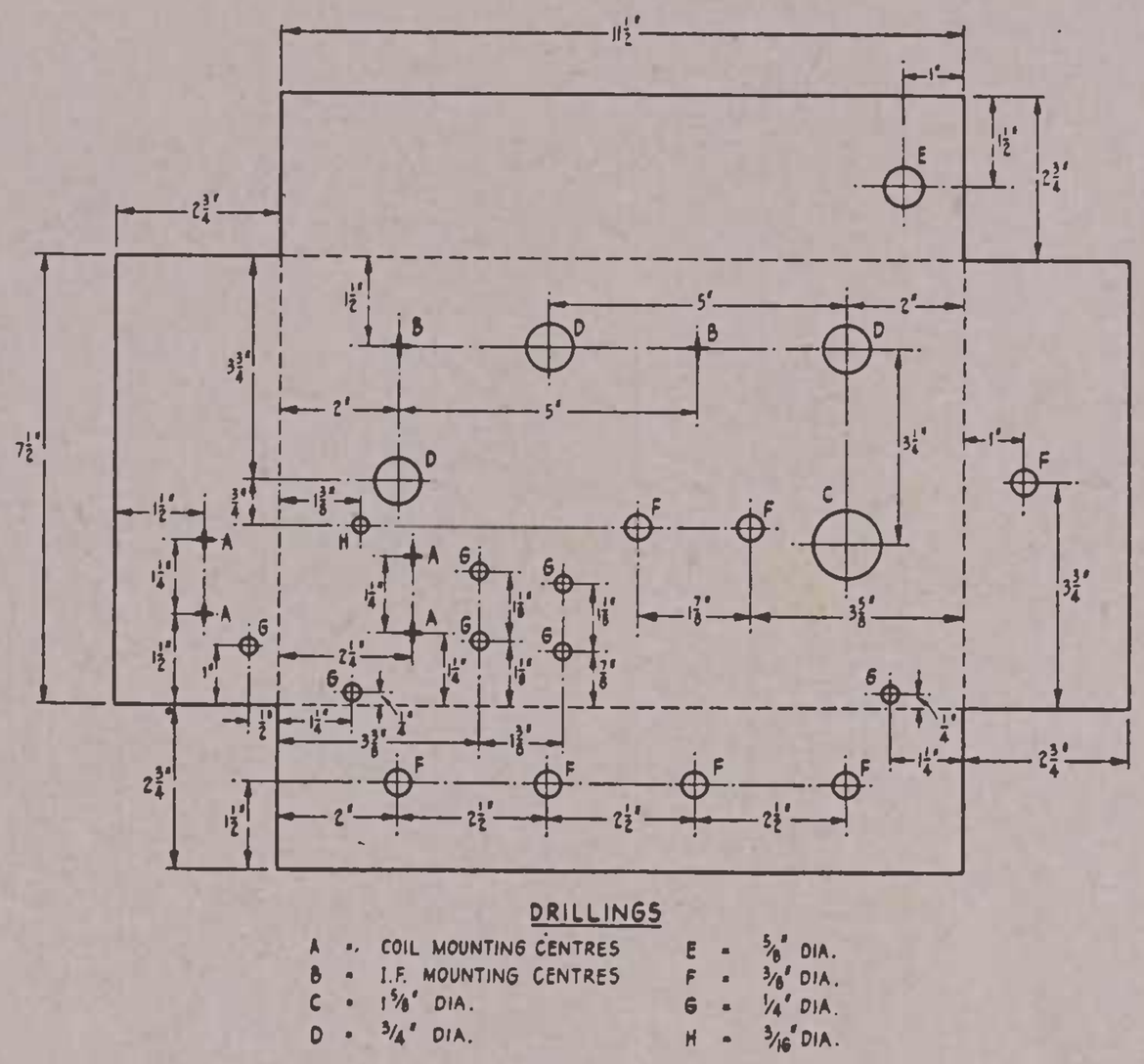
General view of the receiver. The two black circles to the right of the gang condenser are the mounting holes of two of the coils, and the other two can be seen on the side of the chassis, behind the aerial lead which can be seen running out of the photograph. Note the ample room provided round all the main components, making for spaciousness underneath, and thus for easier wiring.

The pentode section of the ECL80 gives a power output of 1.75 watts under the following conditions:—

Plate and Screen Voltage	200v.
Plate Current	17.5ma.
Screen Current	3.3ma.
Grid Bias	—8v.
Plate Load Resistance	11,000 ohms.

From this table it can be seen that the pentode section is very efficient, giving substantial power

output for very modest requirements in plate voltage, and plate and screen current. This enables the set to be run from a small power transformer, thus making this component less expensive than otherwise. The transformer actually used is a 190v.-a-side, rated at 35ma., and this copes satisfactorily with the H.T. requirements, in spite of the fact that the current drawn by the whole set when not tuned to a signal is very slightly more than 35ma. This does not matter at all, however, since the commercial transformer used is very conservatively rated, and also because the current drops to under 35ma. when tuned to a signal. Because some readers will not be familiar with the new tubes and their socket connections, we have shown these with the circuit diagram.



Working drawing for the chassis of the set. The letters A show where the specially shaped holes for the coils should be situated. The coil formers fit into these holes, and after being given a sharp twist are firmly fixed in position without any screws or other fixing devices.

COIL UNIT VERSUS SEPARATE COILS AND SWITCH

When building a set which includes short wave bands, the question always arises whether it is better to purchase a built-up coil unit, or to buy the coils and wave-change switch separately, and wire them up one's self. There is much to be said for the manufactured coil unit when the set is a large one with several wave-bands and an R.F. stage, and indeed for many builders, it is the only solution. But in a simple set like this one, where there is no R.F. stage, and only one short-wave band, with no attempt at bandspreading, there is some advantage in the alternative course. The advantage is mainly one of price, because the four coils and a wave-change switch come out more cheaply than the coil unit. As against that, there is a little more wiring to do, but not very much. For those who like building as much as possible of the set themselves, the separate coil idea is certainly preferable, and we have chosen this method. It has the further advantage that the lay-out of the set is then much less rigidly fixed.

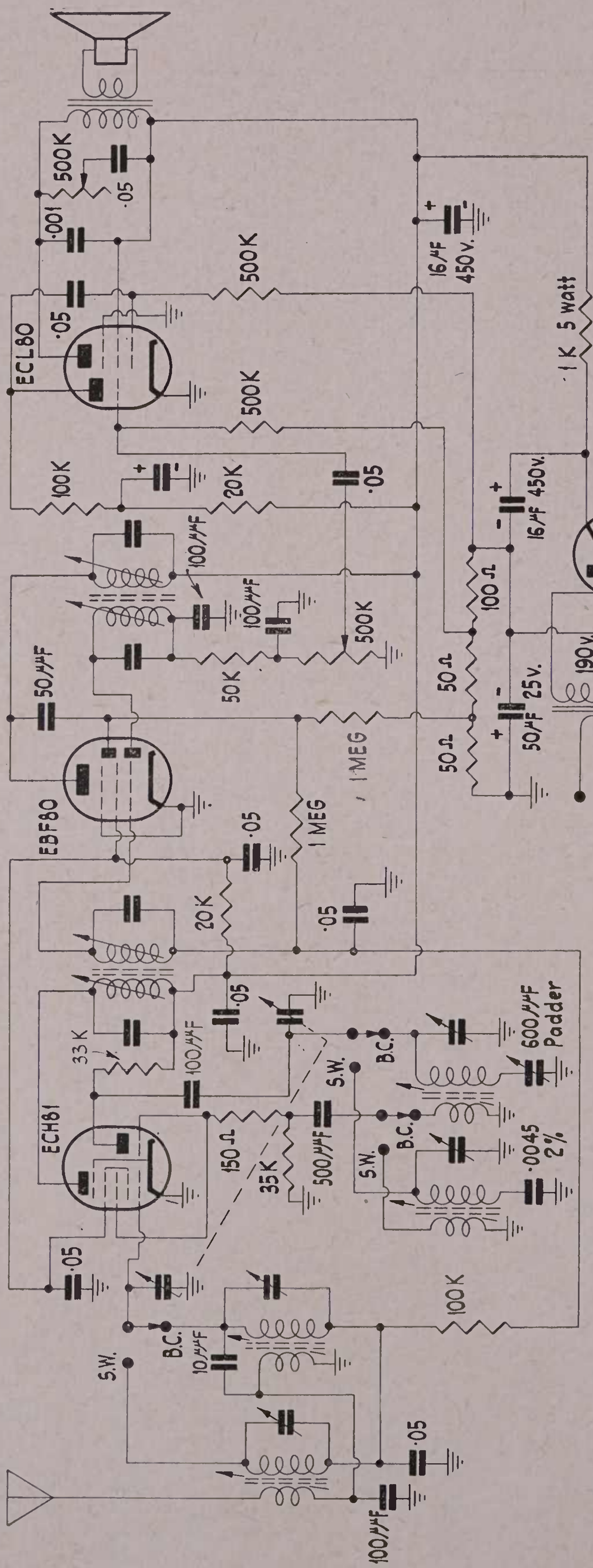
One thing we have tried to do with this set is to spread it out well on the chassis. There is no particular point in a very small chassis, unless a midget set is wanted, and for those who have not had much building experience, there is a good deal against the compact layout that a midget chassis enforces. If, as here, plenty of room is taken, there is no difficulty at all in getting all the parts in in a neat and workmanlike manner, and the circuit does not have to be "layer-built." The photographs show how this object has been achieved, especially in the right-hand front corner where the R.F. section of the set is situated. The wave-change switch has only three two-position switches on it and so uses only a single wafer.

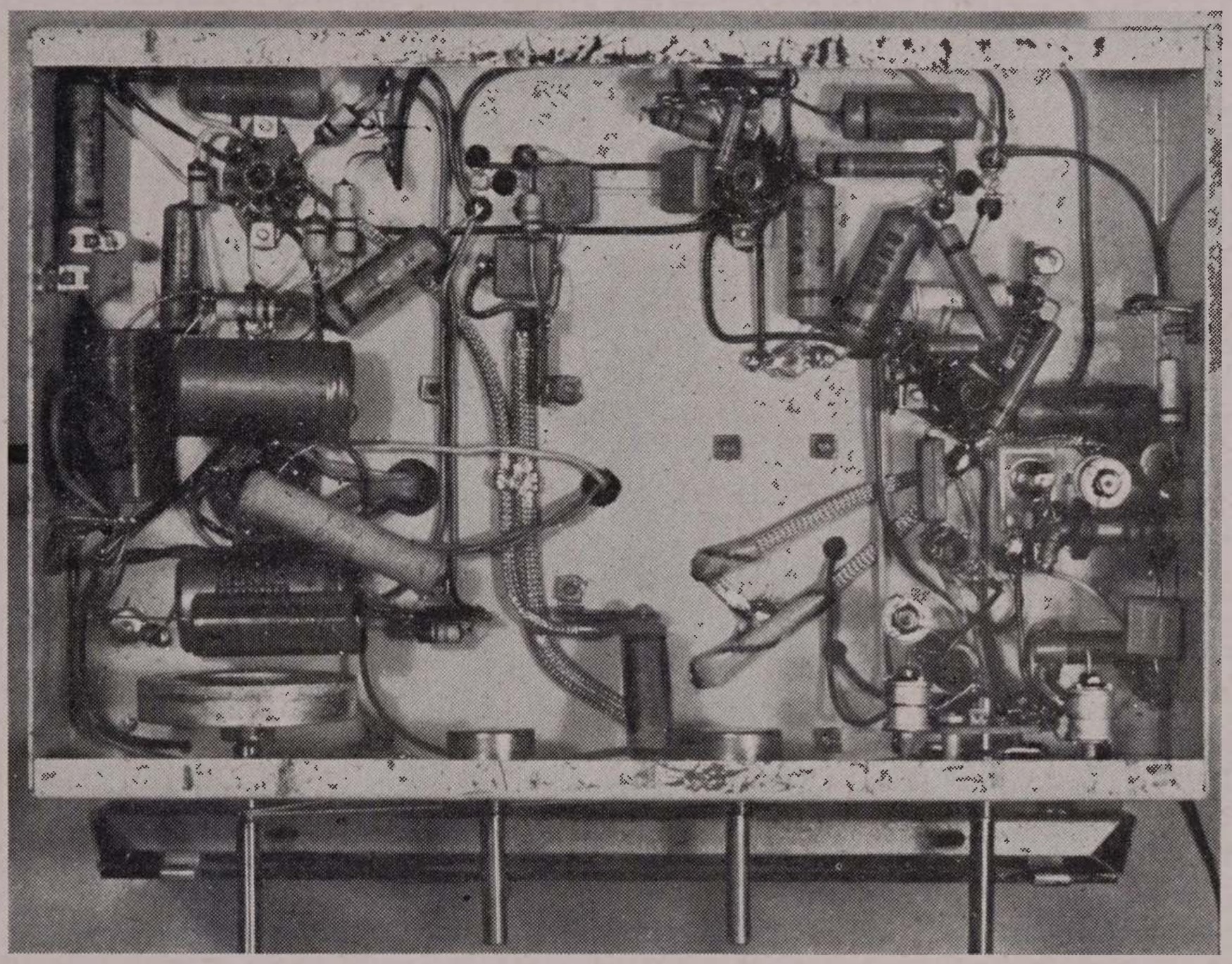
An ingenious trick has been used to eliminate one switch. This is to be found in the aerial circuit; the aerial is taken to a separate switch section in most sets, and the switch connects it on to either the short-wave aerial coil or the broadcast one. Here, however, the aerial goes straight to the short-wave coil. The other end of this is not earthed directly, but through a 100 $\mu\mu$f. fixed condenser. This is effective at short-waves as if it were a direct connection, but at broadcast frequencies, it simply acts as a small bypass condenser across the aerial coil. The broadcast aerial coil is earthed at one end, while the other goes to the lower end of the short-wave aerial coil. In this way, both aerial coils are connected at all times, and there is no need to switch the aerial.

THE MAIN CIRCUIT

These days it is not possible, even if it were desirable, to bring forward any revolutionary changes in the circuit of a small superhet. All the possible permutations and combinations have been tried at one time or another, and as a result, any new circuit, like this one, cannot hope to do more in the way of novelty than introduce some new valves while using standard circuitry.

Since the set was designed mainly with the requirements of the inexperienced constructor in mind, it was decided to use back bias. For the benefit of the uninitiated, this is a scheme by means of which the cathodes of all valves in the set are earthed directly, and a certain connection is used in the power supply in order to make it produce a small negative voltage as well as the large positive voltage which is its main job in life. The negative voltage is obtained in the following way. Instead of grounding the centre-tap of the power transformer, as in most circuits, it is taken to a resistor, the other end of which is earthed. Now since all the H.T. current of all the valves passes through the centre-tap of the power transformer, a voltage is developed across the inserted resistor. Moreover, because the current flows FROM earth TO the transformer centre-tap, the voltage developed across it is of negative polarity with respect to earth. By making the resistor larger, we can increase the negative voltage developed across it, or by making it smaller, decrease that voltage. Now let us see how this negative voltage is used as bias for the grids of the valves. The first thing to note is that the cathodes are all earthed. In our circuit, the total resistance in


500K
.05
.001
ECL80
100K
20K
100μμF
50μμF
50K
500K
EBF80
.05
1 MEG
50Ω
16μF 450V.
1K 5 watt
6X5GT
190V.
190V.
6·3V.
230V. A.C.
50μF 25V.
ECH81
33K
150Ω
35K
500μμF
S.W.
B.C.
600μμF Padder
.0045 2%
10μμF
100K
Heater
Pentode Plate
G3 Pentode
G2 Pentode
G1 Pentode
Cathode & Shield
Triode Grid
Triode Plate
ECL80
Diode Plate 1
Diode Plate 2
G1
G2 (Screen)
EBF80
Cathode, G5 (Supressor) & Internal Shield
G2, G4 (Screen)
ECH81



series with the centre-tap is 200 ohms, made up of 100, 50, and 50 in series. If we look at the grid circuit of the pentode section of the ECL80, we will find that the grid leak, which is present as usual, is not connected at its lower end to earth. Instead it is taken to the centre-tap of the power transformer. In this way, we apply all the negative voltage developed across the chain of small resistors to the grid of the pentode. In fact, because the pentode, which is the output valve, requires a greater negative grid bias than any of the other valves, we have chosen the total resistance to be of such a value that the correct bias for the pentode is obtained. The other valves all require smaller bias voltages, and so these can be obtained by tapping down the bias resistor chain, and picking off the voltages required. The next highest bias is needed by the triode section of the ECL80, and so its grid resistor is taken to the junction between 100 and first 50 ohm resistors. The EBF80 and ECH81 both require the same bias of —2 volts, so that their grid circuits are returned to the junction of the two 50 ohm resistors, where this voltage is found. The circuit is complicated somewhat at this point because provision has to be made for the A.V.C. bias to be added to the bias from the bias chain. This is managed by taking the lower end of the 1Meg. A.V.C. diode's resistor to the tap on the bias chain. In the absence of a signal, the only D.C. voltage on the grids of the first two valves is the —2 volts from the bias chain. This negative bias is also applied to the plate of the A.V.C. diode. This diode is fed with signal from the plate of the I.F. amplifier tube, and because of its negative bias of —2 volts, it is unable to conduct, and therefore to produce any A.V.C. voltage, until the signal at the I.F. tube's plate exceeds a peak voltage of 2 volts. When it does, however, the diode conducts, making the plate negative with respect to its normal potential of —2 volts. In making the plate negative this way, the additional bias provided by the A.V.C. diode is added to the fixed bias, and reduces the gain of the R.F. section of the set. Because of the holding-off action caused by the negative bias on the A.V.C. diode, very weak signals are subjected to the full amplification of the set. This is known as voltage-delayed A.V.C., or simply delayed A.V.C., for short. It is essential in any set which is intended for short-wave reception, because if the negative delay voltage is not present at the diode plate, any signal, however weak, produces some A.V.C. bias, and reduces the sensitivity of the set. This does not do when the signals to be received are very weak, as many short-wave ones are.

There are other advantages of back bias over the more usual scheme of biasing every valve individually with cathode resistors. The main one is that it assists very materially in obtaining a stable set, with the highest gain of which its valves are capable. It also saves a considerable number of small parts, makes the wiring easier, and enables circuits to be very simplified. Here, for instance, the ECL80 is a dual tube, but has only one cathode for both sections. This makes it impossible to use simple cathode bias, because the two halves require different values of grid voltage. Had back bias not been used, a more complicated circuit would certainly have resulted.

It might seem to the uninitiated that the bias voltage is obtained for nothing, as it were. This is not quite true, however, because the voltage has to come from somewhere, and in this case it comes from the power supply. The latter can only produce a certain voltage at a particular current drain, and if we obtain, say, ten volts across the back bias chain, it simply means that we have ten volts less to apply to the plates of the valves. However, changes in plate voltage of the order of six to eight volts have an almost unmeasurable effect on the performance, and grid bias must be provided, so all in all, the back bias method is the cheapest and one of the most satisfactory ways of providing it.

The rest of the circuit is very straight-forward, and really requires no comment.

CONSTRUCTION

The chassis diagrams and photographs give a very good idea of the construction of the set. On the top view, the mounting holes for the coils can readily be seen, and identified with the coils themselves,

which can be seen in the under-chassis view. In the latter, the two which are mounted on the chassis cannot be seen so easily, but they can be recognized as follows. The two coils mounted on the side of the chassis are the aerial coils, the broadcast one farthest from the wave-change switch. This has been done in order to make the shortest leads possible, in the short-wave position. The oscillator coils are upright, so little of them but their tops can be seen in the photograph. They are not quite opposite the aerial coils, and their order is reversed. That is to say, the short- wave coil is this time farthest from the switch. This was done so that the S.W. oscillator coil conld be removed as far from the S.M. aerial coil as can reasonably be done. The broadcast coils both have their trimmer condensers mounted very close to them,,while the S.W. trimmers are the ones which can be seen attached to the wave-change switch. Directly underneath the B.C. aerial coil can be seen the B.C. padder condenser, which has a short lead going to the appropriate lug on the B.C. oscillator coil. A point worth noting is the manner in which the earthing has been arranged in the R.F. portion of the circuit. The gang condenser is just to the right of the oscillator coils in the under-chassis photo; to the right of the coils can be seen two small holes in the chassis, through which come leads. These are from the stator vanes of the gang, and go to the appropriate lugs on the wave-change switch. The earthing wipers on the gang are farther away from the coils still, and it is important to earth them properly. The recommended way is to connect pieces of braid to the earthing lugs on the condenser, and to bring them through the chassis without making electrical connection to it. This is done by slipping a short piece of sphagetti over the portion of the braid which comes through the holes in the chassis. These braid leads, with their insulation as they come through the chassis can be seen in the photograph to the right of the wave-change switch, directly in front of the volume control potentiometer. This is the left-hand of the two potentiometers, next to the wave-change switch.

Another wiring pointer concerns the detector circuit. The leads to and from the volume control potentiometer are shielded in braid. Two leads are inserted in a single piece of shield braid, which runs from the control to the second I.F. transformer. Close to this is mounted a single insulated tag, on which the "high" end of the volume control is connected. This tag is also used to terminate the 50k. filter resistor which is in series with the volume control, and the 100 $\mu\mu$f. by-pass condenser which goes from the junction of the two to earth. The other end of the 50k. resistor terminates on the appropriate lug of the I.F. transformer. All this can be seen quite clearly in the photograph. An important point is that the second lead through the shield braid from the volume control is used to earth its lower end which is NOT earthed to the chassis near the control itself. The earth point used is the same one at which the two 100 $\mu\mu$f. bypass condensers are grounded. The output of the volume control (i.e. the audio taken from the moving arm) is connected as follows. An insulated tag is mounted in front of the volume control, and the 0.05 μf. blocking condenser is taken to it from the centre lug on the control. The audio is then taken to the grid of the triode section of the ECL80 through another piece of shield braid.

We have enlarged on this aspect of the construction for the benefit of more inexperienced builders. The way of wiring the detector circuit that has been described is the best, and should be followed in all sets where the volume control is some distance from the I.F. transformer and detector diode. One is always tempted to do without shielding the leads, and to make things apparently simpler by earthing the lower end of the pot. up near it rather than through a shielded lead, as we have described.In some cases, this might work quite well, but in others, I.F. voltages developed on the leads may cause untold bother by getting into the audio section of the set, from where it is radiated to the I.F. amplifier, causing uncontrollable oscillation. Our way takes a little more doing, but can be guaranteed against trouble of the sort mentioned.

ALIGNMENT

This set uses coils all of which, including the oscillator coils, have adjustable slugs. The maker really intends them to be used with fixed padder condensers, and on the short-wave band this is what we have used. On broadcast however, we have shown a conventional variable padder condenser. The reason for this is that builders are more used to dealing with a variable padder than with a variable-inductance oscillator coil. There are certain advantages in having both variable inductance and a variable padder, but it does make the alignment process a little more difficult. For those who have not had much to do with superhet alignment we strongly recommend that the broadcast oscillator slug be left severely alone, as received from the maker, who adjusts all coils to a standard value of inductance before they leave the factory. Then the normal alignment procedure for a variable padder is followed. For aligning the short-wave band, which has no variable padder, the procedure is no different, except that this time the oscillator tuning slug is used exactly as is the padder on the broadcast band. That is to say, the trimmers are used to get proper alignment at the high-frequency end of the band, and the oscillator slug is used to tweak things up at the low-frequency end. No difficulty will be experienced at all in obtaining proper alignment on both bands if the ordinary practice is followed.

CONCLUSION

So pleased have we been with the results obtainable with this set that we have no hesitation in recommending it to old hands and newcomers alike as one which will give them much pleasure, both in building, and in using afterwards.

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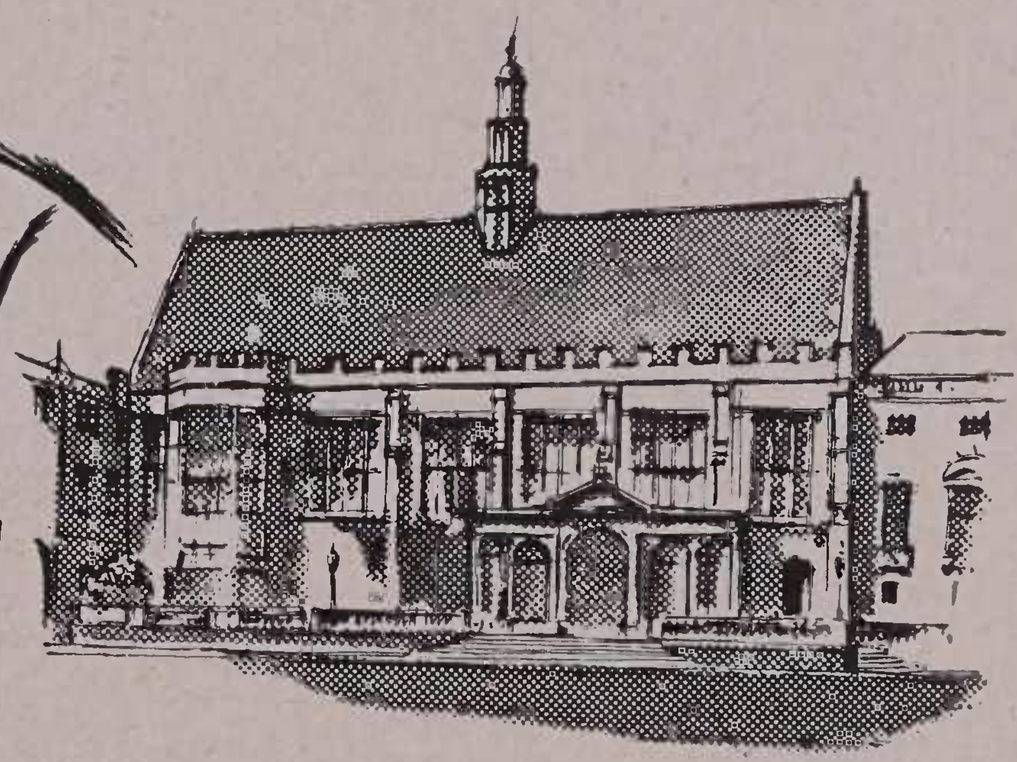

Sir J. J. Thomson, as Cavendish Professor of Physics and Master of Trinity College, was one of Cambridge University's most illustrious figures. Known throughout the world for his discovery of the electron, he played a dominant part in modern scientific achievement. His enquiries into the true nature of cathode rays made possible the engineering and exploitation of the now familiar wireless valve and television tube. Under his direction, the Cavendish Laboratory attracted sufficiently brilliant students to form a physics school of unprecedented eminence, on which the present glory of Cambridge science is founded. It is therefore with pride that we can look back to the year 1896, when the late W. G. Pye started making scientific instruments for the University, and say that the Pye research laboratories and factory have always maintained the traditions of accuracy and enterprise which are associated with the name of Cambridge.

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E5.24

Circuits for the Experimenter

SOME MORE ABOUT PUSH-PULL INPUT CIRCUITS

In last month's issue we indicated the possibility of making an audio amplifier containing only push-pull stages, and said that this was entirely practicable, provided suitable volume-control arrangements could be made. The usual method of control in an all-push-pull amplifier is to use ganged potentiometers. These are difficult to obtain in this country, and in any case suffer from one disadvantage. It is that ordinary commercial components of this kind are not matched with the precision that could be desired for a high-quality amplifier. This could be overcome by the use of special self-balancing push-pull stages, one of which was described on this page in the March 1954 issue of Radio and Electronics. However, there are other schemes which can be used for volume control, and one of the best of them is described in this article.

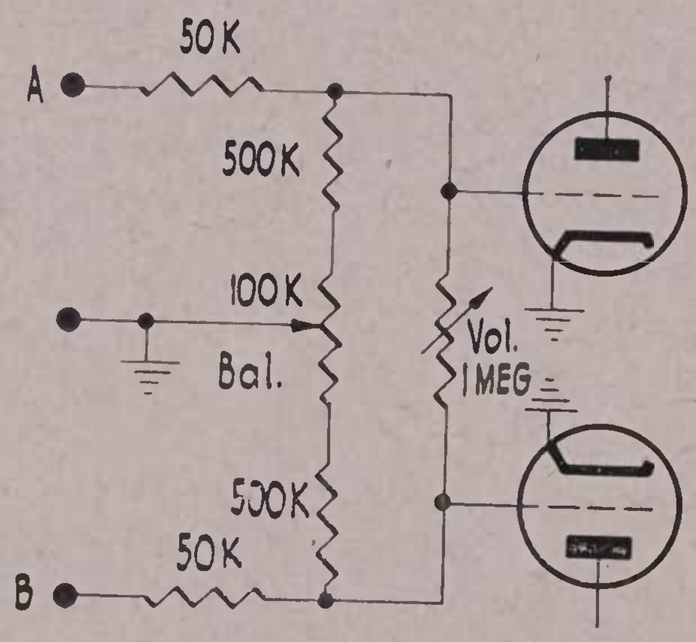

Fig. 1

The circuit is given in Fig. 1., and it has several advantages. In the first place, ganged pots are not required. Secondly, the volume control is an ordinary logarithmic taper one, exactly as used in conventional volume applications. Thirdly, arrangements are made for obtaining accurate balance at the input of the amplifier.

A disadvantage of the circuit is that at minimum volume, the grids are not earthed, as in ordinary volume control schemes. However, if the input circuit is carefully shielded and accurately balanced, there should be no hum trouble at all. This is because a properly balanced push-pull amplifier will not give any output from even large signals at the input grids, provided these are in phase. When the volume control in Fig. 1 is at minimum, the grids are shorted together, so that any signal or hum must be in phase at the grids; if any hum or signal output is obtained under these conditions, this indicates simply that the amplifier is not balanced. For instance, the whole amplifier, including the input circuit, can be balanced by the following procedure. The volume control is set at maximum, terminals A and B are joined, and a signal from a pick-up or oscillator is applied between these joined terminals and earth. R_6 is then adjusted for minimum output. When this test is being carried out, it will be found that when minimum volume is reached, there will still be some very distorted output. This does not indicate a fault, but is the odd-harmonic distortion of the amplifier stages, which cannot be balanced out by the push-pull connection. Care must be taken that the signal does not overload any of the amplifier stages, since the sound in the speaker is the difference between the outputs of the two halves of the amplifier. Moreover, if the amplifier is overloading, there will be large quantities of distortion, not normally present, and these will ruin the balance test.

USE OF THE CIRCUIT WITH GRAMOPHONE PICK-UPS

The circuit as drawn is suitable for use with magnetic pick-ups. It will be noticed that when the volume control is at minimum, the resistance round the loop from A to B is 100,000 ohms. When the control is at maximum, the resistance measured from A to B is more like 500k. This means that if the pick-up requires a constant load resistance to be connected across it (as many do, in order to have a known and specified frequency response) it will be necessary for this resistance to be much less than 200k., otherwise the variable shunt on the pick-up represented by the input circuit will cause considerable variation in the loading on it. The

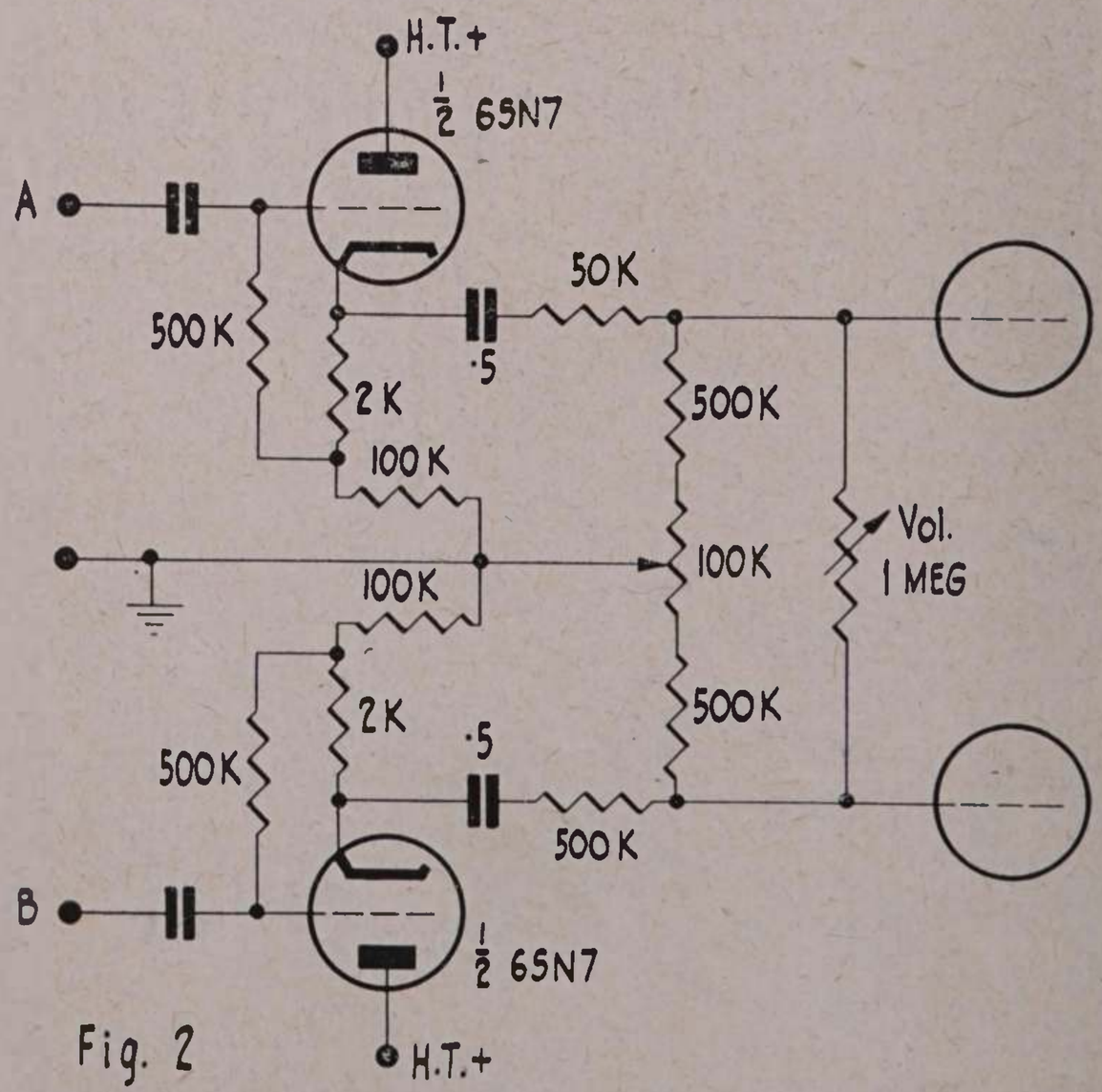

Fig. 2

Fig. 2.

practical result will be a variation in frequency response as the volume control is moved.

One very good way out of this difficulty would be the circuit shown in Fig. 2. Here, a pair of cathode-followers is used to feed the volume control net work. The cathode followers have a very low output impedence, which will not be affected in the least by the variation in the volume control circuit, while their input impedence is very high, and cannot have any effect on the pick-up. Fig. 2 could be used even for crystal pick-ups, and for feeding from a radio tuner which has a detector circuit like that illustrated on this page last month.

When one of these arrangements is used, it will be necessary to ensure that the pick-up output is "floating." That is to say, with a magnetic head, both leads must be brought separately through the shield braid, and the pick-up must be examined to make sure that one lead is not connected to the shield braid at the head end.

Some crystal pick-ups are balanced with respect to ground, but do not appear to be so on account of having one lead connected to the shield braid. These can easily be tested to see if they can be used floating. The method is to bring out separate leads from the two pick-up terminals, and shield them with a piece of braid that does not connect to either of them. Connect a 500k. resistor from each input terminal to ground, on Fig. 2, and connect the pick-up leads to A and B. If the pick-up can be operated in a floating condition, approximately the same output should be obtained from each half of the amplifier, without too much hum becoming apparent. A crystal cartridge which has three terminals on it—one for earth, and two for signal—is intended to be operated in the balanced condition.

The circuits shown here should give the inveterate audio experimenter considerable scope for that most entertaining pastime, trying out something new.

A REMOTE-VOLUME CONTROL

It is often necessary to control the output level of an amplifier from some point remote from the amplifier itself. One such instance is in theatres, where an attendant at the back of the stalls is able to control the volume of the sound amplifier, which is situated in the projection box. Another is in public address work, when the operator has to control the volume from some position other than at the amplifier. Even in home installations it is sometimes desirable to have a volume control handy at one's armchair, in order to avoid having to jump up and down to control the volume.

The technical problem involved in volume control from remote points lies in the fact that conventional methods of volume control require the signal to be present at the position of the actual control knob. If this is to be remote from the rest of the equipment, it means that the signal must be piped to the remote control point, and then piped back again to the amplifier. This is unsatisfactory as a rule, because it is not possible to take a low-powered signal far in a high-impedence circuit (such as we have with the usual ½ of 1Meg. potentiometer) without undesirable effects becoming apparent. One of these is that the wiring to the control will almost certainly pick up a good deal of 50 cycle hum, unless all leads carrying signal are well shielded. If they are, it is impossible to avoid a pronounced loss in high-frequency response, and this is usually undesirable too. Add to these points the fact that a shielded cable is both bulky and expensive, and the idea of piping audio to and from an ordinary volume control becomes even less attractive.

What is required, therefore, is some means of controlling volume that does not require audio to go to the control point. There are a number of possible ways of doing this; one which immediately suggests itself is the use of a tube such as the 6L7, which has two control-grids. One could be used for application of the signal, while the other could

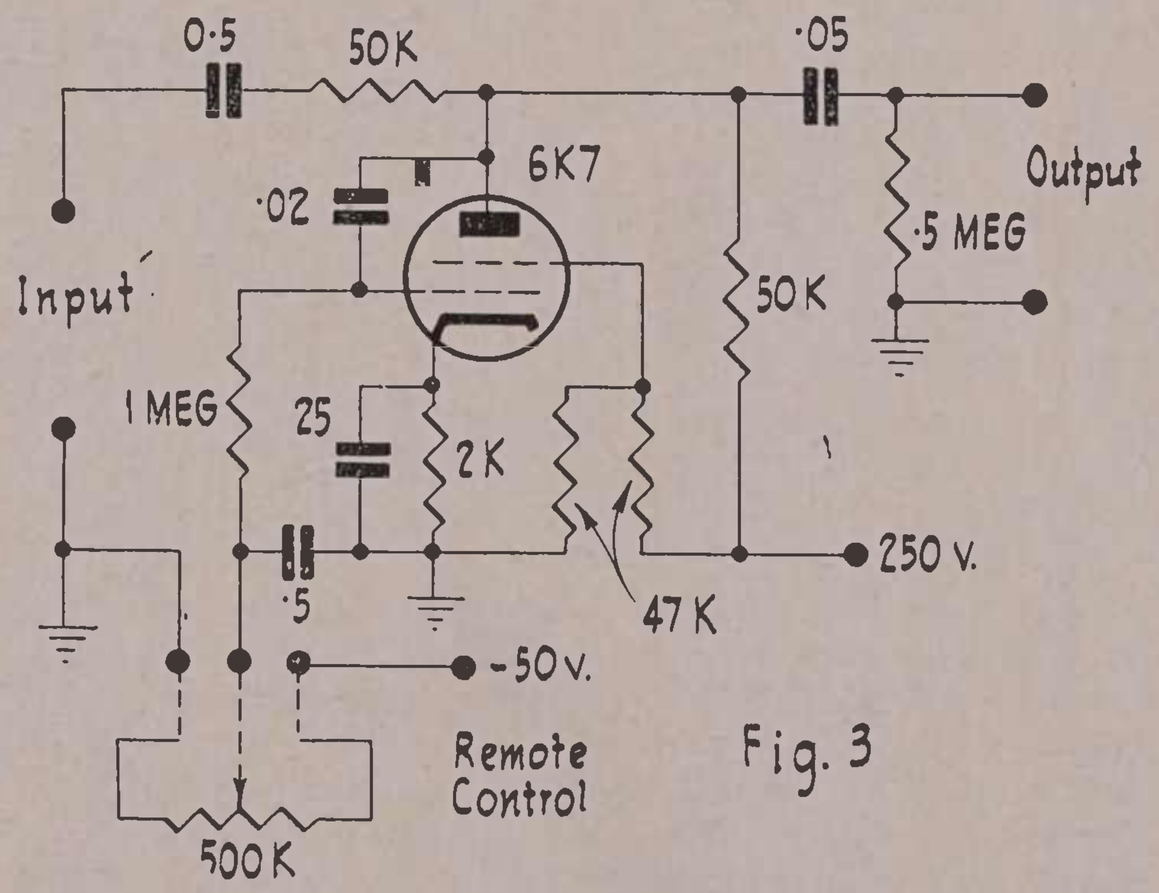

Fig. 3

be provided only with a variable D.C. bias, which would control the gain of the tube. The control bias could be piped to the remote control point without any of the disadvantages associated with taking the signal there, provided only that the control wires are suitably bypassed to prevent their picking up A.C. hum.

The circuit shown here represents an improvement on the scheme suggested above. In it, a pentode is used as the lower leg of a voltage divider, and its effective resistance is varied by means of a controllable D.C. bias on its control grid. In this way, an ordinary remote-cut-off valve such as a 6K7 or EF39 can be made to have an effective resistance which varies from 500 ohms to some 500k., depending on the D.C. grid bias. This needs to have a maximum value of about 50 volts, and a minimum of 3 volts, so that the tube can be operated at any bias value between cut-off and its normal. This circuit has

smaller distortion than a 6L7 or similar tube used as a gain-controlled amplifier, and will handle approximately 12v. R.M.S. signal with less than 2% distortion. At lower signal levels, the distortion is correspondingly less. It is suggested that a level of about 2 volts R.M.S. into the input terminals would be the best level at which to operate the circuit.

An advantage of this arrangement is that it does not affect the gain of an existing amplifier to any extent, either by losses, or by providing amplification that is not needed, and which has to be thrown away again. It is therefore excellent for adding to an existing amplifier between two of the voltage amplifier stages. It can be included as a small sub-chassis screwed to the main one. If no convenient source of negative control voltage exists in the amplifier, this will have to be provided. Since voltage only, and not current, is required, a separate rectifier and high-resistance smoothing circuit can be used, with the input voltage obtained from one side of the power transformer secondary. If there is no room, or no time for installation of such a supply, a 45v. battery could be used instead. It would last a very long time, and would have no undesirable effects on the amplifier when it ran down, apart from reducing the range of control obtainable. All in all, the battery appeals as being the simplest scheme, requiring the smallest number of additional components. It would of course be necessary to have a switch in circuit with it to prevent its running down when the amplifier was not in use. This could be managed by replacing the existing on/off switch with a double-pole one, one pole of which is used to break the control battery's circuit in the "Off" position.

Another useful application for the arrangement would be the control of modulation level in a transmitter, when audio equipment is at some distance from the operating table. We are sure that experimenters everywhere will find considerable use for this arrangement.

New Underwater TV Cameras used in Locating Crashed Comet

Saftey in the air has been brought a step nearer by the remarkable recovery from the sea bed of various important parts of the wreckage of the Comet which crashed so tragically off the coast of Italy some weeks ago.

How many realize, however, that this feat was achieved by the use of two underwater TV cameras of types believed to be unique in the annals of underwater television.

When in position, it is quite immaterial in which direction the new Marconi-Siebe Gorman camera is pointing. Remote control from the salvage ship enables its periscope lense to rotate through 90 degrees, thus providing the apparatus with the same facilities as those of a diver in his ability to see in any direction. The advantages of such a system over the usual rigid lens type of camera are obvious. For example, the latter, when lowered to the bottom over the side of the search vessel, may come to rest with its lens facing away from the wreck, with no indication of the manner in which it must be oriented to bring the object into view. In addition, should the rigid lens type of camera be held off the sea bottom, there is the danger of sea currents causing it to yaw, thus preventing accurate viewing of the object.

A special feature of the Pye equipment also used by the Admiralty during this search, is its small size—it weighs under 2 cwt. complete. Being thus highly manoeuvrable, it also has self-contained lighting, adjustable over a wide range and fed from a camera supply cable. With two lenses remotely selected, the whole unit is housed in a non-magnetic casing to enable it to work in close proximity to an electro magnetic hoist, and in 15 degree steps the camera may be angled through 90 degrees.

Hitherto, cameras had to be dangled over the side and suspended perfectly still, but the remarkable feature about this search was the ability of these cameras to be "trawled" as though they were fishing nets. In the case of the Pye unit a special lamp support with a large "fin" directed the camera relative to the tide.

During the first lighting tests with the Pye equipment, underwater visibility was disappointing, but later pictures of the sea bed 400 feet down were reported as clear as one would expect in London on a dull day.

This new Pye TV unit was assembled in only seven days and worked continually during all possible working hours every day, even in rough seas. Despite colossal bumpings and bangings and the difficulty of transferring it from one ship to another in rough seas, the camera's performance was faultless. Up to its neck in trouble on the second day of searching, after six hours of continuous running, it ploughed through the mud at the bottom 650 feet below the surface. Though for a while vision was obscured because of the mud clinging to the window and the lamp, it eventually cleared itself and produced a perfect picture.

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For the Amateur

AUTOMATIC DX-ING ON TWO METRES

(Continued from April Issue.)

SETTING-UP

When building the receiver, the best plan by far is to build the sub-chassis first and ensure that it works. To do this, it is only necessary to connect a pair of headphones across the transformer secondary and apply voltages to the valves. The potentiometer control of super-regeneration should be used, and if all is well a region will be found on this control within which super-regeneration takes place. At lower and higher voltages, the circuit drops out of super-regeneration. The correct setting of the control is that one which causes the noise to be equally loud over the whole tuning range of the receiver, and this position will be easily found. Should it not be possible to get the appropriate hiss at any setting of the H.T. control, turn off and look for circuit mistakes. If there do not appear to be any, then making the thing go is merely a matter of adjusting the two oscillators, and this can be done for each one, quite independently of the other. For example, with the R.F. oscillator inoperative, a milliammeter in series with the quench oscillator grid leak will tell whether this is functioning. The same test can be made with the R.F. oscillator, while the quench oscillator is made inoperative by breaking the lead from the coil to its plate. Here, there is some possibility that the R.F. oscillator may be "squegging," or acting in a self-quenching manner. It is a good idea to test for this in any event, and should it be found, the symptom will be that super-regenerative hiss is heard, even when the quench oscillator is not allowed to work. The cure is to reduce the size of the R.F. oscillator's grid condenser. Another symptom of squegging in the R.F. oscillator is that the plate current will then be very minute, as will the grid current also. If both oscillators are working properly, then obtaining super-regeneration is only a matter of ensuring that the right amount of quench voltage is fed to the R.F. oscillator to modulate it, thus causing it to go in and out of oscillation once in every quench cycle. This can be adjusted by setting the regeneration control so that the voltage at the tap is approximately 90 volts, and then adjusting the size of the condenser across the primary of the audio transformer until the characterstic hiss is obtained.

Assuming that super-regeneration is O.K., the next thing to do is to see what frequency range the receiver is covering. This is best done with a grid-dip oscillator or an absorption wavemeter. If it is not correct, there should be no need to rewind the oscillator coil as considerable latitude is available simply by squeezing or stretching out the turns of the detector coil very slightly. While this is in progress, leave the R.F. stage plugged in, even if the aerial circuit has not been adjusted, so that the output capacity of the 6AK5 will be taken into account. With the detector covering the right range, the aerial circuit can be tuned up. Set the detector in the centre of its range, pick up a weak signal that will not quite suppress the super-regenerative hiss, and tune the aerial trimmer for resonance. If this is not within range of the trimmer, adjust the inductance of the aerial coil slightly by spacing the turns differently, and try again. To give some idea of the sensitivity of the receiver, we might mention that it works on the twelfth and higher harmonics of our lab. signal generator!

To adjust the signal finding circuits, place a meter in series with the plate circuit of the 6V6. Disconnect the motor battery, and tune the set by hand. As a carrier is tuned, there should be a rise of plate current which reaches a maximum when the signal is properly tuned in. Initially, listen to the set by connecting a pair of headphones across the secondary of the audio transformer, so that you can tell what is happening while watching the 6V6 plate current. The signal used should be strong enough to completely suppress the hiss, and if all is well, the plate current will rise to some fifteen or twenty milliamps, pulling in the relay. A very weak signal will partially suppress the hiss, so that only a slight rise of plate current occurs. In this case, there may be a little output from the speaker, while the relay will not come in. This is quite normal, but will be minimized by making the relay more sensitive. It is possible to make the relay operate off a signal which is not nearly strong enough to suppress the hiss completely, by increasing its sensitivity. There is no advantage however, in having it come in at currents smaller than about 10 ma.

If everything works so far, the only thing left is to get the motor going. Here, the necessity is to have the receiver scanning the band slowly enough. If it is tuned too fast, then the natural delay in the operating time of the control circuit prevents the relay from dropping in during the short time taken by the receiver to traverse the signal. By setting the motor going, and then turning on a signal, the proper tuning rate can easily be found. Needless to say, the slower the better, since this gives the control circuit time to work in the breaks in speech if the signal picked up is modulated. The mechanical arrangement used in the prototype is only one possible way of doing things, and here we expect that the traditional "ham" ingenuity will exert itself. Ideally, the tuning condenser should turn over at about one revolution every two or three seconds, but there is no disadvantage in making it as much slower as may be convenient.

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THE OHM-METER

Readers will probably be interested in the reasons for choosing the exact circuit shown in the diagram, and in any case will want to know the special requirements that have to be met if an external ohm-meter is employed. These requirements are dictated by the type of NTC resistor that is used. The load curve for the 83910/4K is the middle one in the graph, Fig. 2. This curve shows that the lowest resistance reached by one of these is approximately 200 ohms. We are to use two in parallel, so that the lowest resistance we will have to measure accurately will be of the order of 100 ohms. This will correspond with an R.F. power input of between six to eight watts. Now the shape of the curve shows that for small power inputs, say less than 0.25 watts per resistor, the change in resistance is quite small, so that we can expect the smallest power input which can accurately be measured, to be of the order of half a watt. Reference to the curve shows that the resistance of each resistor at a power input of 0.25 watts is about 3000 ohms, so that the upper limit of resistance to be measured will be about 1500 ohms. Now if we look at the scale of an ordinary ohm-meter, we will find that this range of resistance will take up most room on the meter scale if the mid-scale resistance indication is approximately 750 ohms. Most ohm-meters have mid-scale readings that are multiples of 15, because if a 0–1 ma. movement is used, together with a 1.5v. cell, the mid-scale reading will be 150 ohms. Unfortunately, if this range were used for our purposes, it would be found that practically all the left-hand half of the scale would be useless, as representing resistance values from 2000 ohms upwards. But by dividing the scale figures by two, almost three-quarters of the scale becomes useful. In this way it is possible to provide a good open scale from powers of half a watt to eight watts.

The measuring circuit given here therefore arranges for a mid-scale reading of 750 ohms by shunting the meter to read 2 ma. full scale, and using a 1.5v. cell. The series resistance then needed for full-scale reading is then 750 ohms, and the mid-scale reading will have the same value. Accordingly, a 1000-ohm variable resistor is used for zero-setting, and the meter shunt resistor will have a value equal to that of the meter movement. Two switches are provided. One is a normally off push-button which short-circuits the measuring terminals while the zero-setting resistor is adjusted. This is labelled S_1 on the diagram. The other is an on/off toggle, to break the meter circuit when the instrument is not in use.

CALIBRATION

As the resistance of the NTC load resistor has to be interpreted in terms of R.F. power, some kind of calibration will have to be undertaken before the instrument can be put to use. Ideally, the meter should be scaled to read power directly. This can be done in the following way. First of all, from the values in the circuit, we calculate the scale readings that will be obtained for various resistances. In other words, we calibrate the meter as an ohm-meter, by drawing a graph connecting scale reading with resistance measured. If now we draw a further graph connecting NTC resistance with power input, we can finally draw a graph connecting scale reading with power. This graph can be used as the final calibration, or points can be read from it and marked on the actual meter scale, making it direct-reading.

Calculating the resistance scale can easily be done as follows. For zero resistance, we know the meter reads 1 ma. To find the reading for any measured value of resistance, we make use of the fact that for no measured resistance, the total resistance in the meter circuit must be 750 ohms, or by Ohm's Law, 1.5 volts, divided by 2 ma. If, for example, we want to find the scale reading for any value of measured resistance, we simply say "The total circuit resistance is now 750 ohms plus **x**, so that the current must be 1.5v. divided by 750 plus **x**. For example, if **x** is 100 ohms, we have $I = E/R = 1.5/750 + 100 = 1.5/850$ amps. $= 1500/850$ ma. $= 1.76$ ma. Since the meter is shunted, the meter current will be half this, or 0.88 ma. We now have one point for our graph of meter reading versus measured resistance.

By proceeding in this way, we get enough points to draw a smooth curve from which we can find the resistance corresponding to any meter reading.

To calibrate the NTC resistors, we must pass known powers into them, and measure the resistance at the same time. This is most easily done by setting up a circuit with two meters, the resistors in parallel, and an adjustable voltage source. One meter measures the current through the resistors; the other measures the voltage across them. Knowing both these, we can easily calculate both the power and the resistance. By using a number of voltages across the resistors, and taking current measurements at each one, we can draw the required curve of power versus resistance. At maximum power, the resistance will be about 100

ohms, and the voltage and current will respectively be round about 28 volts and 320 ma. A supply of this sort is unfortunately rather unusual, but seeing that the calibration has to be done only once, it should be possible to arrange a temporary one that is suitable. For example, should a bank of accumulators be available, they would be ideal. Similarly, a battery charger might be found which could be used. Otherwise it should be possible to use a radio-type power supply, rated at 150 to 200 ma., and allow it to be over-run for the short time needed for each reading. The difficulty will only occur at the higher powers, because at lower ones, the current required will come well within the rated capabilities of such a power supply. A high-wattage adjustable resistor in series with the NTCs will enable the current and voltage to be adjusted to suitable values for taking readings, and after

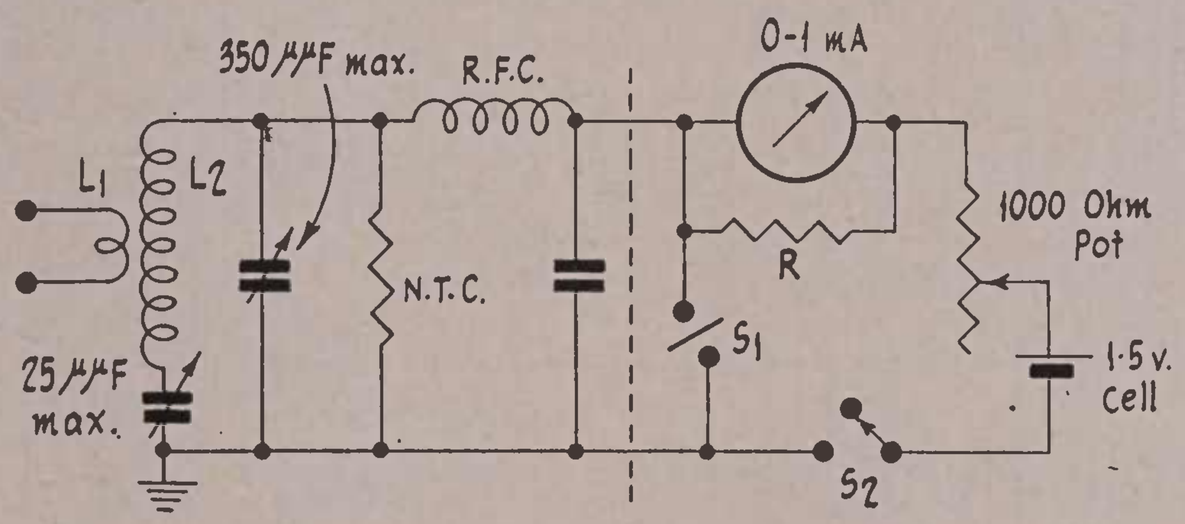


Fig. 1.—Circuit of the power meter. For the six-metre band, L_2, has 11 turns of 16g. tinned copper wire, double spaced, and ½ in. in diameter. L_1, is a two-turn link which can be permanently or temporarily coupled to L_2. R is a shunt equal to the resistance of the meter, so that the latter reads 2 ma. full scale.

the graph has been drawn, it is merely a matter of reading points on the two graphs obtained, to enable us to draw a new one connecting power with meter reading.

ADJUSTMENT

There should not be much need to detail the method of adjusting the power meter when it is in actual use. The measuring circuit is first adjusted for the correct zero, after which it is left turned on, and while the coupling and matching to the transmitter is in progress, the needle will act as the indicator to show whether maximum power is being fed into the load.

There are three adjustments which have to be made. First, the coupling to the transmitter, secondly the tuning of the matching section of the power meter, and finally, the matching of the NTC load resistor. The first of these can be treated as a final adjustment, to be critically adjusted as a last step, so that the first thing to do is merely to couple the meter fairly closely to the transmitter, after first having adjusted the output tank to resonance. It will be noted that we have indicated a fixed link at the power meter tank circuit, so that coupling to the transmitter will best be done by using a piece of twisted pair, terminated in a two-turn link, which can be pushed in and out of the turns of the transmitter final tank circuit. Next, we provide ourselves with a resonance indicator consisting of a dial lamp with a one-turn link connected to it. This is used as a quick means of checking that the final tank and load circuits are adjusted to resonance. It is necessary, because unfortunately, the NTC load resistors take quite a long time to heat up to their final temperature. This makes proper tuning adjustments somewhat difficult to make unless an independent resonance indicator is used.

After adjusting the final tank to resonance, and inserting the load coupling link, the output condenser of the matching circuit is adjusted to a capacity of about 100 μμf., as judged by eye. This done, the lamp is coupled as loosely as possible to the final tank circuit of the transmitter, and the 25 μμf. tuning condenser of the matching unit is adjusted to resonance by noting the setting at which the lamp glows **least,** indicating that power is being drawn from the final tank. This done, we wait for half a minute and watch the needle of the power meter. This will be found to creep slowly up scale, and if the final reading is somewhere near the expected power output, the trial adjustments cannot have been far out. However, if the indicated power is too small, as will probably be the case, the matching must be improved. This is done by making a small change in the setting of the large matching condenser, quickly re-tuning the load circuit by re-adjusting the 25 μμf. condenser. If an improvement has been made, as indicated by the needle starting to creep upwards, the matching condenser is moved a little more in the same direction as before, taking care to re-tune the circuit with the tuning-condenser. At this point, the tuning of the final tank circuit should be checked, and if it is found to have changed appreciably, it should be re-set, this time for maximum glow in the indicator lamp. Any great change in the tuning of the final tank indicates too tight coupling with the load circuit, and the link should be moved out slightly. With the correct amount of coupling, the tank circuit tuning should change very little after the load circuit is brought into tune. Of course, if the indicated power is very small indeed, in spite of any adjustments that may be made to the load circuit, this indicates too little coupling to the final tank. The best coupling is the greatest that can be made without de-tuning the final tank circuit. This will be found to correspond with the value for greatest power output.

When the adjustment of the condensers in the load circuit have been adjusted for maximum power into the NTC load resistor, the power is either read directly from the scale, or else by reference to the calibration curve if the meter has not been scaled directly in power.

A little practice may be needed in obtaining the correct adjustment of the load matching unit, because of the difficulty in following what is happening. This is entirely due to the considerable time needed by the NTC resistors before they come to their final working temperature. The main thing is to appreciate this fact, and therefore to work slowly. One thing that will assist is to remember that usually, there will be much more capacity in the circuit from the large matching condenser than there will be from the small, or tuning condenser. When this is the case, the tuning is varied relatively little when the matching condenser is varied over quite wide limits, because altering a large capacity in series with a very small one makes little difference to the total circuit capacity, and therefore to the frequency to which the whole is tuned. In addition, when the circuit is well loaded up, the tuning will be quite broad, and not at all critical.

The circuit illustrated would make a worth-while addition to a transmitter as an integral part of it,

especially in those cases where performance checks from day to day are essential. Then, the setting-up procedure would be greatly simplified and speeded up, because the controls could be left in the positions which give optimum matching. Then, all that would be needed to take a power reading would be to switch in the coupling loop, and remove the actual aerial from the circuit. A reading of power output would then take no more than half a minute or so.

MODIFICATIONS FOR HIGHER POWER

On account of the difficulty of predicting the actual resistance of the NTC resistors while under load, it is not practicable to make up a power dividing circuit in which the NTC resistors dissipate a known fraction of the total power output. It would, however, be possible to do something of this kind, by making a composite dummy load containing ordinary non-inductive resistors and NTC resistors. Then, the whole dummy load could be experimentally calibrated in terms of power input versus the resistance of the NTC portion of the load. For example, if a 10-watt 100-ohm resistor were placed in series with the two NTC resistors used in the present circuit, there would clearly be something like a 50/50 ratio of power division between the two at power inputs which cause the NTCs to dissipate their 8 watts. At low input powers, the series resistors would represent only a small portion of the total load resistance, and would have only a small effect on the sensitivity of indication. As long as the power calibrations were performed on the composite load as a whole, this expedient would enable the same two NTC resistors to measure inputs up to 16 watts. One could then imagine a two-range power meter. On the lower range, the NTC resistors alone would be used, exactly as in our circuit diagram. Then by switching in the series resistor, the range could be extended to twice the previous full-scale reading. What can be done in this way can be left to the ingenuity of individual designers, remembering that a series-parallel arrangement in which the NTC resistors dissipated approximately a quarter of the total power would be quite feasible.

For extending the range of power downwards, it should be remembered that for measuring powers up to 30 or 40 milliwatts, the miniature NTC resistors come into their own, and offer a simple means of measuring power at even micro-wave frequencies.

ELECTRONICS IN MEDICINE

ELECTRO-MEDICAL APPLICATIONS

To the January, 1954, issue of "Electronic Engineering," we are indebted for news of two applications of electronics to medical research which have taken place during the past year. These are the 8 Me.v. linear accelerator installed at the Hammersmith Hospital, London, and the artificial heart-lung apparatus.

The linear accelerator was built by the Metropolitan-Vickers Company and was developed in conjunction with the Atomic Energy Research Establishment and Radiotherapeutic Research Unit of the Medical Research Council. The machine, which is the first of its kind to be built specifically for X-ray therapy, has completed its performance tests and is now in regular use.

Electrons are injected into the accelerator tube from a gun operating at 45-50kv. and power flux of some 3.6mw. peak power is required. On emerging from the accelerator tube, the high energy electron beam is made to strike a gold target and X-rays are produced which can be directed accurately into the patient at any desired angle. The patient is positioned in the X-ray beam by moving the floor of the treatment room up or down, and by the use of a specially designed moving couch. The movements of the X-ray beam, the floor and the couch, are controlled automatically by electronic methods.

For the first time there are incorporated in this one machine all the facilities needed to permit the full exploitation of the technical advantages to be gained by using very high energy radiation. It makes possible the delivery of an adequate dose to a deep-seated tumour of highly penetrating 8 million volt X-rays,collimated in a well-defined, high intensity beam, which can be directed into the patient at any angle. The high intensity shortens the time of each treatment to about two minutes, and the extremely penetrating nature of the X-rays allows the delivery of a high dose to the tumour without any danger of damage to the skin.

Undergoing construction in the same hospital is a 45 in. cyclotron which will be used for the producton of very short life radio-active isotopes. It weighs some 180 tons, and is housed in a large room with concrete walls and ceilings over 6 ft. thick, and is sealed in by concrete sliding doors weighing over 200 tons. The whole installation is operated from a remote control room.

EXTRA-CORPOREAL HEART AND LUNG EQUIPMENT

Produced by New Electronic Products Ltd. for the University of London Post Graduate Medical School, this equipment is designed to duplicate the functions of the human heart in pumping blood through the system and the lungs in oxygenating the blood. These aims are met by using a large rotating plastic cylinder in which the blood can be oxygenated by spreading it over the surface of internal blades, and two pumps, which draw blood from the body to the oxygenator cylinder and then return it to the arteries.

It is essential to provide close control of both the suction (venous) and pumping (arterial) pressures as well as the quantity of blood in the oxygenator.

In practice, the pumps and oxygenator, with its associated cylinders of oxygen and carbon dioxide, are built into one mobile cabinet and the control gear into another smaller one.

The pumps are driven by variable speed electric motors which can be run from a standstill to full-speed by transductor controlled power supply units. The blood pressures in and out, as well as the blood level in the oxygenator, are measured by special gauges incorporating differential transformers, the output voltages of which are used in combination to supply the control current to transductors.

Provision is made for manual or fully automatic control. Speeds, pressures and level are displayed on meters on the control panel, danger limits being indicated by warning lights.

The oxygenator cylinder is thermostatically controlled normally at blood heat. Extra blood can be drawn from a transfusion bottle into the oxygenator by pressing a button on the control trolley when necessary to make up patient's blood-loss.

The equipment has wide applications in resuscitation, and in special treatments where large-scale blood transfusion is involved, as well as opening the way to new surgical technique, especially in heart and lung operations.

Careful analysis of the performance of this machine has proved its fitness for human service, and further development is aimed towards smaller, simpler and utterly reliable equipment for routine operating theatre use.

TELEVISION CAMERA USED FOR BLOOD COUNTS

In the United States a television camera and a microscope have been combined to improve the speed and accuracy of making blood counts for medical diagnosis. Blood counts determine the number of red cells in a given volume of blood and are an important indicator in many diseases.

A blood count is now made by a technician peering through a microscope at a dilute solution of the blood. He counts the number of red cells in a test area and multiplies this by the fraction of the blood volume that the test specimen represents.

As usually performed, the resulting blood count is subject to variations depending upon the technician's skill. In addition, manual counts are tedious and time-consuming, and blood samples are not uniform.

The new equipment can make several counts and average them out for a true figure, while a technician using the old method is making one count which might be 20 per cent. in error.

NON-LINEAR RESISTORS

By the Engineering Department, Aerovox Corporation

A few electrical devices are distinguished by their non-linear current-vs-voltage characteristics of a magnitude sufficiently great to affect performance. Often this phenomenon is a characteristic. For example; non-linearity is observed in the plate characteristic of a vacuum tube under certain operating conditions, the extremity of a diode tube response, iron-cored inductors operated in the region of saturation, and in biased capacitors having special ceramic dielectrics (dielectric amplifiers). These are only a few examples. The non-linearity of certain 2-terminal devices such as resistor also may be employed to modify the operating characteristics of some circuits. These latter non-linear resistors do not obey the simple relationship R = EI of Ohm's Law.

Simple non-linear resistors are used in oscillators, wave shaping networks, voltage regulators, current regulators, constant-output potentiometers and voltage dividers, voltage-selective circuits, amplitude limiters, frequency multipliers, surge suppressors, etc. Their use in electronics is increasing as new requirements for non-linear current-voltage response arise.

This article describes the general characteristics of some common 2-terminal non-linear resistors of several classes. In some instances, as will be seen, these devices have other prime uses and their application as non-linear resistors is secondary. Typical applications will be shown.

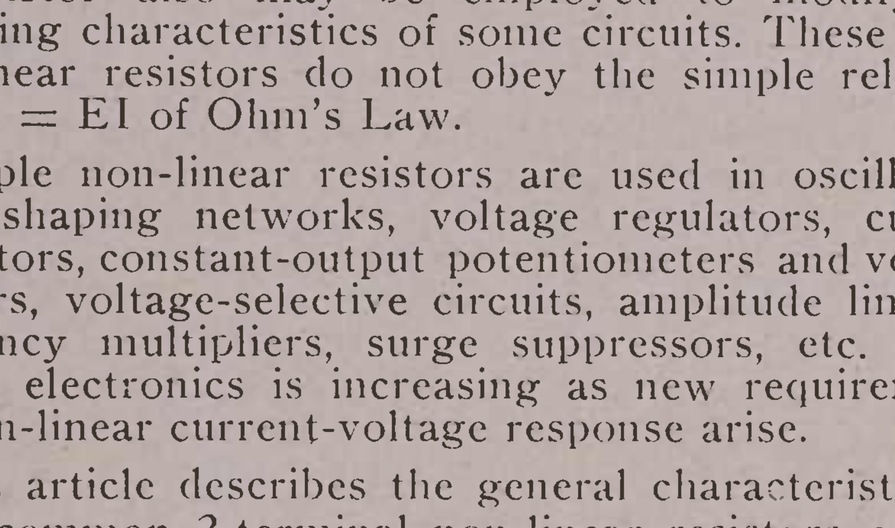


FIGURE 1

THYRITE

Thyrite resistors were introduced by General Electric Company and were applied in the electric power field some number of years before entering electronics. Thyrite resistors are made of silicon carbide, bound with a filler, then pressed and fired at high temperature. They are fabricated in the form of pigtailed rods (identical to "radio resistors"), discs, washers, and stacks. Small units suitable for electronic applications are supplied up to 10 watts power rating (continuous).

The non-linearity of the thyrite resistor is expressed by $I = kE^n$, where I is the instantaneous alternating or direct current (amperes), E the instantaneous applied voltage, k a constant (amperes at 1 volt), and an exponent between 3.5 and 7 governed by the manufacturing process. Figure 1 shows a set of typical thyrite current-voltage curves for several types of G. E. thyrite resistors. The curve for a conventional 1-megohm linear resistor is plotted for comparison. From these curves, it may be seen that large current changes result from small applied-voltage changes.

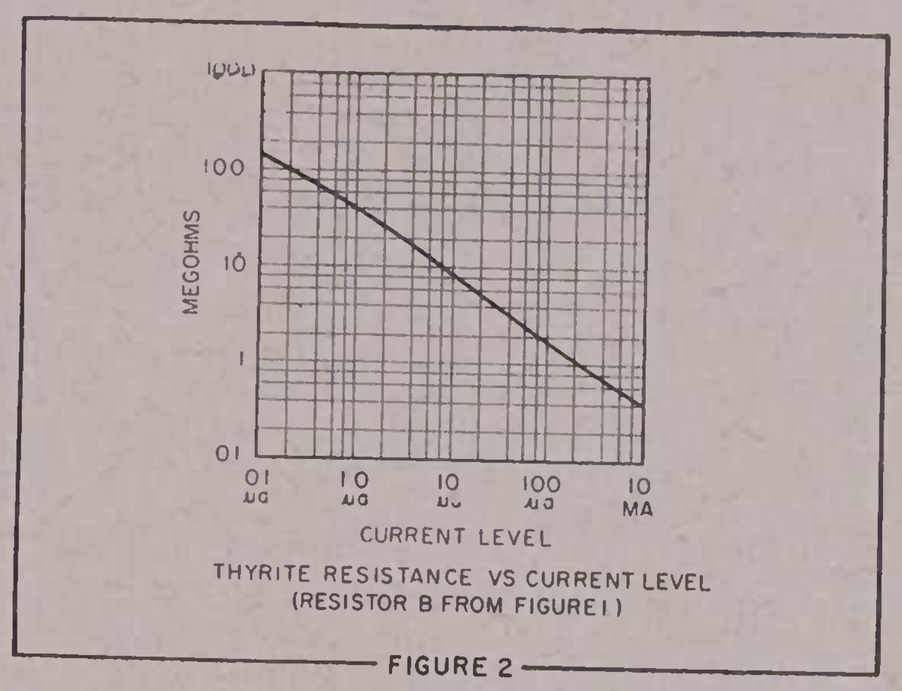


FIGURE 2

Figure 2 is a plot of resistance vs current for resistor B from Fig. 1. Note in Fig. 2 that a change of 10,000 to 1 in current flowing through this resistor changes the resistance of the latter approximately 375:1.

Thyrite resistors have the advantage of operating in both A.C. and D.C. circuits. Any rectification effects are negligible. (Fig. 3 shows a typical static positive-negative conduction curve). High-frequency A.C. operation of Thyrite is possible, the limiting factor appearing to be capacitance. It should be noted, however, that in A.C. operation the non-linearity of the Thyrite volt-ampere characteristic causes distortion of the current waveform. Fig. 4 shows the distorted current wave accompanying a sine wave of applied voltage. Observe that odd-ordered harmonics are prevalent. This phenomenon is utilized in simple frequency multipliers and harmonic accentuators.

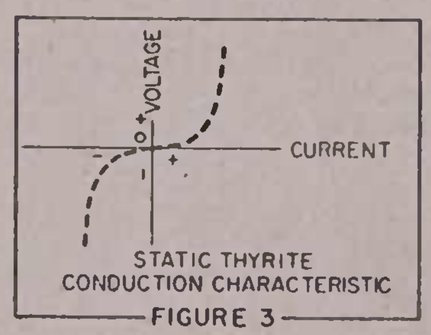


FIGURE 3

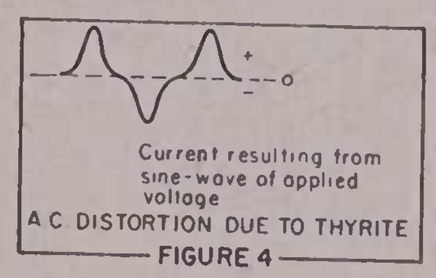


FIGURE 4

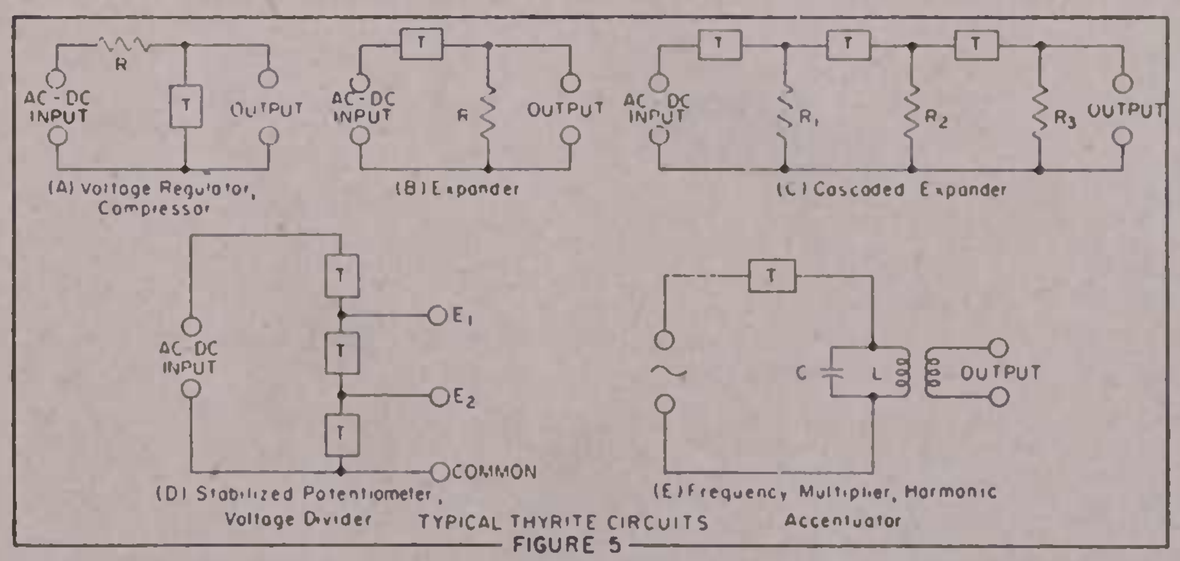


FIGURE 5

The temperature coefficient of thyrite resistance is negative in sign and varies from —0.4 to —0.73 per cent. per degree centigrade in the range 0 to 100°C.

Figure 5 shows several typical circuits utilizing the properties of thyrite resistors.

Figure 5(A) is a simple voltage regulator or compressor for smoothing variations in supply voltage. The fluctuating input voltage produces fluctuating current which flows through the thyrite resistor (T) and a linear limiting resistor (R) in series. Fluctuations in the resulting voltage drop across the thyrite resistor are considerably lower in amplitude than those in the supply voltage, due to the non-linear E/I relationship in the thyrite. It should be noted that a voltage reduction unavoidably occurs because of potentiometer action between R and T.

In the expander circuit in Fig. 5(B), the opposite action is secured. Small fluctuations in applied voltage produce large fluctuations in current through thyrite resistor T. These current fluctuations in turn produce a fluctuating output-voltage drop across R. Since the resistance of R must be small with respect to that of T, voltage divider action between the thyrite and linear resistance legs of the circuit produces a drop in voltage level. Several TR sections may be cascaded, as shown in Fig. 5(C), to secure additional expander action, at the expense of course of further voltage division in each section.

Figure 5(D) shows a potentiometer or voltage divider with thyrite sections. The non-linear E/I characteristic of the thyrite sections yields an early constant output voltage at each tap, although supply and load currents are variable.

For efficient operation of the circuits shown in Fig. 5(A) and (D), the thyrite current must be high with respect to the output load current. In Fig. 5(B) and (C), current in resistor R must be high with respect to output load current.

Figure (5)E shows how a thyrite resistor can be connected into a circuit to accentuate harmonics and act as a simple frequency multiplier .Alternating current is fed into the circuit and undergoes distortion in passing through the thyrite. The tuned circuit, LC, is adjusted to the desired multiple frequency. It has been shown already in Fig. 4 that odd harmonics are favoured by this type of operation. The thyrite frequency multiplier thus is most practical for tripling, quintupling, etc. The thyrite resistor is a dissipative element, however, and its insertion into a circuit in the manner shown in Fig. 5(E) results in some power loss. In applications where a considerable amount of power is available, the relative simplicity of the thyrite frequency multiplier can offset its unavoidable power absorption.

(To be concluded).

Television In Auckland

IMPRESSIVE PYE DEMONSTRATIONS

Thousands upon thousands of Aucklanders, and visitors from all over the province, saw their first real live television demonstrated by Pye (New Zealand) Ltd., at the Auckland Easter Show last month. The promoters of the Show, the Auckland Manufacturers' Association and the Auckland A. and P. Association, erected a special television building for the occasion, and, at very short notice, Pye television assembled, installed, and operated the three-camera-chain equipment which had been so successfully demonstrated in Wellington earlier this year. Ted Grant, chief engineer of Akrad Radio Corporation Ltd., of Waihi, was in charge of operations and the demonstration was a tribute both to his technical and organizing ability and to the remarkably designed equipment which can be brought into full-scale use at such short notice. On March 26 the area where the T.V. building now stands was bare ground and all the equipment was in Wellington. On April 10, just a fortnight later, Pye's second station in New Zealand, ZL1XS, was transmitting, and pictures were being received on Pye receivers at the Show grounds, in wards of Auckland's hospitals, and at various locations in the city and suburbs.

FINE PERMANENT BUILDING

The organizing committee showed admirable foresight in deciding to construct a permanent building to house the T.V. control room, studio, dressing rooms, and offices. The building is 55 ft. long and 25 ft. wide with a 5 ft. overhanging roof, giving ample protection in all weathers for spectators to watch control room and studio operations. The studio itself allows ample room for audience-participation shows, and incorporates a stage and dressing rooms so that live productions can be handled with ease.

FULL-SCALE VARIETY PROGRAMMES

On the programme side the demonstrations once more evidenced the extreme versatility of New Zealand talent and the intense interest of everybody in the possibilities of television. Selwyn Toogood, who was so successful in his first appearances on T.V. at the Pye demonstration in Wellington, gave several performances each of his well-known "It's in the Bag" programme and of "Lux Money-Go-Round" in the Studio. Toogood's manner, already extremely popular on radio, is very well suited to television which gives him so many opportunities to exploit his acting abilities, his ready wit, and his capacity to carry his audience and contestants with him. Other local artists provided a range of entertainment from vocal and instrumental numbers through dancing, acting and singing, to demonstrations, lectures, and magicianship.

In addition, performances in the nearby show ring, including night football and polo, animal parades, and official ceremonies were televised. Picture quality on the Pye black daylight viewing screens with automatic picture control was remarkably good both for studio and outside broadcasts, and without doubt the Pye television demonstration proved an outstanding drawcard of the exhibition.

INTERVIEW WITH MR. G. A. WOOLLER

"The Government has already told us that it does not intend in the meantime to proceed with a television service," said Mr. G. A. Wooller, managing-director of Pye (New Zealand) Ltd. in an interview with our reporter. "However, the interest displayed by the Aucklanders who saw the demonstration here, as well as the hundreds of thousands who witnessed the Pye demonstrations in Wellington in January, does indicate that there is a growing public awareness of the entertainment opportunities inherent in Television. We realize that television is essentially show business, and it does seem that show business is not meant for Government control. TV will come to New Zealand eventually—nothing is surer than that. When it does come, in the right hands, New Zealanders will learn, as millions of people have all over the world, the new visitas it opens up in every aspect of everyday life. And the trade will learn a great deal more about the electronic age in which we are growing up. Public interest was intense, and we were at many times embarrassed by the crush of people pressing round the viewing windows of the control room and the studio. As in Wellington, we were amazed to find how many Aucklanders have already taken an active interest in television and who had their own sets tuned to our transmissions. The training of television servicemen at the Seddon Memorial Technical College under Mr. R. Waddell has no doubt contributed to this interest. A number of these men have taken the opportunity presented to them by this Pye demonstration to add to their knowledge of modern television equipment."

ALL NEW ZEALAND STAFF

Mr. Wooller remarked on one feature of the Pye demonstration that has particular significance for the trade. The Auckland demonstration was handled, from start to finish, by local technical staff and locally available talent. Under Ted Grant's supervision Auckland and Waihi men assembled, tested, operated, and maintained in use all the control room and studio equipment associated with a three-chain installation. Servicemen trained at Auckland's Seddon Technical College assisted by their instructors, installed and maintained the Pye receivers, gaining valuable practical TV experience at the same time. Miss Rosemary Dempsey, of 1XN Whangarei, was chief announcer and make-up expert, and did a very fine job in her first appearances before TV cameras. Mr. A. Lyons, an Auckland resident who has had 2½ years' experience with the B.B.C. on TV stage production, was the producer who interviewed and selected talent, conducted rehearsals, and produced schedules for the daily afternoon and evening transmissions. In a large measure the smooth running of the programmes was due to his abilities. And, above all, Aucklanders found that there is a wealth of talent, amateur and professional, in their midst and that TV is the ideal medium to enable the greatest number of people to share and enjoy to the full a wide variety of accomplishments.

TUBE DATA: RCA-5763 BEAM TETRODE

Information published by courtesy of Messrs. A.W.A. Ltd.

RCA-5763 is a transmitting beam power amplifier of the heater-cathode type intended for use in compact, low-power mobile transmitters and in the low-power stages of larger fixed station transmitters. It has a maximum plate dissipation of 12 watts. Because of its high transconductance, and a plate characteristic favourable to the generation of a high harmonic output, the 5763 is particularly useful in the doubler and tripler stages of transmitters and can be operated with full input up to 175 Mc.

The 5763 features heavy control-grid support rods and two control-grid base-pin connections which provide for cooler grid operation. Its 6-volt heater can be conveniently operated from a storage battery in mobile or emergency-communications equipment. The exceptional efficiency of the 5763 as frequency multiplier is made possible by the large cathode area which supplies the high peak currents necessary for multiplier service.

Electrical:

Heater for Unipotential Cathode:	
Voltage (A.C. or D.C.)	6.0 ± 10% volts
Current	0.75 ampere
Transconductance for plate current of 45 ma	7,000 μmhos
Mu-Factor, Grid No. 2 to Grid No. 1	16.0
Direct Interelectrode Capacitance (No external shield):	
Grid No. 1 to Plate	0.3 max. μμf
Input	9.5 μμf
Output	4.5 μμf

Mechanical:

Mounting Position	Any
Maximum Overall Length	2⅝ in.
Maximum Seated Length	2⅜ in.
Length from Base Seat to Bulb Top (excluding tip)	2 in. ± 3/32 in.
Maximum Diam.	⅞ in.
Bulb	T6½ in.
Base	Small-button Noval 9-Pin

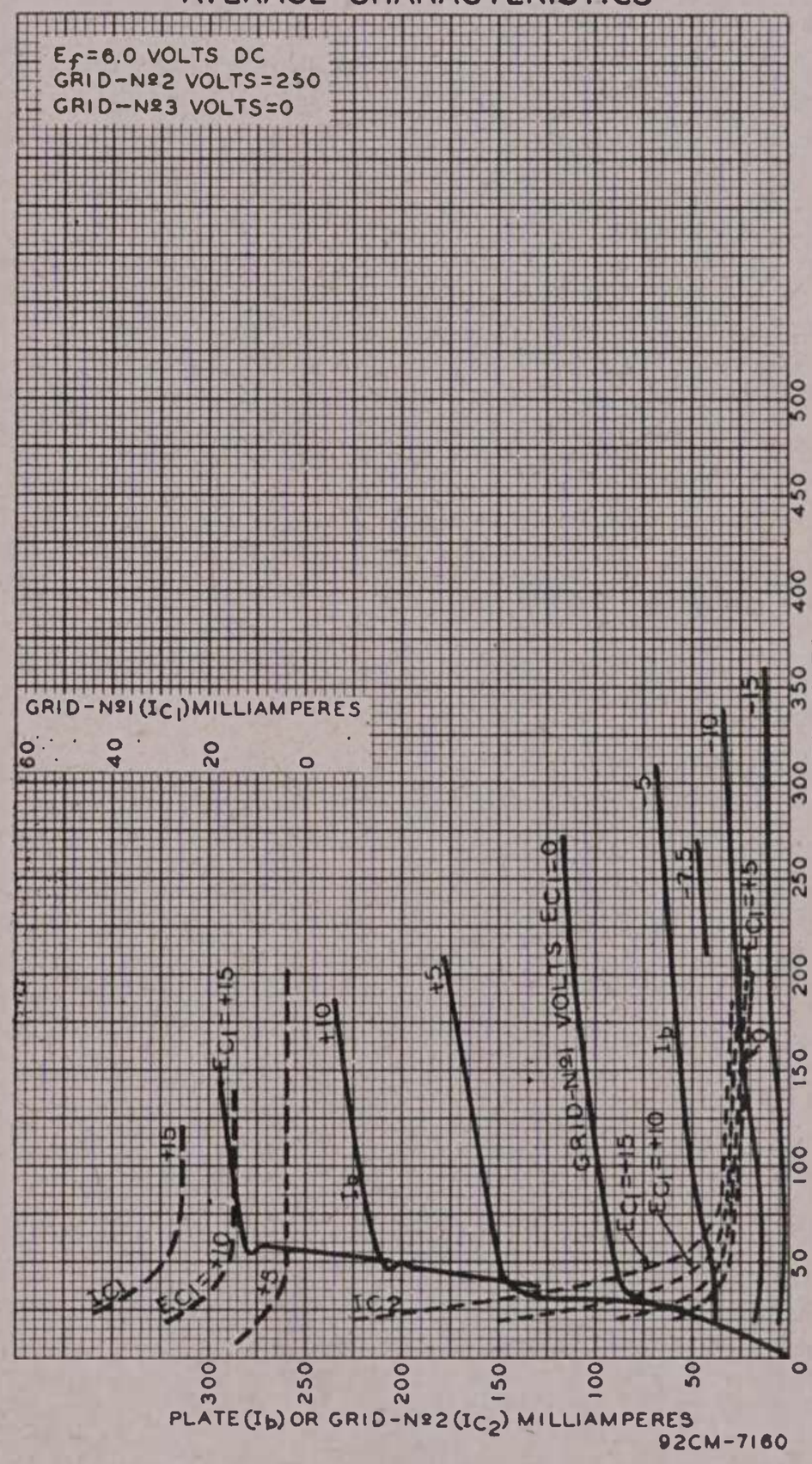
RF POWER AMPLIFIER & OSC. - Class C Telegraphy §

AND RF POWER AMPLIFIER - Class C FM Telephony

Maximum CCS ‡ Ratings, Absolute Values:

D.C. Plate Voltage	300 max. volts
D.C. Grid No. 3 (Suppressor) Voltage	0 max. volts
D.C. Grid No. 2 (Screen) Voltage	250 max. volts
D.C. Grid No. 1 (Control-Grid) Vtge	—125 max. volts
D.C. Plate Current	50 max. ma
D.C. Grid—No. 2 Current	15 max. ma
D.C. Grid—No. 1 Current	5 max. ma
Plate Input	15 max. watts
Grid—No. 2 Input	2 max. watts
Plate Dissipation	12 max. watts

AVERAGE CHARACTERISTICS



Peak Heater-Cathode Voltage:

Heater neg. with respect to cathode	100 max. volts
Heater pos. with respect to cathode	100 max. volts
Bulb temperature at hottest point on Bulb Surface	250 max. ° C.

Typical Operation:

	At 50 Mc
D.C. Plate Voltage	300 volts
Grid No. 3	Tied to cathode at socket
D.C. Grid—No. 2 Voltage	250 volts
D.C. Grid—No. 1 Voltage	—60 volts
From a grid resistor of	22,000 ohms
Peak R.F. Grid—No. 1 Voltage	80 volts
D.C. Plate Current	50 ma
D.C. Grid—No. 2 Current	5 ma
D.C. Grid—No. 1 Current (Approx.)	3 ma
Driving Power (Approx.)	0.35 watt
Power Output (Approx.) °	8 watts

° The useful power output is approximately 7 watts.

FREQUENCY MULTIPLIER

Maximum CCS ‡ Ratings, Absolute Values:

D.C. Plate Voltage	300 max. volts
D.C. Grid—No. 3 (Suppressor) Voltage	0 max. volts
D.C. Grid—No. 2 (Screen) Voltage	250 max. volts
D.C. Grid—No. 1 (Control-Grid) Voltage	—125 max. volts
D.C. Plate Current	50 max. ma
D.C. Grid No. 2 Current	15 max. ma
D.C. Grid No. 1 Current	5 max. ma
Plate Input	15 max. watts
Grid No. 2 Input	2 max. watts
Plate Dissipation	12 max. watts
Peak Heater-Cathode Voltage:	
Heater neg. with respect to cathode	100 max. volts
Heater pos. with respect to cathode	100 max. volts
Bulb Temperature at Hottest Point on Bulb Surface	250 max. °C

Typical Operation:

	Doubler to 175 Mc	Tripler to 175 Mc	
D.C. Plate Voltage	300	300	volts
Grid No. 3	Tied to cath. at socket		
D.C. Grid No. 2 Voltage	*	*	volts
D.C. Grid No. 1 Voltage	—75	—100	volts
From a grid No. 1 resistor of	75,000	100,000	ohms
Peak RF Grid No. 1 Voltage	95	120	volts
D.C. Plate Current	40	35	ma
D.C. Grid No. 2 Current	4.0	5.0	ma
D.C. Grid No. 1 Current (app.)	1.0	1.0	ma
Driving Power (approx.)	0.6	0.6	watt
Power Output (approx.)¶	3.6	2.8	watts

¶Useful power output is approximately 2.1 watts for doubler service and 1.3 watts for tripler service.

Maximum Circuit Values (for maximum rated conditions):

Grid No. 1 Circuit Resistance .... 0.1 max. meg.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	Min.	Max.	
Heater Current	1	0.69	0.81	amp.
Grid No. 1 to Plate Capac.†	–	–	0.3	μμf.
Input Capacitance†	–	8	11	μμf.
Output Capacitance†	-	3.8	5.2	μμf.

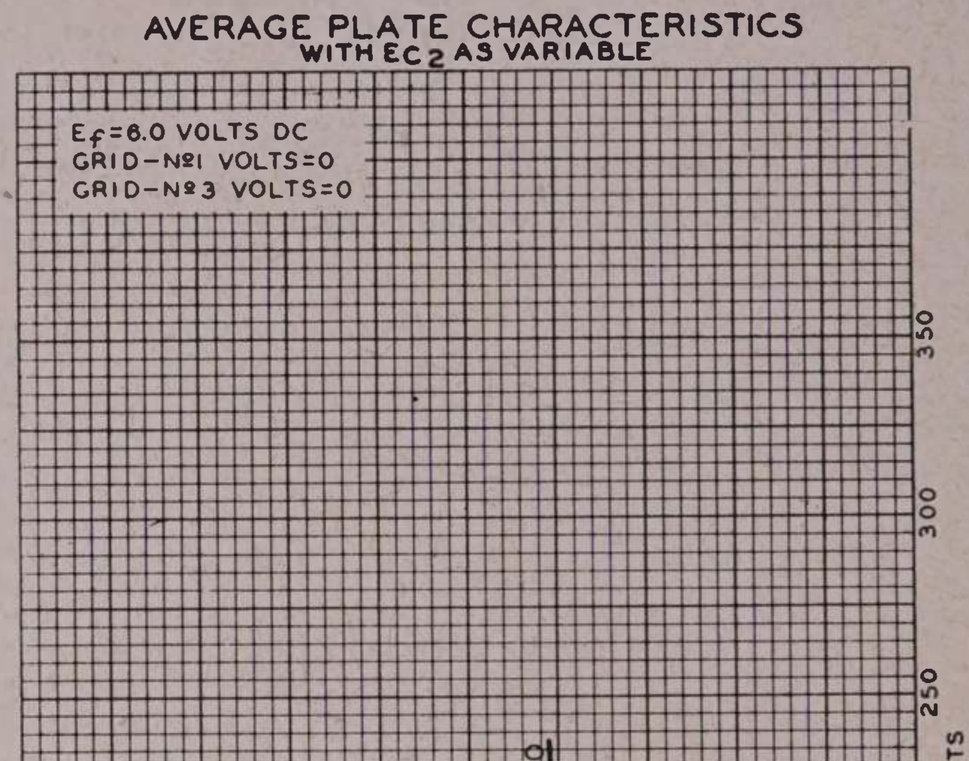
Note 1: With 6 volts A.C. on heater.

§ Key-down conditions per tube without amplitude modulation. Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent. of the carrier conditions.

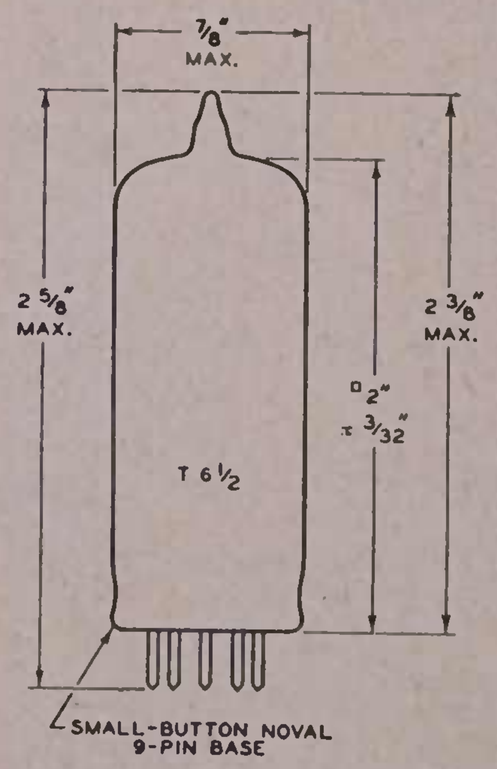
‡ Continuous Commercial Service.

† **With no external shield.**

* Obtained from plate supply voltage of 300 volts through a series resistor of 12,500 ohms.

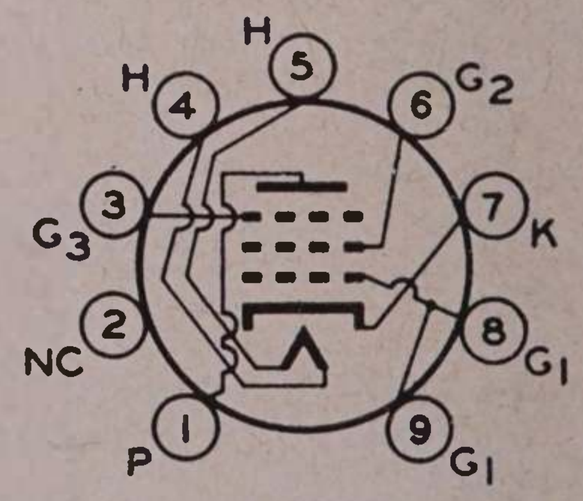


DIMENSIONAL OUTLINE



□ MEASURED FROM BASE SEAT TO BULB-TOP LINE AS DETERMINED BY RING GAUGE OF 7/16" I.D.

SOCKET CONNECTIONS
Bottom View



PIN 1 – PLATE
PIN 2 – NO CONNECTION
PIN 3 – GRID No. 3
PIN 4 – HEATER
PIN 5 – HEATER
PIN 6 – GRID No. 2
PIN 7 – CATHODE
PIN 8 – GRID No. 1
PIN 9 – GRID No. 1

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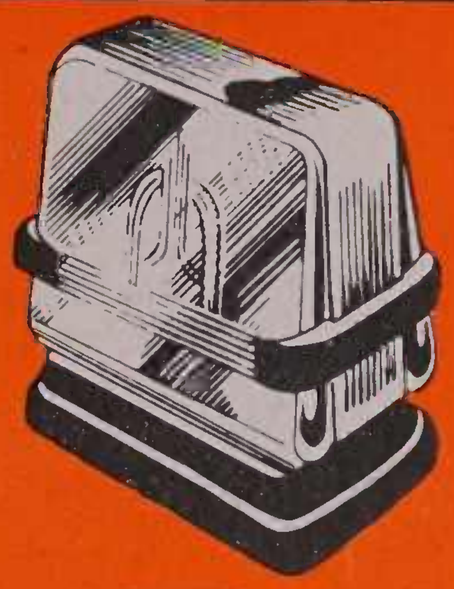

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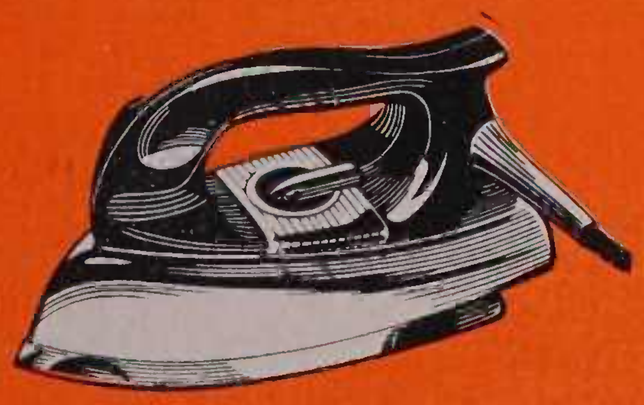

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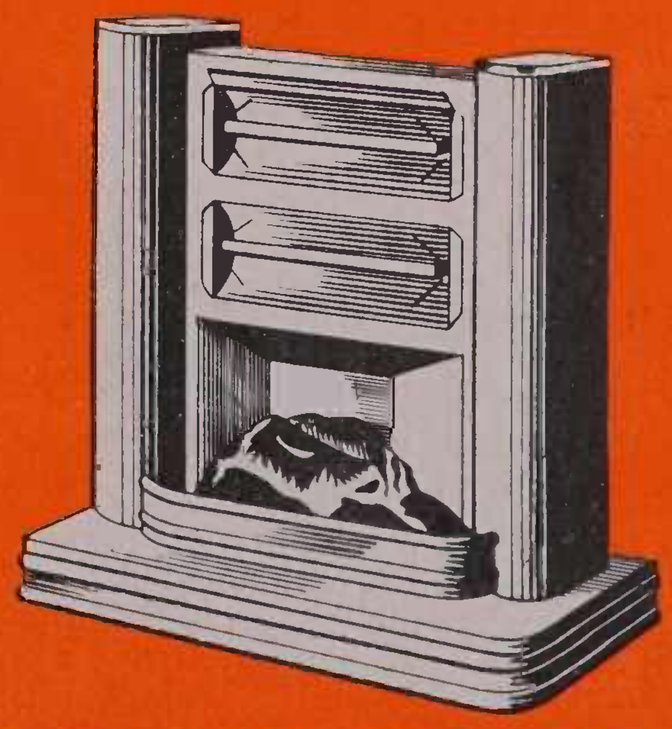

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QUAY STREET, AUCKLAND

THE REVERSAL OF A.C. MOTORS

By J. L. WATTS, A.M.I.E.E.

Editor's Note

The ability to reverse the direction of rotation of a small A.C. motor can be exceedingly useful to those who sell and install them, particularly where special applications are called for. The following article is so comprehensive and clearly written that we immediately took steps to reproduce it here. We are indebted to the publishers of "Electrical Industries Export," 6 Cavendish Place, Regent Street, London, for permission to do so.

POLYPHASE INDUCTION MOTORS

To reverse an induction motor it is necessary to reverse the rotation of the magnetic field, since the rotor moves in the direction of the rotating field. Such reversal is effected by changing the phase sequence of the supply to the phases of the stator windings. No alteration is required in the rotor circuit of a slip-ring motor, whether the motor is three-phase, two-phase, or single-phase.

Thus a three-phase motor may be reversed by changing over the connections of any two of the supply lines, the change being made at any convenient point such as a distribution board, switch, starter or at the motor itself. Where a star-delta starter is used on which there are six leads between the motor and its starter, it is much the best plan to change over two of the connections on the supply side of the starter. If frequent reversal is required a double-pole two-way switch may be used to change the connections, but if it is required that the reversing switch should also be capable of isolating the motor from the supply a three-pole two-way switch with "off" position is required as shown in Fig. 1.

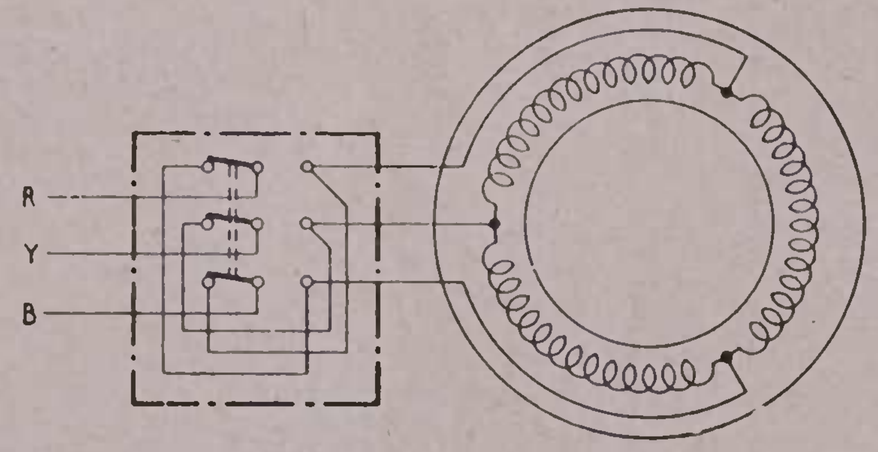

Fig. 1. Reversal of three-phase induction motor

In order to reverse a two-phase three-wire motor the connections to the phase or "outer" terminals should be reversed, the connections on the neutral line being unchanged. For isolation as well as reversal a three-pole twoway switch with "off" position is required. A two-phase four-wire motor may be reversed by changing over the connections to one phase only of the stator windings. For isolation as well as reversal a four-pole twoway switch with "off" position is required.

POLYPHASE COMMUTATOR MOTORS

A three-phase rotor-fed (Schrage) comutator motor also may be reversed by changing over any two of the three supply leads to the motor. Some of the smaller motors will run equally well in either direction without alteration of the brush settings but others may require it in order to obtain the best starting torque and highest power factor. If the speed is controlled by brush movement effected by means of a pilot motor the phase sequence of the supply to the pilot motor circuit must not be altered when reversing the commutator motor.

Commutator motors can also be made for reversing by switching only, giving the same characteristics in both directions without brush shift. Similar remarks apply to stator fed commutator motors.

SYNCHRONOUS MOTORS

Synchronous motors are inherently not self-starting and will run in whichever direction they are started. Thus in order to reverse a synchronous motor which is started by induction methods it is necessary to use whatever methods are applicable to the starting device used.

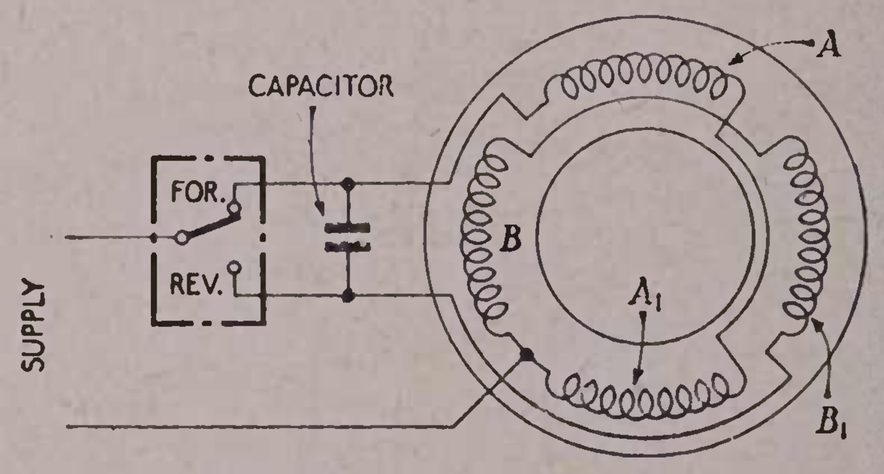

Fig. 2. Reversal of single-phase capacitor motor

SINGLE-PHASE SPLIT-PHASE MOTORS

In order that torque may be produced by a stationary rotor it must be acted on by a revolving magnetic field, i.e., the magnetic field of the stator must vary not only in strength but in direction at different instants. Single-phase motors are normally made selfstarting by phase-splitting, i.e., by fitting an auxiliary winding on the stator which is used to produce magnetic flux midway between the poles of the main or running windings, this auxiliary winding being fed with current which is out of phase with that in the main windings. The phase difference may be obtained by suitable proportioning of the number of turns and size of wire, or by connecting a resistor, choke coil or capacitor in series with the auxiliary winding. Another starting arrangement utilises a phase-splitting device consisting of a reactance in parallel with the auxiliary winding, this parallel circuit being fed from the supply through a resistor.

Normal types of split-phase single phase motor can be reversed by changing over the connections to either the stator main winding or the auxiliary winding. A double-pole twoway switch can be used for

reversal only but a four-pole twoway switch with "off" position is required for reversal and isolation.

CAPACITOR MOTORS

There are three main groups of single-phase motors which employ capacitors, the plain capicitor motor also known as permanent-capacitor or single-value capacitor, the capacitor-start motor, and the capacitor-start-and-run or two-value capacitor motor. In the permanent-capacitor motor the stator carries a main winding fed from the single-phase mains and an auxiliary winding, which is fed from the mains

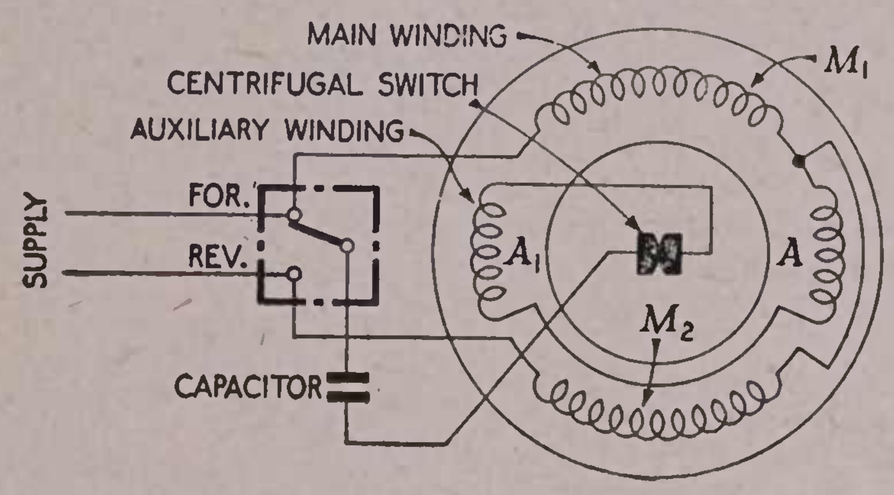

Fig. 3. Reversal of capacitor motor with swing connection

through a capacitor all the time the motor is running. The motor may be reversed by reversing the connections to either the main or the auxiliary winding, but not to both. Where the main and auxiliary windings are electrically similar, the motor can be started in either direction, or stopped, but not isolated, by means of a single-pole two-way switch with "off" position as shown in Fig. 2. It will be seen that either winding acts as the main winding depending on the position of the switch and both windings remain in circuit while the motor is running.

In the capacitor-start motor the running or main winding is connected directly to the supply and the auxiliary winding is fed from the supply through a capacitor during the starting period only. Such a motor is reversed by changing over the connections to either the starting winding or the running winding, as in the case of a permanent capacitor motor. Another type of capacitor-start motor employs the "swing" connection and can be reversed but not stopped by means of a single-pole-two-way switch as shown in Fig 3. For one direction of rotation the starting winding A A_1 and the capacitor are fed from the mid point of the two main stator windings M_1 M_2 and one of the pole supply; for the opposite direction of rotation the auxiliary winding is fed from the mid-point and the other pole.

One type of capacitor-start motor has starting windings which are arranged to create starting poles which are not quite midway between the main poles. Such motors are not intended for reversible operation and in order to reverse such a motor the stator should be reversed bodily in its case.

The auxiliary windings of the capacitor-start-and-run motor are connected to the supply through a large capacitor at starting, and through a smaller capacitor when running; the change over being made either by hand or automatically by means of a centrifugally operated switch. In some cases the change of capacity may be obtained by using two capacitors which are connected in parallel with each other at starting and in series with each other during running. The motor is reversible by changing over the connections to either the main or the auxiliary windings on the stator.

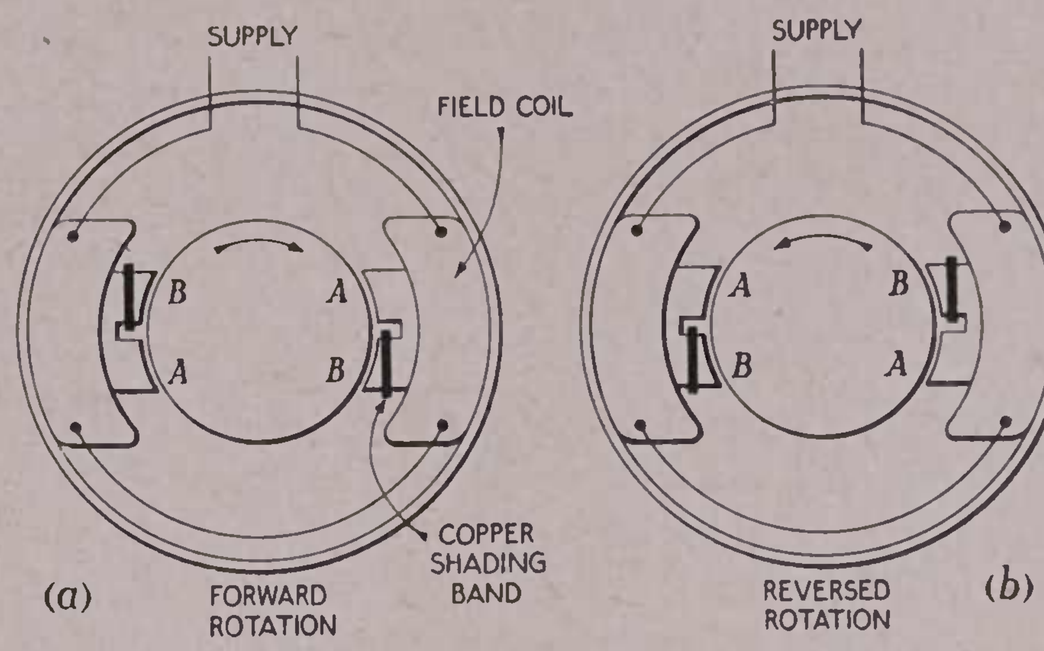

Fig. 4. Reversal of simple shaded pole motor

SHADED-POLE MOTORS

The rotating magnetic field, which is necessary for starting an induction motor, is produced in the shaded-pole motor by means of short circuited copper bands which encircle a portion of each pole face, as shown in Fig. 4. The purpose of the bands is to delay the cycle of flux in the encircled portion of the pole face so that the peak flux occurs in the encircled portions B after it occurs in the other portions A. Thus the magnetic field moves in the direction of B from A and the rotor is dragged round in the same direction. In order to reverse such a motor the relative positions of the two portions of each pole face must be changed as shown in Fig. 4b. This is a mechanical operation and the method which can be employed may depend on the construction of the motor. It may be possible to turn the wound stator core round in its case, or to turn the stator, case and end shields round with respect to the rotor and its bearings.

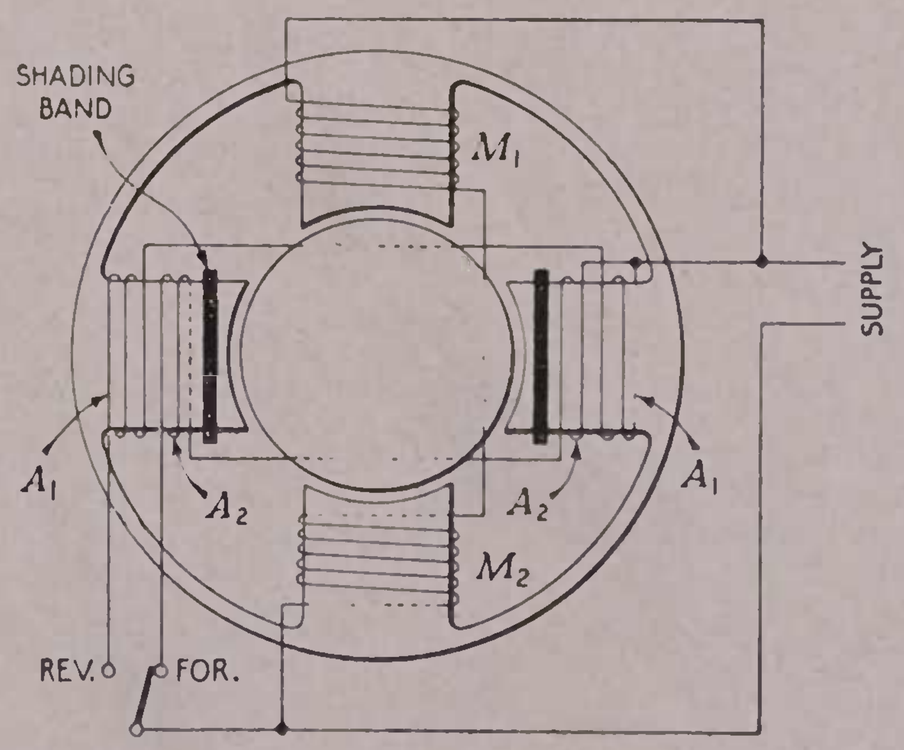

Fig. 5. Electrically reversible shaded-pole motor

Special types of shaded-pole motor are obtainable which can be reversed electrically by a switch. One type has a main stator winding with split poles; each pole section is wound with an insulated winding which can be short circuited to act as the shading winding is required. Thus the motor can be reversed, by means of a single-pole two-way switch arranged to short circuit one or other of the windings. The arrangement of another reversible shaded-pole motor is shown in Fig. 5. It has a main winding M_1 M_2 on

one pair of poles, and auxiliary poles, each of which has a short circuited shading band together with two separate insulated windings A_1 and A_2 which are connected so as to create opposite magnetic polarities. A single-pole two-way switch is employed so that an auxiliary pole can be used as the shaded-pole for either of the main poles.

Some shaded-pole motors are built which have distributed windings in slots in the stator core, as in split-phase and capacitor motors. The shading coils of such a motor usually consist of a few short circuited turns of thick insulated wire. One form of reversible shaded-pole motor has two main stator windings MM, and RR, with a single shaded-pole

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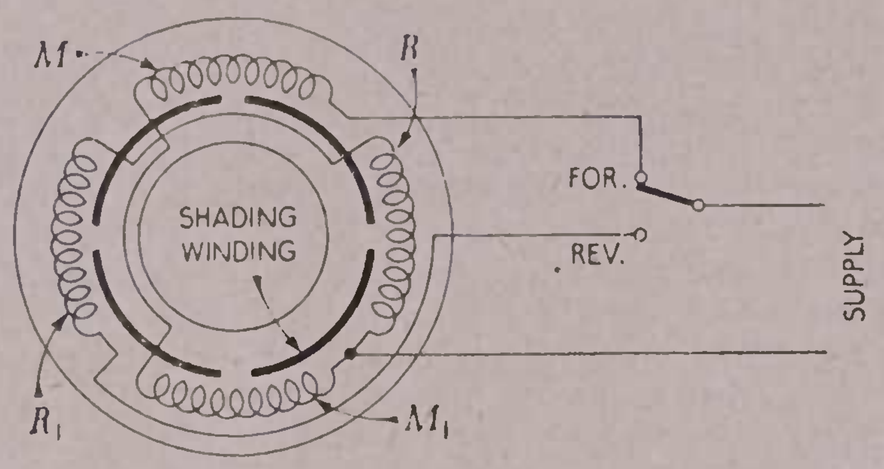


Fig. 6.

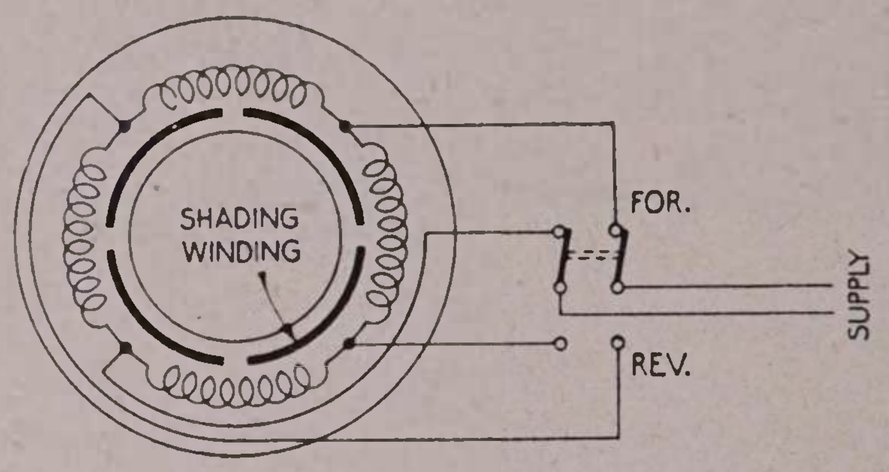


Fig. 7.

Other forms of Reversible Shaded Pole Motors.

winding, as shown in Fig. 6. A single-pole two-way switch with "off" position can be used to stop the motor or to run it in either direction, but not to isolate it, by using either one or the other of the main windings. Another reversible shaded-pole motor which has distributed stator windings is wound for reversible operation as shown in Fig. 7. The main windings are tapped at points displaced 45 electrical degrees from the shading coils. By using a double-pole two-way switch with "off" position, the motor can be run in either direction or stopped and isolated from the supply. Since the full stator winding is used for both directions of rotation this motor is more efficient than other types of reversible shaded-pole motors.

THE RELUCTANCE-START MOTOR

In the reluctance-start motor the rotation of the magnetic field required for starting is produced by having a stepped radial air gap under each pole face, half the pole having a wide gap and the other half camparatively narrow. Most of the flux from each pole will pass across the shortest portion of the air gaps, but there is less hysteresis in the portion of the magnetic circuit which has the longest gap. In consequence the peak value of the flux will occur in the wider gaps before it reaches its peak value in the shorter gaps. This causes the rotor to turn in the direction of from the wide gap to the short gap. Such a motor can be reversed if the relative positions of the two portions of each pole face can be changed; possibly by turning the wound stator round in its case, or turning the stator case and end shields on the rotor and bearings. The connections of the stator windings shown in Fig. 6 are sometimes used in a reversible reluctance-start motor which has distributed stator windings, the tips of the stator teeth halfway between the main coils being cut off to provide a larger air gap at that portion.

SERIES MOTOR

Series motors with laminated fields are commonly employed on single-phase A.C. systems. Fractional horse-power sizes are generally of the universal type and have similar speed-torque characteristics on A.C. and D.C. In such machines the armature receives its current by conduction and the motor can be reversed by changing over the connections to either the armature or the field coils, as in the case of D.C. motors. Some series motors have a split field winding, one section only being used for each direction of rotation. Such a motor can be started in either direction or stopped, but not isolated, by means of a single-pole two-way switch with "off" position. Slight alteration of the brush position may be required after reversal in order to avoid sparking at the commutator and to obtain the same speed-torque characteristics in the new rotation. Field systems of some of the larger motors are fitted with compensating windings in series with the field windings, for the purpose of

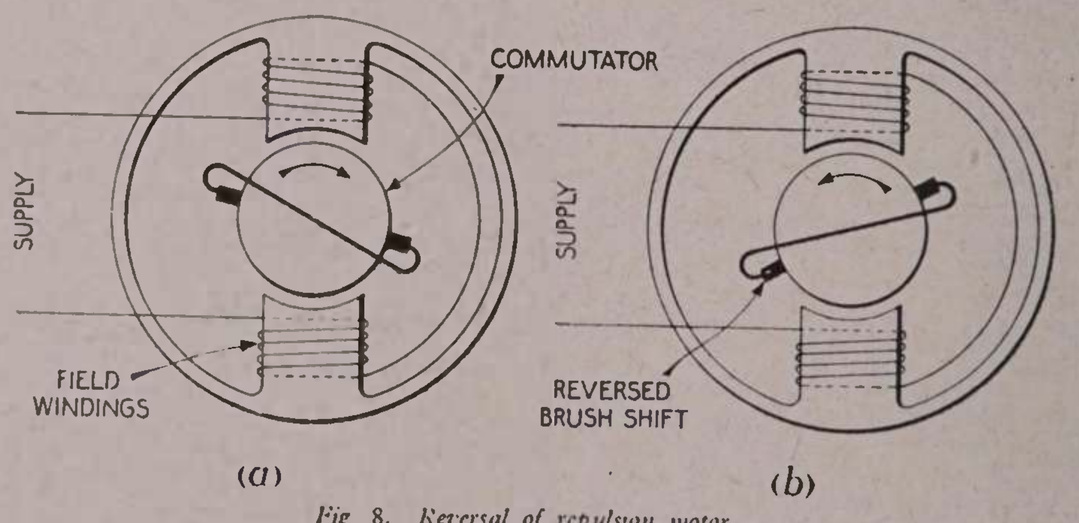


Fig 8. Reversal of repulsion motor

neutralising the armature reaction field. If such a motor is reversed by reversing the armature current the current through the compensating windings must also be reversed; the armature and the compensating windings must be treated as one unit.

REPULSION TYPES

The plain repulsion motor has a stator (field) winding which is fed from the single-phase supply as shown diagrammatically in Fig. 8, with a slotted armature similar to that of a D.C. motor, the windings of which are connected to a commutator. The brushes on the commutator are short circuited together and generally not insulated from the frame of the motor. The rotor windings thus receive current by induction from the pulsating magnetic field of the stator, and the starting torque results from the displacement of the brushes from the neutral position,

which causes the axis of the armature reaction field to be displaced from that of the stator magnetic field.

This type of motor is reversible by shifting the whole set of brushes slightly round the commutator; the brush positions for both directions of rotation are generally marked on the frame of the motor.

The stators or field systems of some repulsion motors have two sets of windings in series with each other. One (inducing) winding creates the induced armature (rotor) current, whilst the other (field) winding creates the magnetic field with which the rotor current-carrying conductors react to create the torque. Such motors can be reversed by changing over the connections to either of the stator windings. Yet another electrically-reversible repulsion motor has an inducing winding and two field windings, one field winding for each direction of rotation. Such a motor can be controlled but not isolated, by means of a single-pole two-way switch with "off" position to select the field winding to give required direction of rotation.

When a plain repulsion motor is reversed by shifting the brushes, no connections have to be altered but the angular position of the brushes is critical and slight displacement from the optimum position causes considerable reduction of torque and speed. Some repulsion motors are built in which both speed variation and reversal are effected by brush shifting by means of an external lever. This type is sometimes used on cranes and hoists.

Repulsion motors may be designed for reversal by switching, without shifting the brushes, by providing two sets of brushes with a special double-pole switch arranged to short circuit either one set of brushes or the other, according to the required direction of rotation.

REPULSION-START MOTORS

Repulsion-start-induction motors are of similar construction to the plain repulsion motor, but contain an additional device on the rotor which operates by centrifugal force to short circuit the commutator segments after the motor has accelerated to a certain critical speed at starting, thereby converting it to an induction motor. In the "brush-riding" type of motor the brushes remain on the commutator after the latter has been short circuited. In the "brush-lifting" type of motor the centrifugal device raises the brushes from the commutator after the latter has been short-circuited, in order to minimise wear of the brushes and commutator. The repulsion-induction motor, on the other hand, is similar to a plain repulsion motor but has an additional short circuited cage winding in slots in the rotor below the insulated winding. The methods of reversing the repulsion-start-induction and the repulsion-induction motors are generally similar to those employed with plain repulsion motors.

NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. Advertising rates are charged according to space occupied. For further particulars contact Advertising Manager, R. and E., Box 8022, Wellington.

CLIPPER RADIOS

The first of an entirely new range of radios and radiograms under the brand name of Clipper is to be released in May. Distributors: G. A. Wooller and Co., Ltd.

All Clipper models will be sold at rock-bottom prices, with allowance for the full dealer margin and without any sacrifice of quality. Mr. George Wooller confidently predicts that Clipper is going to be one of the largest selling lines on the New Zealand market.

Clipper radios and radiograms are to be "open sellers"—they will be offered to better radio dealers throughout the country without discrimination. Attractive sales promotion material is available, and G. A. Wooller and Co., Ltd., invite enquiries from all radio dealers who wish to stock what is sure to be a most popular brand of low-priced models.

The first Clipper model, to be called the Studio Gram (Model 5G4), is a 5-valve, dual-wave, table model radiogram incorporating the new **Garrard** RC 11 3-speed automatic changer. The cabinet, of the latest American design, will be available in light or dark solid oak. A 6 in. x 4 in. elliptical speaker gives really astounding power and performance, enhanced by the special cabinet shape. Reception on both broadcast and short wave bands is outstanding.

The Studio Gram will be really sensational value at a retail price of only £44 10s. This is undoubtedly the best value ever offered in New Zealand, and the price allows for the full dealer margin.

Clipper radios are being manufactured by the Akrad Radio Corporation Ltd., and distributed throughout New Zealand by G. A. Wooller and Co., Ltd., who welcome enquiries to P.O. Box 2167, Auckland, (Phone 45-970).

The next model in the Clipper range will be a 6-valve, 3-speed console radiogram. Full details will be available shortly.

* * *

MAGNETOPHON RECORDING TAPE

Messrs. Direct Imports Ltd., Hastings, announce that they have become agents for the famous "Magnetophon" brand of recording tape. The makers will be remembered as the first in the world to perfect high-quality magnetic recording, when the German forces and broadcasting system made considerable use of it, several years before either Britain or America had anything comparable. This new tape is remarkable for its high sensitivity, and its excellent mechanical qualities.

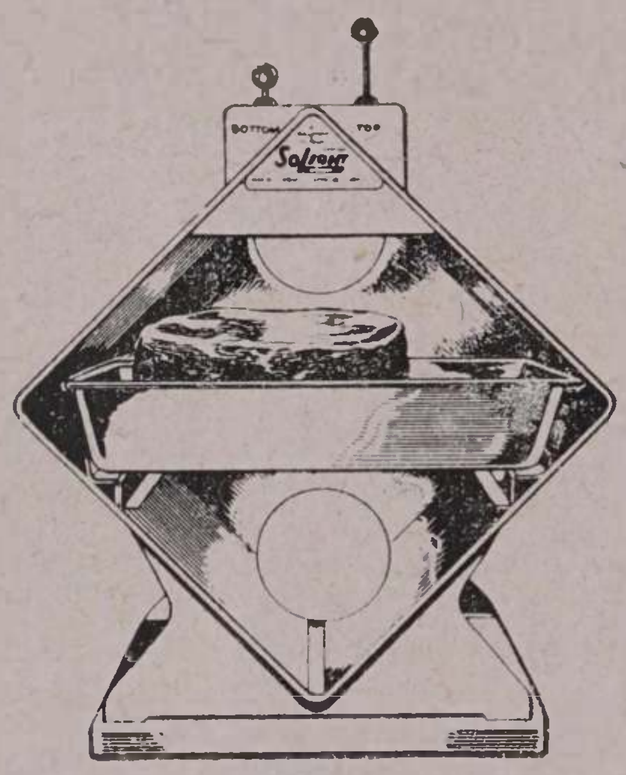
It is stated to have a recording sensitivity at $7\frac{1}{2}$ inches per second approximately 12db. higher at 1000c/sec., and 3 to 5db. higher at 10,000c/sec. than certain standard tapes, making it superior for obtaining high-quality results at the lower tape speeds standard for home recorders.

Mechanically, its PVC base gives it remarkable tensile strength and very small elongation under tension. The permanent elongation under a load of 1kg. (2.2 lb.) is stated to be only 0.04 per cent. of its length. The PVC base also gives it the property that even after prolonged storage, sharp crossing will not cause loss of mechanical strength. Breakages under normal use are thus minimised.

The New "SOLIGHT" OVEN

The first question to be asked of any oven is "How well does it cook," Satisfied users throughout the country are daily offering their testimonials in appreciation of the Solight Oven, and demonstrations before hundreds of people have left none in doubt—Solight cooked food cannot be bettered! The pure, fumeless heat from the lamps has nothing but a beneficial effect on food, and a universal comment is that flavour and aroma are more richly preserved by a Solight, than by any other oven.

The unique feature of the Solight Oven is, of course, the fact that it derives heat for cooking from two ordinary 200 watt houselamps. This feature raises the question as to how it is possible to cook with lamps which are designed for the purpose of providing light. The query arises because it is not generally known that the lamp filaments reach a



temperature of near 5,000° F., nor is it known that infra-red radiation accounts for 67 per cent. of the heat given off by the filament while luminous radiation disposes of only 8 per cent.

The lamps are, in effect, two small but high temperature elements surpassing in efficiency the much larger elements of conventional ovens, because these operate at a temperature rarely exceeding 1,800° F. The strength of radiation depends on a temperature, and this fact explains why 200 watt lamps operating at 5,000° F. can be as efficient, or more so, than conventional oven elements operating at 1,800° F. This is so regardless of the fact that the open type elements may be consuming anything up to 3,500 watts.

One big advantage of the low powered lamps is the low operating cost, but apart from this, and their efficiency as a source of heat, the lamps have many other advantages over the conventional resistance element. They are considerably cheaper and more easily installed, more easily serviced and replaced, and never leave one in doubt as to whether they are functioning properly.

Lamp life is obviously an important consideration, regardless of their cheap replacement cost. As tangible evidence of the belief regarding lamp-life, the manufacturers have had no hesitation in agreeing to replace original lamps if they burn out inside of 12 months. This apparent generosity surprises most folks, until it is explained that the lamps are really better treated in a Solight than in a sealed lighting fixture. There is no escape for the heat from the latter, but in the Solight, heat from the lamps is absorbed by the food and this actually has a beneficial cooling influence on the filaments.

One other important advantage from the use of lamps is the perfect control of heat which is achieved with them. They are placed one each at top and bottom of the oven—are independently switched and both are movable to or from the oven centre. By observing the simple principle that the closer the lamps to the food cooked the greater the heat, it is possible to set each lamp in the position most suitable to whatever is cooking. A few minutes of experience is sufficient to make this operation as simple and effective as raising or lowering a gas jet under a saucepan. Movement of a lamp to or from the food effects an immediate change in the heat, with the same speed as does the adjustment of a gas jet.

The Solight door can be opened at any time while food is baking, and this opportunity for visual inspection obviates all thoughts of actual baking temperatures and there is no setting of automatic controls to concern the user. If adjustments to the lamp are seen to be necessary when the door is opened, then such adjustments are made on the instant, simply by moving either or both lamps to or from the food.

Waves of radiant energy are only converted to heat when they strike a receptive or absorbing surface. These waves radiate in all directions from the lamps so that only a certain percentage radiate on to the food being cooked. It is necessary to reflect the remainder back towards the oven centre and the Solight accomplishes this most effectively with its characteristic shape and with the aid of the special aluminium used in its construction. Aluminium is a particularly high reflector of infra-red and reflects up to 98 per cent. of some wave lengths. This reflectivity does not depend on the brightly polished surface so necessary for the maximum reflection of light rays. The surface can actually whiten out considerably before having any significant effect on heat reflection, and this obviates any necessity for laborious polishing. When it is thought necessary to do so, the surface can be reconditioned in a few minutes with a gentle application of dry steel-wool pads. In this way it can be guaranteed to give a lifetime service.

The internal walls of the Solight are much cooler than those of conventional ovens, because the latter absorbs the heat while those of the Solight reflect it. For this reason the walls do not burn or char anything splashed or spilt on them during the process of cooking, so that the Solight is a housewife's dream—positively no trouble to clean!

One great benefit of aluminium is its light weight, which simplifies construction as well as making possible a truly portable oven, weighing only 9lb. Apart from its efficiency as a reflector the light weight naturally absorbs less heat then the heavy metal walls of conventional ovens, and this is a very real reason for Solight efficiency. It is a fact which further explains why two 200 watt lamps provide sufficient heat for cooking food in quantities comparable with ovens using up to 3,500 watts. The Solight heat is reserved for the food being cooked and it is not wasted on 50 or 60 lb. of metal as well.

There is much of interest about the Solight which cannot be covered in a write-up of this nature, but the manufacturers, Appliance Distributors Itd. of 114 Victoria Street, W., Auckland, will be pleased to answer any inquiries.

P.B.A.

FOR THE TECHNICIAN

THE MORPHY-RICHARDS AUTOMATIC TOASTER

VOLTAGE RANGES

110/120, 120/125, 200/215, 220/235, 240/250

FOR USE ON A.C. ONLY. LOADING 1,250 WATTS

BRIEF DESCRIPTION

The Morphy-Richards automatic toaster is designed to give the user toast which is uniformly and consistently browned to a selected degree. Almost everyone really likes toast of the same colour, so that the browning control can be considered as an adjustment for varying kinds and newness of bread. The basic difference between the two models is the fitting of the dashpot which limits the speed at which the toast pops up. All models subsequent and including serial No. D.F. are now fitted with this attachment.

Note: If a customer requires his toaster converted, a new main feature, Code 32806 (see parts drawing), and other minor parts are required.

OPERATION

Bread is dropped into the slots on the top of the cowl where it rests on the carrier arms. To start the toaster, depress the moving handle until it engages. Shortly before this engagement, the main contact will be completed through the elements (see Section 4, Timer). Toasting will now begin.

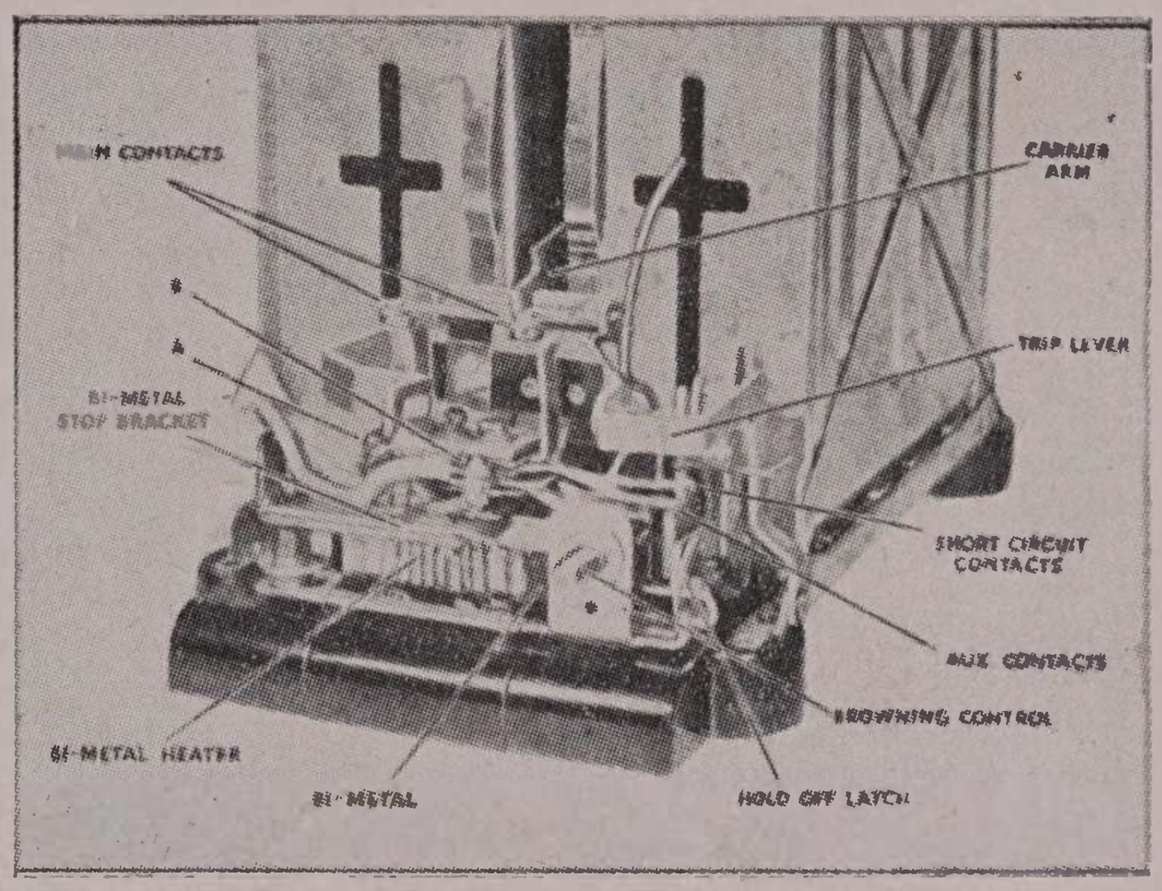
TIMER UNIT

The Timer Unit (see Fig. 2) is a unique device designed to provide a timed interval which varies with the state of the toaster. Obviously, when the toaster is cold, a longer timing cycle will be required than when it is warm. This ensures that the toast will be delivered uniformly brown every time.

Bi-metal deflection is the principle employed and at the end of a timed cycle the timer relay arm is released, thus releasing the carrier arm, which due to the spring tension employed, rises and presents the toast for easy handling. As the carrier arm rises it carries with it one set of the main contacts, breaks the circuit, and so switches off the current to the elements.

TRIP BUTTON

Pressing the trip button releases the relay arm so that the bread carrier rises and switches off the mains. After pressing the trip button a unique and patented feature comes into operation and prevents the toaster from starting a further cycle until the bi-metal has regained the correct position for beginning again. The feature is called the "Hold Off Latch." After operation of the trip button, the elements do not glow immediately after loading with fresh pieces of bread; this is due to the operation of the hold off latch.



BROWNING CONTROL

The browning control knob permits the selection of lighter or darker toast. The setting will naturally depend on whether white or brown bread is used and also on how new it is.

REFLECTORS

Behind each element is an aluminium reflector which reflects the radiant heat and provides a thermally insulating blanket of still air.

CRUMB TRAY

The crumb tray is of double construction, comprising the crumb tray and a table shield, which is spaced from it. This spacing allows a cooling draught of air to flow between the two portions and cools the lower one, thus reducing the risk of damage to a table or tray surface.

1—TEST EQUIPMENT

The following equipment is essential for the correct servicing of the Morphy-Richards automatic toasters: (1) stop watch; (2) voltmeter of appropriate ranges; (3) series resistance, 11 amp rating 4 ohms; (4) pliers; (5) screwdriver; (6) feeler gauges; (7) Bostik C. cement or similar adhesive.

A supply voltage up to 250 volts will also be necessary, as toasters are made in the following ranges: 110-120v., 200-215v., 220-235v., and 240-250v. The following colour code is employed to differentiate between the various timers and elements: 110-120v., blue element and green timer; 200-215v., yellow element and timer; 220-235v., blue element and timer; 240-250v., red element and timer.

Important.—Each of the upper voltage ranges employs different elements and timers. Use of the wrong type will lead to burnt or underdone toast.

The 110-120v. toaster has its own timer but uses 220/235v. elements connected in parallel.

The colours are marked on the timer bases and the front of the elements.

2—TESTING AND STRIPPING

First check whether—

(i) The toaster is the correct model for the supply.

(ii) The plug is wired correctly.

Mechanical faults—

(iii) Remove the cowl in the following manner: (a) Provide a felt pad, or old blanket, which will not damage the chromium plating; (b) Slacken the grub screw in the moving handle and remove handle (32233) from handle bracket. A fibre roller is fitted in a slot in the handle bracket. Its purpose is to centralise the handle bracket and prevent metal to metal scraping; (c) pull off the numbered control knob (32236); (d) turn the toaster over on the felt pad and remove the four retaining screws (20269). These are the outer ones and not those covered by the cork feet; (e) now turn the toaster the right way up and raise the cowl 1 inch at the cord entry end. Push it gently forward to provide clearance for the cowl lip at the timer end. Look through the toast slots and steer the cowl corner past timer mechanism. Do not force the cowl as the timer contacts can be easily damaged during removal. (f) Place the cowl in a safe position to avoid damage.

iv) Your customers complaint should now give you a lead but it is always advisable to check completely to ensure that every fault is removed, so carry out the following mechanical checks.

(v) Engage main contacts by depressing loading arm (32457—TA/1) (32800—TA/1B). They should both make and have a pressure of about 5 oz. If either side does not make good contact, give it the necessary set down. As the contact bar is of nickel this can be done quite easily by the fingers.

(vi) On model TA/1 examine the handle bracket bearings (32407) and tighten if loose.

(vii) On models TA/1 and TA/1B if the handle bracket is out of shape, straighten by means of a pair of pliers, and examine for loose screws or parted welds.

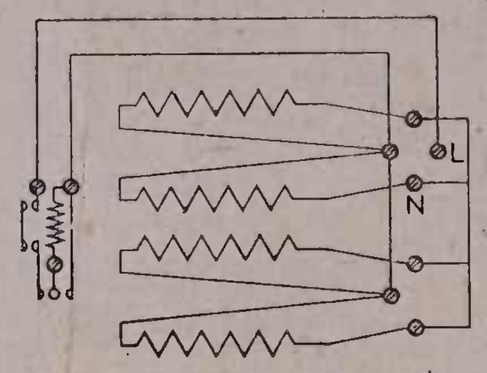
(viii) Check that the channel arm (32405—TA/1) (32805—TA/1B) is free to move centrally in its slot. If it should be scraping the reflectors, check that reflectors are flat.

ix) Toasters manufactured before September 1949, prefix serial BB to BJ were not provided with cross frame bracing. Due to extremely rough handling it is possible for the frame to shift backward or forwards from the perpendicular. If this has occurred the loading arm may not be making contact with the relay arm on the timer. The main contacts may not make or the reset wire on the timer fall under the reset peg on the loading arm (32457).

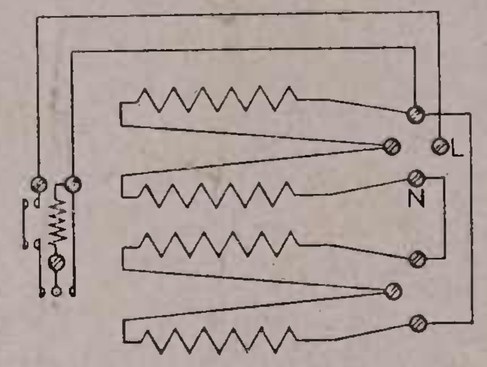
Electrical faults—

(x) Having carried out a mechanical examination proceed to check the electrical circuits. Plug into the appropriate supply voltage, set browning control at 3½, switch on, and adjust by means of a series resistance to a voltage in the middle of the range.

(xi) If any of the elements do not glow, one of them may be open circuited, as toaster elements above 200 volts are connected in series in each toasting chamber, failure of one element will cause both elements in a



Schematic wiring diagram for Toaster 'L' Range.
100 Volt Ranges



Schematic wiring diagram for Toaster T.H. and 1 Ranges

200 Volt Ranges

chamber not to glow. Disconnect toaster from the mains, test each element for continuity and if a defective element is revealed, remove from toaster by squeezing together both members of the guide wires (32211) and lift clear of slots and press gently upwards to release from top slot. Disconnect failed element from terminals and lift element and its reflector clear. Fit new element well inside the reflector, making sure that it is the correct voltage, as per the following colour: Yellow 200/215v. Blue 220/235v. and 110/120v. Red 240/250v.

(xii) If none of the elements glow, switch off mains, remove base plate from the plastic moulding at the cord entry end, switch on the mains and by means of a suitable voltmeter, check if the supply is reaching the toaster terminals.

(xiii) Having checked that the supply reaches the toaster terminals, switch off and by means of a suitably insulated piece of wire, short-circuit the two leads between the terminal base and the timer. Switch on and note if elements glow, if they do, the timer is at fault.

(xiv) If the fault is in the timer, switch off the mains, check that both main contacts are making and free from dirt, etc., switch on. If still no current, disconnect mains connections. Remove timer complete with moulding from the toaster frame by removing two 4BA screws from the underside. The timer can now be lifted clear.

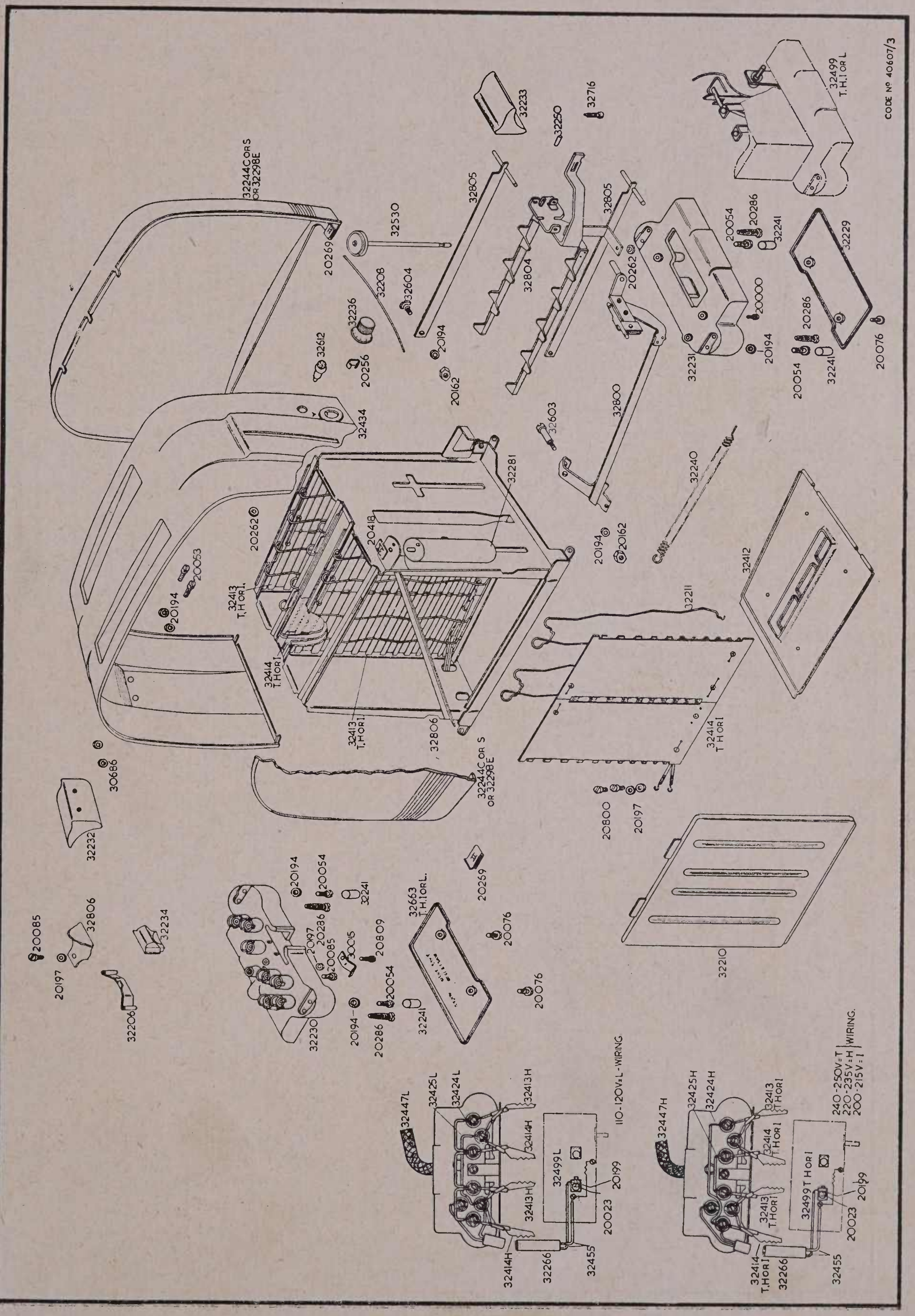
(xv)Starting from cold, depress the loading arm until it engages with the timer. Time the toasting cycle and ensure that the correct voltage is employed throughout the timing.

The toaster should switch off between 2 min. 20 seconds and 3 mins. 10 seconds, starting from cold when browning control is set at 3..

If the timer is defective refer to section 4.

Note:—On opposite page, exploded view of the Toaster, showing the stock numbers of all parts.

(To be concluded.)


CODE Nº 40607/3
32244C OR S OR 3229BE
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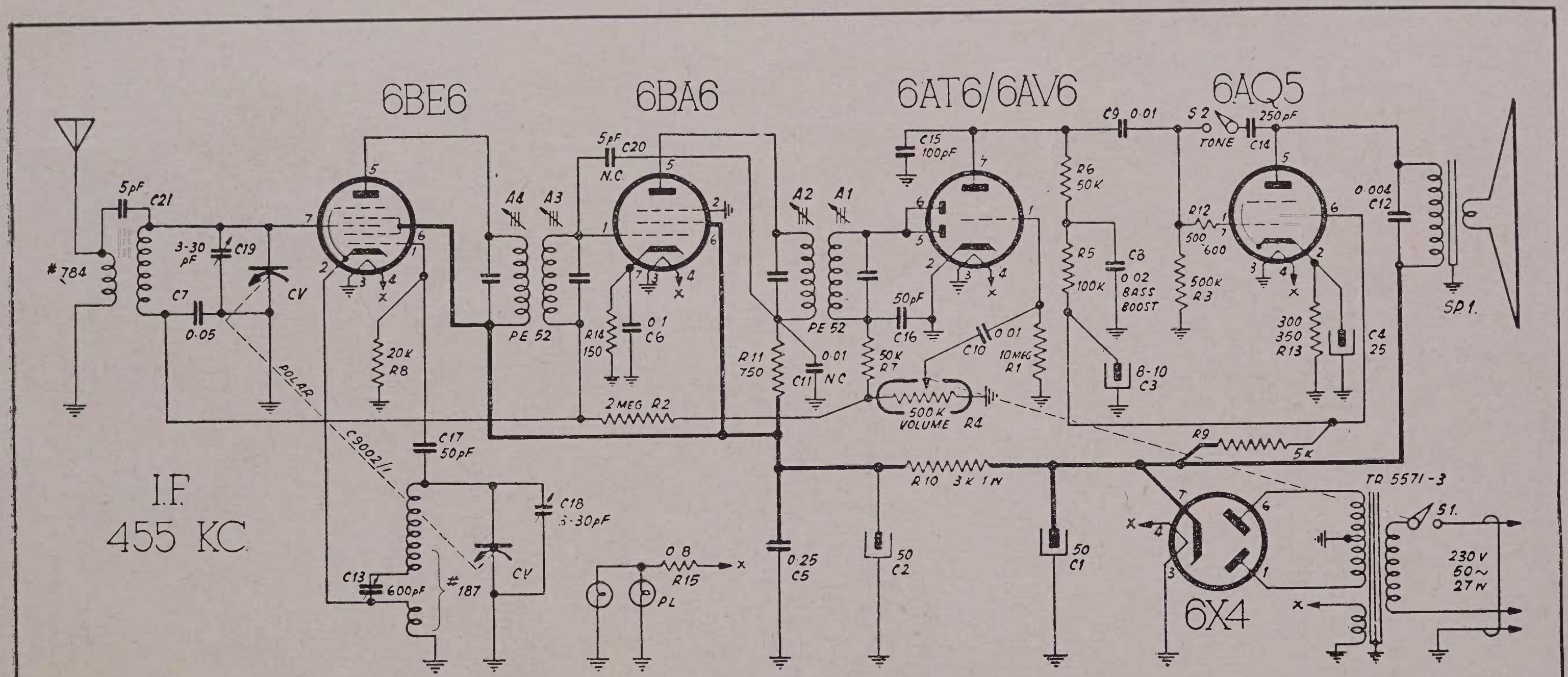
32241
20000
20194
32231
20054
20286
32241
32229
20076
32434
32281
20262
20418
20053
20194
32413 T.H OR L.
32414 T.HORI
32603
32800
32240
20194
20162
32211
32412
32413 T.HORI
32806
32244C OR S OR 3229BE
20085
20197
32806
32232
30686
32234
32206
20085
20194
20054
20286
20097
20085
30015
32241
20809
20194
20286
20054
32241
32230
32663 T.H.1 OR L.
20269
20076
20076
20800
20197
32414 T HORI
32210
-WIRING
32447L
32425L
32424L
32413H
32414H
32413H
32499L
20199
20023
32414H
32266
32455
110-120V=L-WIRING
32447H
32425H
32424H
32413 T.HORI
32414 T.HORI
32413 T.HORI
32499T HORI
32414 T.HORI
32266
32455
20023
20199
240-250V=T
220-235V=H
200-215V=I
WIRING.

GULBRANSEN MODEL 5152



SCHEMATIC DIAGRAM MODEL 5152

VOLTAGE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
Conv.	6BE6	—2	0	—	6.25 ac	100	100	0	—
I.F.	6BA6	0	—	—	,,	95	100	1.7	—
Det-A.F.	6AV6	0	—	—	,,	0	0	80V	—
Output	6AQ5	0	7.5	—	,,	158	155	0	—
Rect	6X4	150 ac	—	—	,,	—	150 ac	168	—

RESISTANCE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
Conv.	6BE6	20K	0.25	—	—	500K	500K	2.5 meg	—
I.F.	6BA6	2.5 meg	—	—	—	500K	500K	150	—
Det-A.F.	6AT6	10 ,,	—	—	—	550K	550K	650K	—
Output	6AQ5	500K	300	—	—	500K	500K	500K	—
Rect.	6X4	200	—	—	—	—	200	500K	—

1. D.C. voltage measurements are at 2,000 ohms per volt—A.C. voltage measured at 1,000 ohms per volt.
2. Socket connections are shown as bottom views.
3. Measured values are from socket pin to common negative (chassis).
4. Nominal tolerance on component values make possible a variation of + 10% in voltage and resistance readings.
5. Volume control at maximum, no signal applied for voltage measurements.
6. Resistance readings in B+ circuits may vary widely according to the condition of filter capacitors.

Trade Winds

WHAT DO YOU WANT OF LIFE?

This is the arresting title of the attractive leaflet produced by the N.Z. Radio Traders' Federation and the N.Z. Radio and Television Manufacturers Federation. Intended to attract youths leaving school to enter these fascinating fields of radio and electronics on both the technical and the sales side, the leaflet describes the opportunities available to those with an eye to well paid jobs in the future. 25,000 of these leaflets have been distributed throughout N.Z., and we hope that, by this means, the industry can be assured of a regular intake of enthusiastic young men who, in future years, will do more than maintain the high standards for which the industry is renowned.

N.Z. RADIO TRADERS' FEDERATION

The Annual Conference of the N.Z. Radio Traders' Federation will be held in Wellington, on Tuesday and Wednesday 25th and 26th May, when it is hoped to welcome a large number of delegates from all districts.

The remits received should promote useful and stimulating discussion and interchange of ideas and opinions. Needless to say, the Wellington Branch has an interesting entertainment programme well in hand.

WELLINGTON RADIO TRADERS' ASSOCIATION

At the last meeting of the Wellington Radio Traders' Association, plans were put in hand for the entertainment of visiting delegates during the Annual Conference of the N.Z. Radio Traders' Federation to be held in Wellington on 25th and 26th May.

Approval was given to three remits to Conference, concerning the present situation with regard to the supply of condensers, improvements to the quality of locally made dry cell batteries, and an alteration to the rules of the N.Z. Radio Traders' Federation to permit the Immediate Past President to vote at meetings of the Federation Executive.

Suggestions were also made with a view to improving the present syllabus and increasing attendances at the Television Courses provided by the Wellington Technical College. It was felt that the exclusion of Friday evenings and a later starting hour of classes would be helpful, that greater emphasis should be placed on the practical rather than highly theoretical training, and that greater publicity should be given to details of the course and the work of the Technical College in this respect.

* * *

ELECTRIC UTILITIES

Electric Utilities Ltd. announces that it manufactures tubular elements in copper, "Iconie," "Alumbro" and mild steel for all types of heating, including water, air, acids and oil.

Improved methods of manufacture in collaboration with overseas factories have resulted in better insulation being assured, and consequently, the improvement in the life of the product.

Mr. J. Nicholson, Managing Director of the Company, on a recent trip to England, the Continent and the U.S.A. studied methods of manufacture in these countries, and on his return ordered plant and re-organized production methods incorporating the best principles seen in the various plants visited.

* * *

T.V. CORRESPONDENCE COURSES

Some time ago an announcement appeared in our journal concerning the possibility of the establishment of a correspondence course in television which would allow country servicemen to take advantage of the tuition at present being given to their city counterparts at the Seddon Memorial Technical College.

Now, we are advised by the N.Z. Radio-Television and Electrical Traders' Association (Inc.) that the Director of Education, in conjunction with the Principal of the S.M.T.C., is seriously considering the establishment of such a correspondence course, and that a decision concerning the practicability or otherwise of such a scheme will be announced shortly.

According to Mr. R. Waddell, the TV Instructor at the S.M.T.C., the proposed course is quite practical for a limited number of pupils.

The N.Z. Radio-Television and Electrical Traders' Association (Inc.) therefore, desires to thank all those who have expressed their interest in this scheme, and advises that the latter will be informed of further developments as soon as possible.

* * *

NEW COSMOCORD REPRESENTATIVE

During his recent visit to N.Z., Mr. Schumann, Director of Cosmocord Ltd., Enfield, Middlesex, appointed David J. Reid of 271 Victoria Street West, Auckland, sole New Zealand Factory Representative for his Company. All future enquiries for the well-known ACOS lines should be forwarded to David J. Reid.

* * *

INDUCTANCE SPECIALISTS INTERIM CATALOGUE

Inductance Specialists Ltd., announce the publication of their 1954 Interim Catalogue of "Q" Components. Copies may be obtained from Inductance Specialists Ltd., of 157 Thorndon Quay, Wellington, N.I.

* * *

NEECO EXECUTIVES CONFER

Gathered in Wellington recently for their half-yearly conference were the managers of Neeco branches in the four main centres.

Present were Messrs. E. N. Tewsley (Auckland), K. S. Donovan (Wellington), J. Cunningham (Christchurch), and D. H. Shortt (Dunedin).

The conference was opened by Mr. C. E. Fuller, Director and General Manager, in his capacity as chairman, and others who attended were Messrs. J. G. Ritchie (Secretary), P. D. England (Sales Manager), N. H. Matthews (Advertising Manager), P.B. Tucker (Radio Manager), F. K. Garry, S. C. MacDiarmid, and P. C. Weston, executive engineering staff.

OBITUARY

MR. B. T. GILES

The whole of the radio and electrical industry throughout N.Z. has been deeply shocked by the untimely death of one of its foremost leaders, Mr. B. T. Giles, in the tragic Singapore air disaster last March.

One of New Zealand's distinguished Naval Officers, and a prominent Wellington business man, Mr. Giles, with his enquiring mind, tremendous vitality and unflagging enthusiasm and energy, had quickly won renown for himself as one of the foremost leaders in industrial research in this country. Only in December last we had the honour of reporting his discovery in New Zealand of valuable Perlite deposits with their subsequent important industrial implications.

Though educated in Nelson and Westport, Mr. Giles was a Wellingtonian by birth, and later returned to his native city where he trained first with the Post and Telegraph Department, and later with two well-known commercial firms. In 1938, with Mr. K. L. Elliott he founded the now well-known firm of Giles and Elliott Ltd.

As a lieutenant in the R.N.Z.V.R. at the outbreak of World War II, Mr. Giles proceeded to Britain where he was engaged on secret radar research, one of his major tasks being that of assisting in the design of radar equipment for destroyers and other small craft.

During the latter part of the War, with the rank of Commander, he served in the Pacific and then in Washington as N.Z. Naval Attache.

On returning to civilian life and business once more, Mr. Giles devoted much time to research into heat insulation, which led to his discovery last October of Perlite deposits in N.Z.

For his family, the tragedy is a double one, in that Mrs. Giles also perished with her husband. We know that we speak for the whole of the radio and electrical industry throughout N.Z. when we express our deepest sympathy to Mr. and Mrs. Giles' two young sons and respective families.

A bed's best friend

Cosicover

All-Wool Electric Blanket

The COSICOVER Electric Blanket is the perfect example of the "warmth without weight" ideal. Its initial cost is not great, and savings on future blanket purchases are considerable. Then, the COSICOVER itself is ALL PURE WOOL and can be laundered on removal of the heating pad. Single and double bed sizes available, both guaranteed 12 months. The COSICOVER has an enormous sales potential. Just display it on your counter. The weather will do the rest.

Further information from

THE **NATIONAL** NEECO **ELECTRICAL**

AND ENGINEERING COMPANY LIMITED

Auckland, Wellington, Christchurch, Dunedin, Hamilton
Wanganui, Hastings, Invercargill

PERSONALITIES

March 17th saw Mr. Tasman A. Smith of Direct Imports Ltd., Hastings, winging his way to Canada en route to the Netherlands and the Hanover Trade Fair in Germany. Also on his itinerary is a visit to the British Industries Fair and his firm's principals in the U.K. Homeward bound, his three months' trip will be concluded with some calls in the U.S.A.

* * *

Following the call of business—or is it just "itchy feet"—many of New Zealand's leading personalities in the Radio and Electrical fields seem to be travelling overseas these days.

March saw the departure of Mr. Clifton Lewis of Radio (1936) Ltd., Auckland, for a brief overseas visit, while Mr. J. Wyness, energetic Managing Director of H.M.V. (N.Z.) Ltd., departed these shores in April, bound for Britain. The travel bug has also bitten Mr. H. Brown of Loudspeakers Ltd., Wellington, who has recently been paying a visit to his firm's principals' the Rola Co. (Aust.) Pty Ltd., of Melbourne.

* * *

DAVID J. REID

Readers will have noted with interest the announcement elsewhere in this issue of the appointment of David J. Reid of Auckland as sole New Zealand Factory Representative for Cosmocord Ltd., of Middlesex, England. For many years Dave Reid has been well known in the radio and electrical fields in Auckland, having been a most successful and popular manager for the Auckland Branch of the Swan Electric Co. Ltd., since the inception of that company until the retirement of Mr. Swann. Since then, Dave been in business on his own and has acquired some valuable agencies in radio and other fields. His outstanding personality and likeable character have quickly assured him of a leading place in radio and electrical spheres in Auckland, and the good wishes of the trade go with him in this latest appointment.

CLASSIFIED ADVERTISEMENTS

FOR SALE

LEAK OUTPUT TRANSFORMER, primary impedance 5,000Ω; load impedance 1Ω, 4Ω, 9Ω, 16Ω. In brand new condition. What offers? Write R. Isles, 22 Ashridge Road, Napier.

FOR SALE.—Together or separately, two GOODMANS AXION 80 SPEAKERS. One 15, one 3.5 ohms. These speakers are designed for high-fidelity reproduction using small infinite baffle. Stated response, 20 to 20,000 c/sec. Reply, "SPEAKER," c/o "R. & E."

NEWS FROM GOVERNMENT DEPARTMENTS

One of the most important telecommunications groups to visit New Zealand in recent years was the Commonwealth Telecommunications Board under the Chairmanship of Sir Stanley Angwin. The Board visited Wellington and Auckland during the first half of April.

The Board, which normally sits in London, was set up in 1948 to direct and co-ordinate Commonwealth telecommunications development, and has carried out this duty most successfully. No one would question the vital need for strong communications links between countries of the Commonwealth in peace and war, and for this reason co-ordination is of the utmost necessity.

Sir Stanley Angwin, K.B.E., D.S.O., M.C., T.D., D.Sc. (Eng.), M.I.C.E., M.I.E.E., the Chairman of the Board, is one of the telecommunications outstanding men of this century. He became Assistant Engineer-in-Chief of the British Post Office in 1932; Deputy Engineer-in-Chief in 1935; and Engineer-in-Chief in 1939. During his period of high office in the Post Office many of the most important technical developments took place. It was under his direction that the radio section developed equipment for short-wave radio-telephony and built up the multiplicity of overseas radio services which has given Great Britain a predominating position in world telephony.

Other advances which he directed included the adoption of the coaxial cable system as a normal method of providing trunk-line communications, "two-voice" frequency signalling between zone centres and the use of submerged repeaters on submarine telephone cables.

Sir Stanley was knighted in 1941 and received the K.B.E. in 1945. In 1947 he was made a Fellow of Queen Mary College, and in 1953 the Honorary Degree of Doctor of Science (Engineering) was conferred upon him by the University of London. Sir Stanley is a Member of the Institutions of Civil and Electrical Engineers; he was president of the L.E.E. in 1943-44, and was awarded the Faraday Medal in 1953. (Lord Rutherford, of Nelson, New Zealand, was a Faraday Medallist.)

One of the most important questions discussed by the Board while in Wellington was the proposal to build a new radio transmitting and receiving station at Vancouver to provide direct radio-telephone and radio-telegraph service between Canada and New Zealand and Canada and Australia. It was hoped that the Canada-Australia service would be ready for the 1956 Olympic Games in Melbourne. Construction of this radio station would mean the installation in New Zealand of additional radio equipment at the newly opened Himatangi Radio transmitting station.

The New Zealand Post Office's next main inland telecommunications advance is the projected use of coaxial cable. An order for 82 miles of cable for laying between Hamilton and Auckland has just been placed. The cable will be a four-tube one with 56 subsidiary circuits to surrounding intermediate centres. One pair of tubes will be able to provide 960 toll channels. One toll channel can provide 24 voice-frequency telegraph channels.

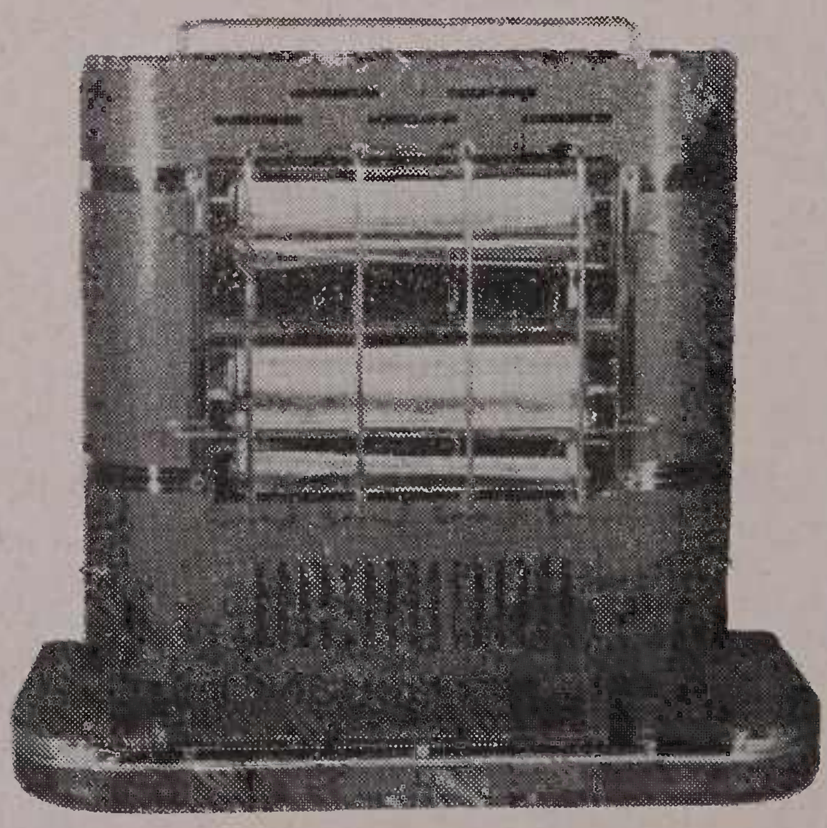
With every increase in the number of telephone users, a greater demand is made on toll services. To meet this demand, the Post Office is engaged on three main developments. The first is a four-hop radio link from Wellington to Christchurch which will give another 24 channels. The second is voice-frequency direct dialling. This enables a toll operator in one town to dial direct the person wanted in another town and so saves line time. This is already in use between most centres. The third and most important development is the projected use of coaxial cable. A possible future development is the use of micro-wave radio relay systems.

"R & E" TECHNICAL PHOTOGRAPHS

Copies of original designs produced in our laboratory and featured in these pages are available. Prices are: Size 6 in. x 4 in. 3s. 6d; 8 in. x 6 in. 4s. 6d; 10 in. x 8 in. 5s. 6d. Please remit cash with order to RADIO and ELECTRONICS (N.Z.) LTD., P. O. Box 8022, Wellington, New Zealand.

EDINBURGH
Electric Radiator
ANOTHER PANAMA PRODUCT

★ Two 10-inch bars
★ Individual Switching
★ Red Glow Visible at Base
★ Louvres for Heat Dissipation
★ Crackle Finish
★ Chromium Trimmings
★ Easily Portable



Available from

CORY-WRIGHT and SALMON LTD. WELLINGTON

It Catches the Eye of Passers-By

H. M. V. HEAT CONTROLLED IRON

Here's a sales prospect customers WILL LOOK OVER with more than casual interest and which retailers cannot OVERLOOK to stock! The H.M.V. No 5 Iron is a lightweight, cleverly designed iron that is thermostatically heat-controlled for complete safety, selecting at the turn of a dial just the right temperature for ironing rayon, silk, cotton, or linen. The bakelite handle is heat-resistant and heat-insulating . . . the soleplate is untarnishable . . . uniform ironing is assured . . . and ironing around and over buckles, buttons, pleats, etc., is made easy by the iron's shape. It's H.M.V., so it must be good—a good seller and a good product!

MAKE INQUIRIES NOW TO:

HIS MASTERS VOICE (N.Z.) LTD.

BOX 296, WELLINGTON

WANT ACCURACY?

DON'T GUESS . . BE SURE!

Tape rules are fine for dressmakers; and we have noticed that surveyors, hop-step-and-jump judges, and well-diggers use them, too. But when it comes to tiddly little screws and such-like pieces of fine production, you want real accuracy. If *you* have a manufacturing problem—say 50,000 component parts machinable from bar stock—each one exactly the same as t'other—get in touch with us and we'll get our micrometers and automatic lathes at the ready.

AUTO MACHINE MANUFACTURING COMPANY LIMITED

18-20 NELSON STREET, AUCKLAND, C.1.

P.O. Box 179. Telephone 31-638 (3 lines). Telegrams: "Auto."

NEW ZEALAND EASTER SHOW

The great Easter Show is over, and Aucklanders and all visitors to that fair city have gained some appreciation of the solid foundations upon which the economy of our country is built—namely, its agriculture and its industries.

With much business to be done in Auckland, our reporter had time for only the briefest glimpse of this magnificent show, but a review of some of the stands relating to the radio and electrical industry was published in our April number. Elsewhere in this May issue appears a report on one of the principal highlights—the impressive Pye TV demonstration.

In the way of novelties and real economizers, however, mention must be made of the "Solight" range of products manufactured by Appliance Distributors Ltd., of Auckland. This comprises the "Solight" Oven, the "Mealmaster," which is a unit with two standard hotplates, warming compartment, and "Solight" oven and the new "Solight" domestic stove. Though of conventional outward appearance, this stove, fitted with three standard hotplates in the porcelain enamel top, has a truly revolutionary oven, heated only by four 200-watt lamps. Its manufacturers claim that it will cook anything in the same time as the ordinary open element type of stove of 3,000 watts. Though the stove has a maximum loading of 5,400 watts, the oven consumes only 800, and, with such perfect cooking results and the great saving in power costs, this stove is assured of a warm welcome from New Zeauand housewives.

BINDERS FOR "R. & E."

These are available to hold 12 issues—price 5s. 6d.
Available from our Office, P.O. Box 8022, Wellington

BACK NUMBERS OF "R. & E."

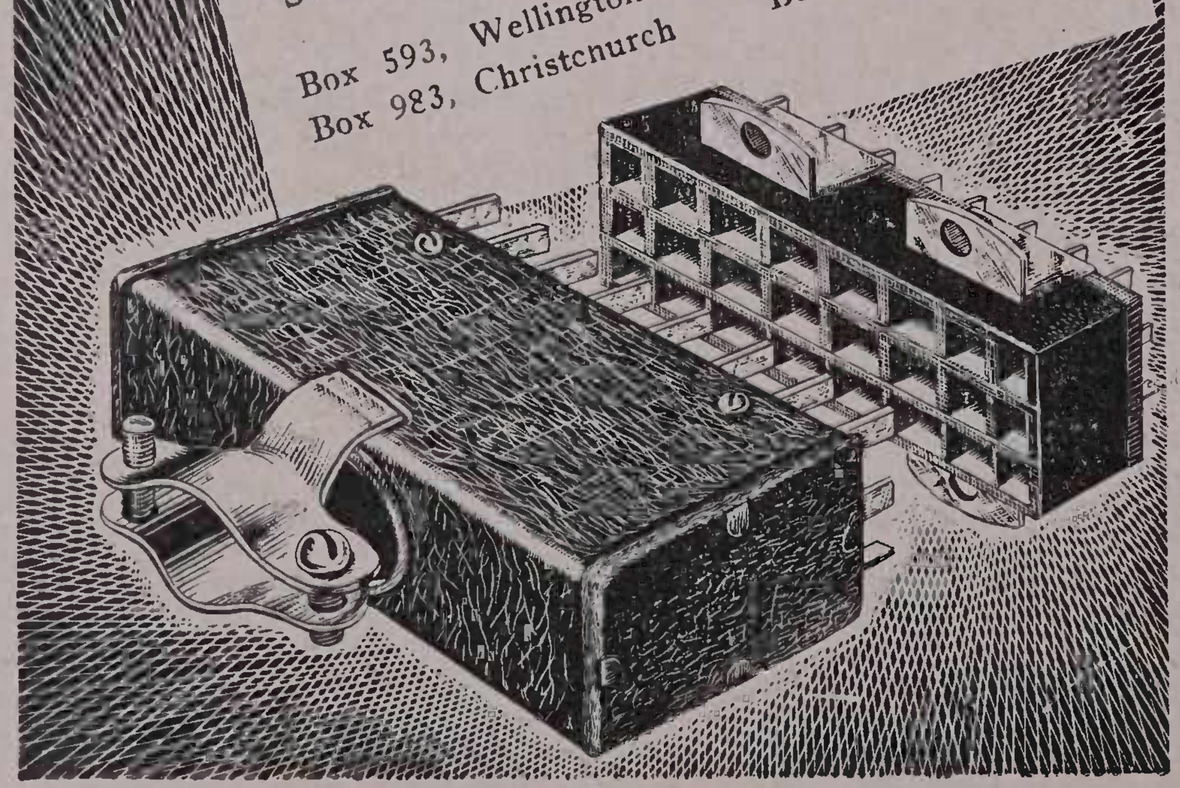
Available from our Office,
P.O. Box 8022, Wellington.

PAINTON
a name Synonymous with
PLUGS and SOCKETS

Sole N.Z. STC Agents

STANDARD TELEPHONES & CABLES PTY. LTD.

Box 593, Wellington
Box 983, Christchurch
Box 571, Auckland
Box 293, Wanganui



Styled for the times!

"FLAMBEAU" Lamp Bracket. Projection 6½ ins. Overall height, including glassware and lampholder, 17 ins. In Bronze or Pewter.

- EVERLASTING
- WILL NOT RUST.
- ONE OF OUR RANGE OF WEATHER-PROOF LIGHTING FIXTURES.

RETAIL PRICE, .63s. 9d.

FROM YOUR WHOLESALE ELECTRICAL MERCHANT

A
ROBAT
PRODUCT

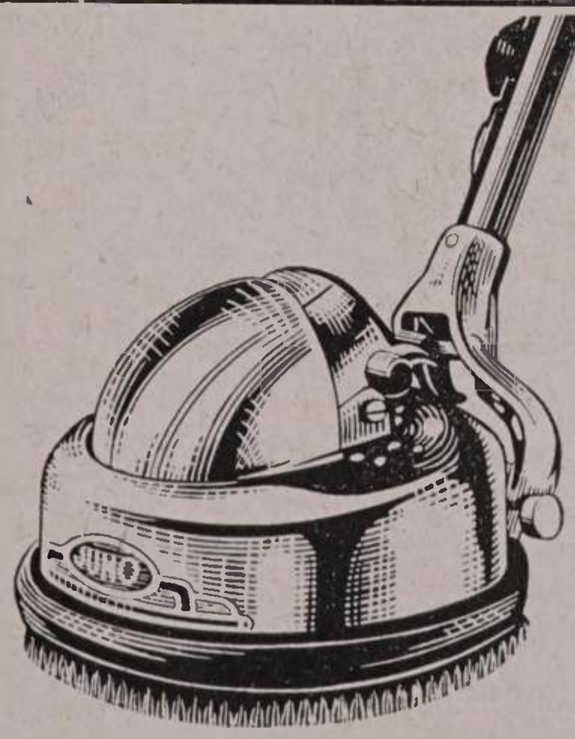
ROBERTSON and BATCHELOR LTD.
85 Clarence Road, Christchurch

New Zealand Agents:

E.M.I. SUPPLIERS

(Trade Division of H.M.V. (N.Z.) Ltd.)

162-172 WAKEFIELD STREET, WELLINGTON C.P.O. Box 296 Phone 54-890

PRICE  REDUDCED!

Previously priced at £21 - 10 - 0

NOW ONLY £19-19-0

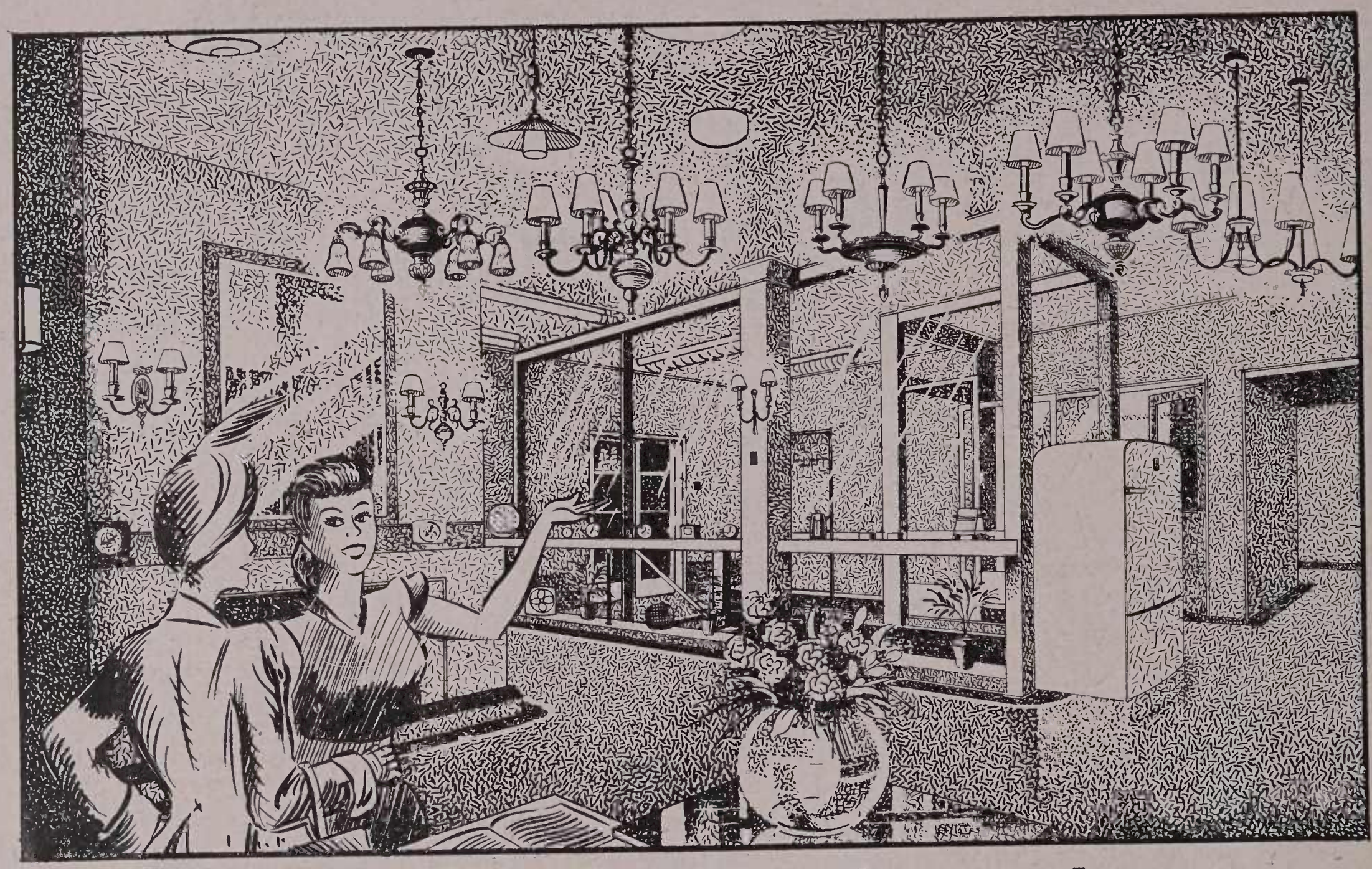
TRUVOX

The World's Finest

FLOOR POLISHER

Truvox, the housewife's answer to lovelier floors with effortless ease has now been reduced in price! £19 19s. is now the cash price for this famous labour-saver, which is used extensively throughout Great Britain, U.S.A., Switzerland, Australia, and other countries. Remember, Truvox is the Floor Polisher with the exclusive safety clutch, already tested and proved in hundreds of New Zealand homes.

Trade Inquiries to New Zealand Representatives: DIRECT IMPORTS (N.Z.) LTD., P.O. Box 72, Hastings



In each of the four main centres — the B.G.E.C. showroom is ★ ★ ★ YOUR SALESROOM ★ ★ ★

You get full profit from your customers' visits to B.G.E.C.

In each of the 4 main centres B.G.E.C. showrooms display G.E.C. electrical appliances and domestic aids. Skilled demonstrators assist and advise your customers. You receive your normal profit from all sales resulting from your introductions. B.G.E.C. showrooms also display a comprehensive range of contemporary and period lighting fittings. The free advice and help of B.G.E.C. illuminating engineers are always available to you or your customers. Your customers' purchases mean more profit for you.

If you have no showroom introduction tickets on hand, it is so easy to obtain a supply.

PIN THIS COUPON TO YOUR BUSINESS LETTERHEAD & MAIL TO YOUR B.G.E.C. OFFICE IN YOUR AREA

BRITISH GENERAL ELECTRIC COMPANY LIMITED

Wellington, Auckland, Christchurch, Dunedin

REPRESENTING THE GENERAL ELECTRIC CO. LTD. OF ENGLAND

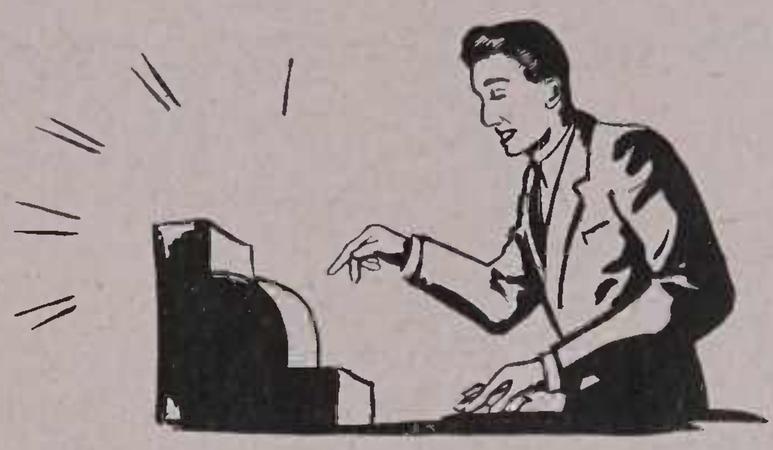
(COUPON) Please supply me with B.G.E.C. Showroom Introduction Tickets (Post to B.G.E.C. with your letterhead)

16 million of these

EVEREADY

TRADE-MARK

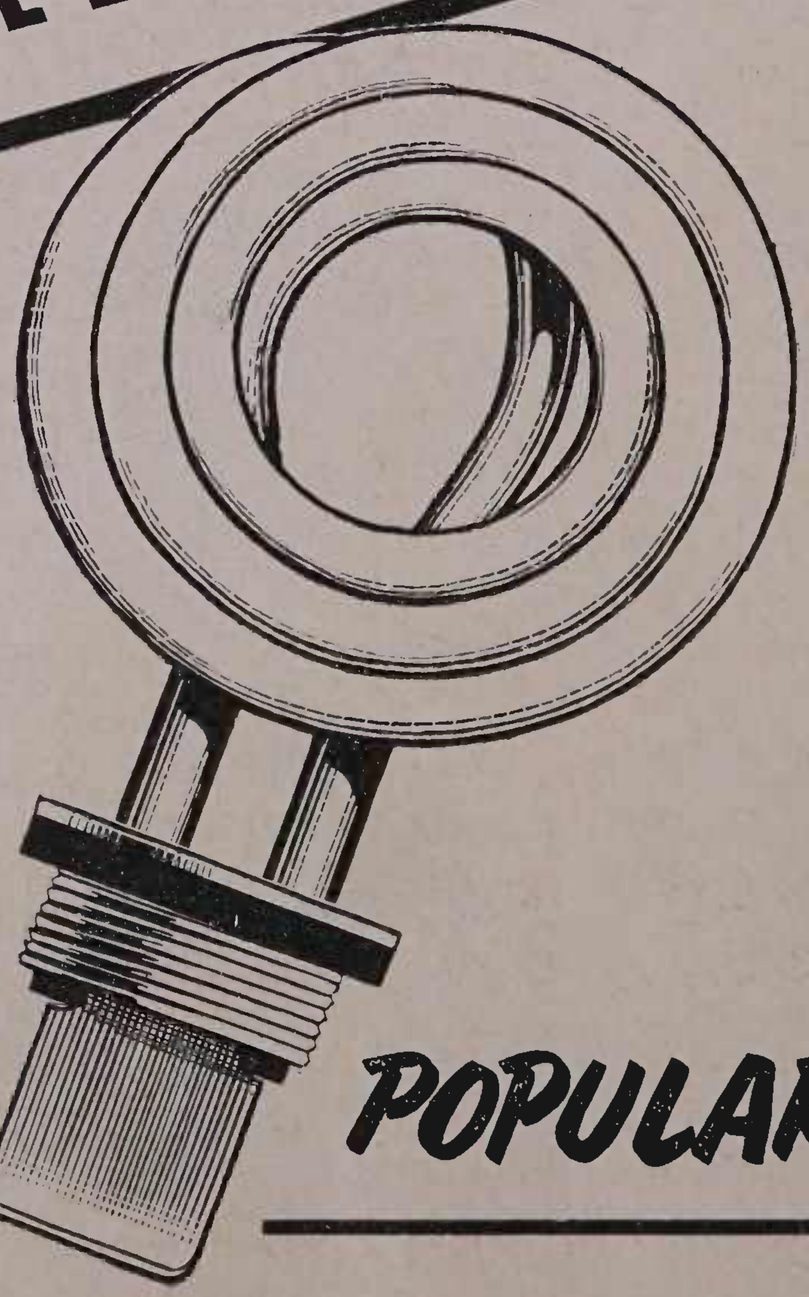
Salesmen on the job for you!



This year's "EVEREADY" advertising campaign is the biggest ever—with a total of 365 insertions of large-space advertisements in newspapers and magazines whose combined circulations total more than one million. This means 16 million impressions of "EVEREADY" advertisements—16 million "EVEREADY" salesmen doing a wonderful job of sales promotion for YOU!

Display and recommend "EVEREADY" Flashlights and Batteries at every opportunity—profit to the full from this sales-promoting publicity.

It pays to stock



- More people ask for EUTRON by name than any other brand. Improved insulation and earthing make EUTRON the safest and most reliable element to recommend.
- Advertised over 11 radio stations throughout New Zealand and sold only through legitimate retailers.

Manufactured by ELECTRIC UTILITIES CO. LTD., 316 Great North Road, Grey Lynn, Auckland, W.2.

(Subsidiary of Nicholson's Holdings Ltd.)

CASH-IN ON EUTRON POPULARITY

MILLIWATT

FOR ELECTRIC PADS AND BLANKETS

They Soothe, Heal, Dry and Comfort

90% OF MIDDLE-AGE ACHES AND PAINS ARE CAUSED THROUGH SLEEPING ON WET BEDS. YOURS IS WET. THE SALT CONTENT OF PERSPIRATION IS LEFT IN THE MATTRESS AND *MUST* ATTRACT MOISTURE FROM THE AIR.

BUY A MILLIWAT BLANKET OR PAD TODAY !
DON'T TAKE THE RISK.

Winter is nearly on us, and chills can lead to death!

ALL MILLIWATT PADS AND BLANKETS ARE PROTECTED BY DUAL THERMOSTATS, AND ARE AVAILABLE IN SINGLE OR CONTROLLED THREE-HEAT.

DOUBLE BLANKETS HAVE DUAL CONTROL

PERFECTLY SAFE

48 in. x 60 in. Single-heat Dual-control Double-bed Blanket
48 in. x 60 in. Three-heat Dual-control Double-bed Blanket
30 in. x 50 in. Single-heat Single-bed Blanket ....
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FULLY GUARANTEED

13¼ in. x 15 in. Single-heat Pad
13¼ in. x 15 in. Three-heat Pad
15 in. x 26 in. Single-heat Pad
15 in. x 26 in. Three-heat Pad
3½ in. x 4 in. Eye and Ear Pad

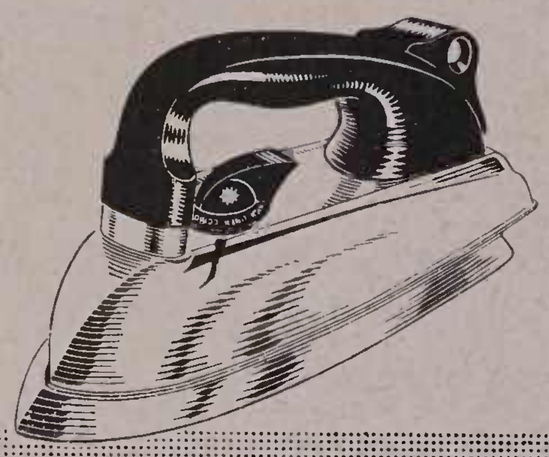
If your radio and electrical dealer or chemist cannot supply, write to
SWAN ELECTRIC CO. LTD.
Master Distributors Offices in Auckland, Wellington and Christchurch.

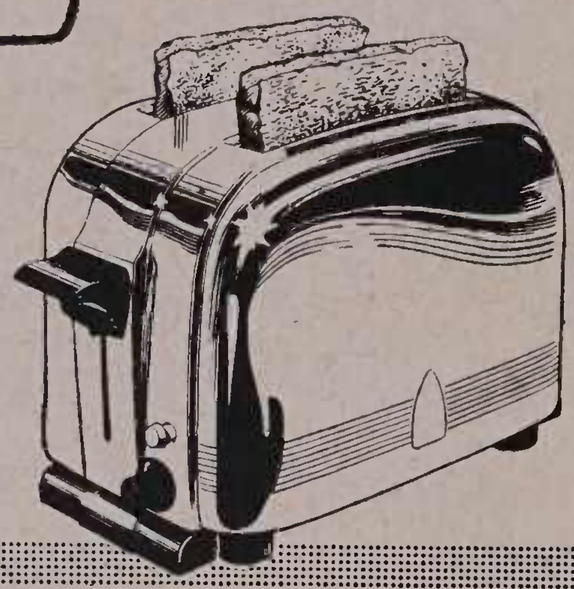
INSIST ON MILLIWATT
DONT TAKE SUBSTITUTES

New Zealand's most popular electrical appliances

MAKES IRONING EASY

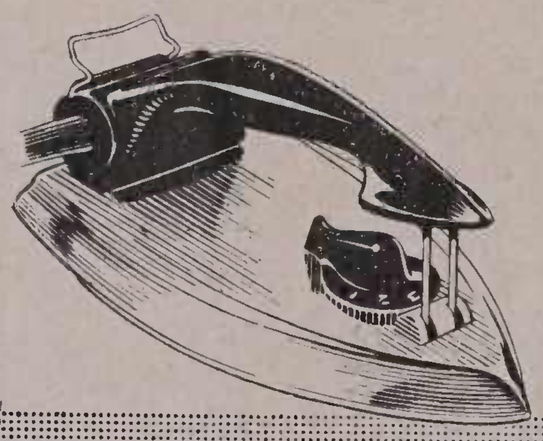
The famous Morphy-Richards automatic electric iron with tell-tale light that prevents scorching. Correct heat for all fabrics. In colours and chrome.





TOASTING MADE EASY

Golden brown toast—exactly as you like it. Toasts two slices, both sides. When ready, toast "pops-up," current cuts out automatically.

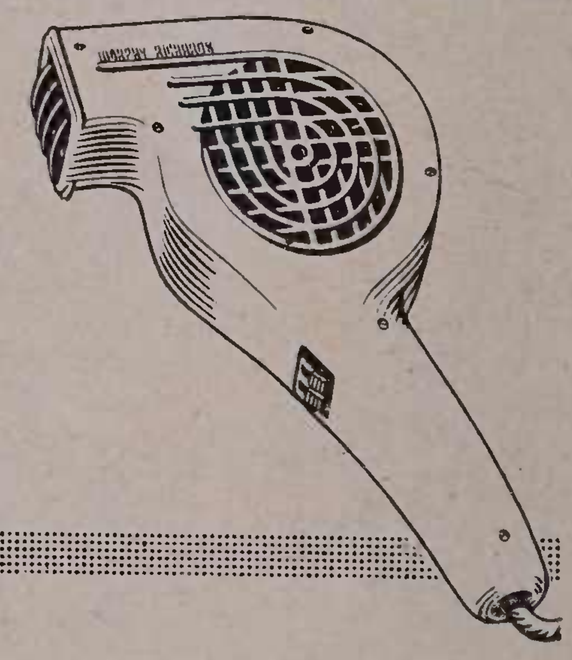


EASY FOR TRAVELLING

The Morphy-Richards Auto-control Travel Iron. Streamlined, light-weight, easy-to-pack. With heat selector dial. A.C. or D.C. current.

HAIR DRYING IS EASY

—with the Morphy-Richards Noiseless Hair-Dryer. Handsome, streamlined design in cream plastic. Blows hot or cold air.



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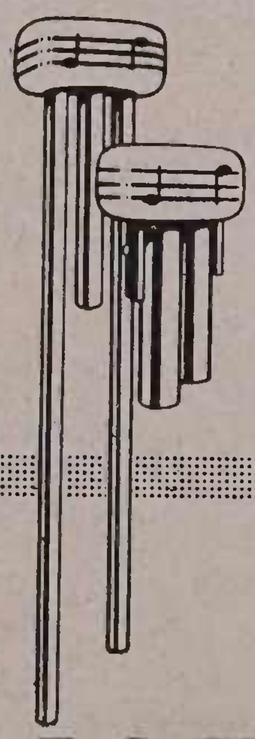
The Morphy-Richards Iron Stand keeps iron out of harm's way—prevents scorching. For all irons.



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Morphy-Richards "Cyldon" Chimes. Various sizes and models. For A.C. current or batteries.

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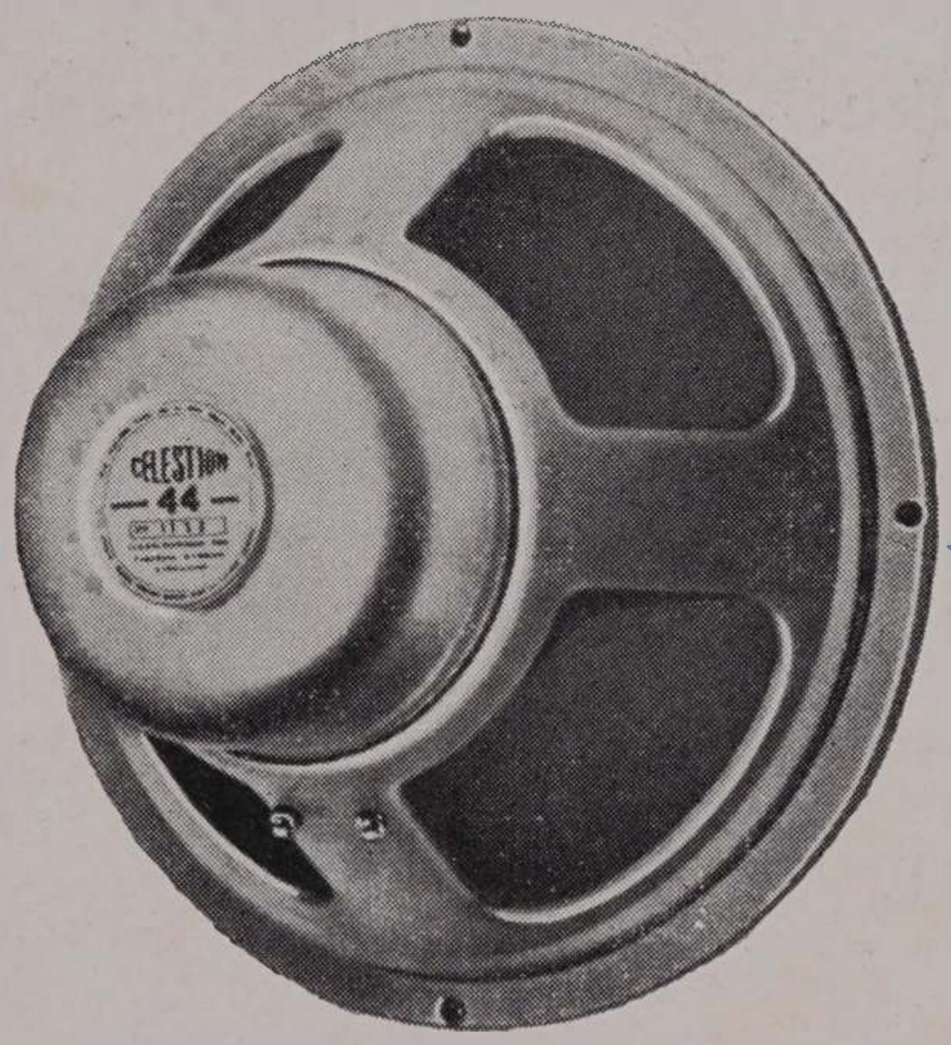

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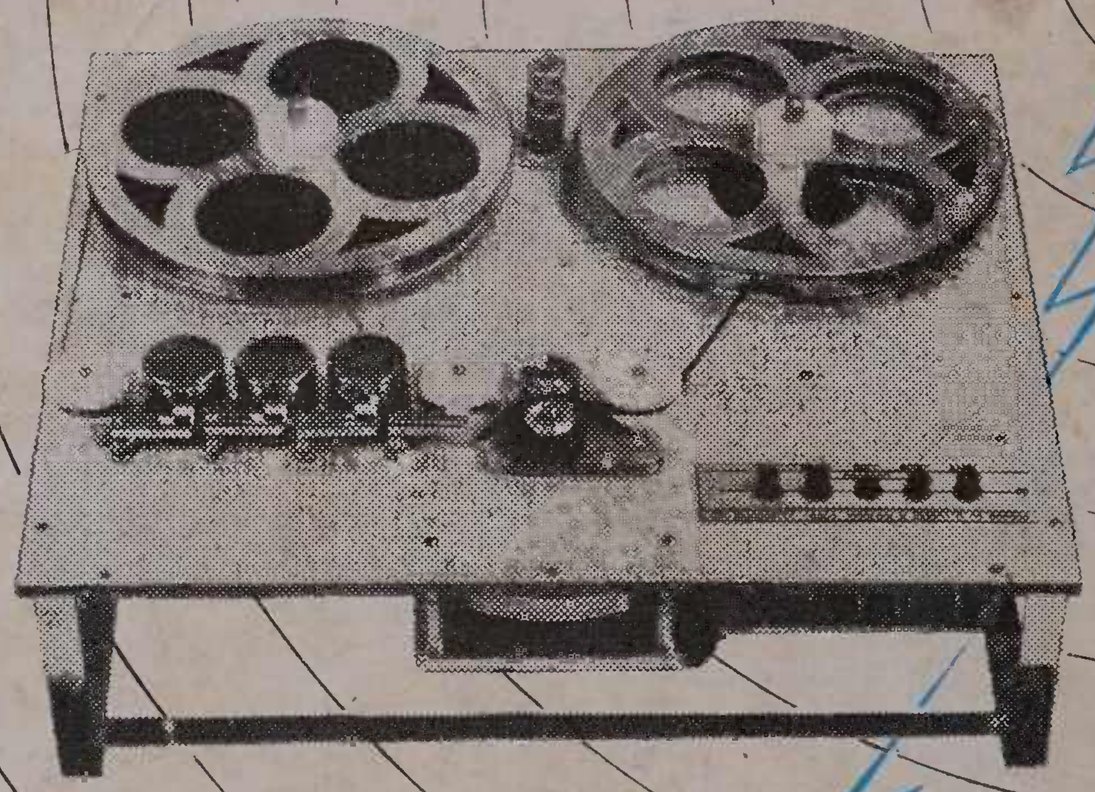
The most outstanding tape recording deck available in New Zealand

MODEL 5

"BRADMASTER"

featuring BRADMATIC High Fidelity Twin Track Sound Heads



Two speeds . . . $3\frac{3}{4}$ and $7\frac{1}{2}$ inches per second. Speeds can be changed while machine is running or stationary. Heavy Alloy flywheels . . . freedom from "wow" and "flutter." Double servo brakes on each hub. Push button control.

Three BRADMATIC Heads for monitoring during recording. Push button withdrawal of Tape Pads and Pinch Roller for easy threading.
Three heavy duty motors . . . 230v. 50 c.p.s.
Hard Scratch-free plastic finish top.
Size: $13\frac{1}{4}$ in. x $15\frac{1}{2}$ in. x $6\frac{1}{4}$ in.
Weight: 17 lb.

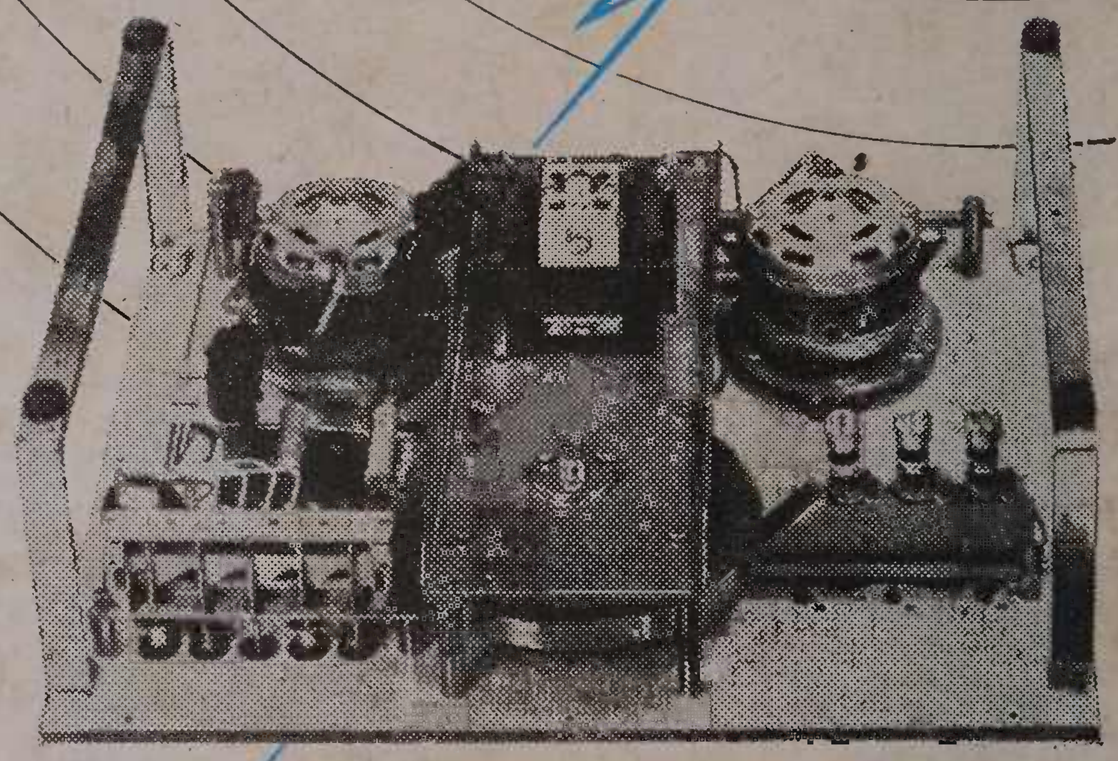
The "Bradmaster" tape deck is easily adjusted for twin track recording . . . heads can be aligned to play tapes recorded on any other make of machine. The machine accommodates standard 7-inch reels (1,200 ft.). If used in conjunction with good amplifiers and with best quality tape, the following frequency response can be obtained.

Tape Speed $7\frac{1}{2}$ in. per sec.—

60– 8,000 C.P.S. plus and minus 4 db.
50–10,000 C.P.S. plus and minus 7 db.
40–11,000 C.P.S. plus and minus 10 db.

Tape Speed $3\frac{3}{4}$ in. per sec. (speech only)—

60–5,000 C.P.S. plus and minus 5 db.
60–6,000 C.P.S. plus and minus 10 db.



Recommended circuits for pre-amplifier, compensation, and bias/erase sections of the electronic equipment are available with each deck if required.

We regret that sterling exchange regulations have limited the supply of BRADMATIC products stocked by our branches. However, for clients who have sterling allocations of their own, we can guarantee prompt delivery.

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