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MARCH, 1958

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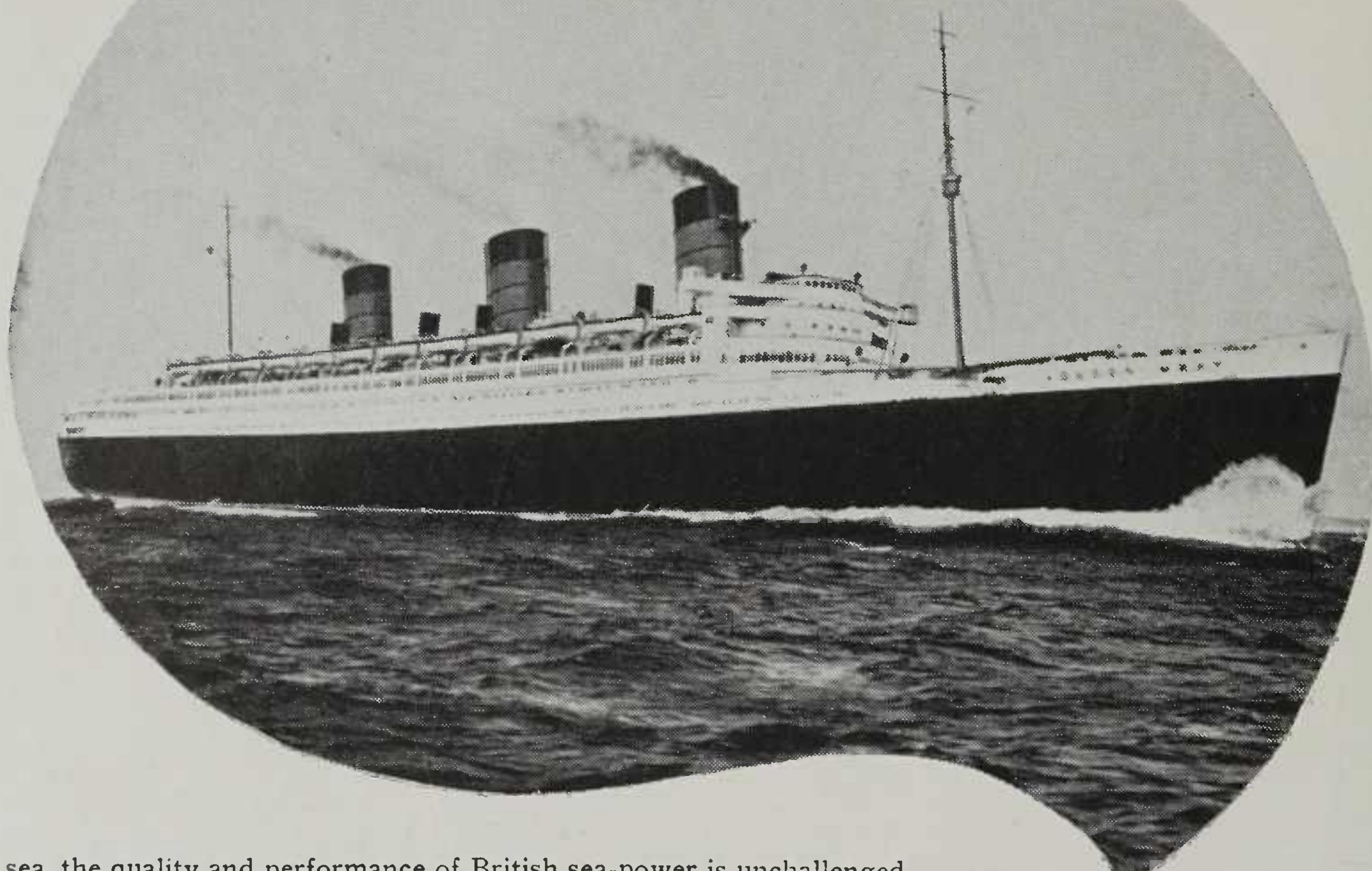
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The New Zealand Radio and Electrical
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Traders' Association (Inc.).

Managing and Technical Director:
W. D. FOSTER, B.Sc.

Subscriptions:
2s. 3d. per copy; 27s. per annum, posted.
Advertising Rates supplied on application.

CORRESPONDENCE

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be addressed to:

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"Radio and Electrical Review"
P.O. Box 6361,
Wellington, New Zealand.

OFFICES AND LABORATORY:
48 Abel Smith Street, Wellington.
Radio and Electronics (N.Z.) Ltd.,
Telephone, Wellington, 50-660.
Telegrams and Cables:
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SOLE ADVERTISING REPRESENTA-
TIVES for THE UNITED KINGDOM:
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Cables: Cowlawads, London.

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MARCH, 1958

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Garth Wilson — A Tribute

It is with deep regret that members of the radio trade throughout New Zealand will have heard of the untimely death of Garth Wilson, at the early age of forty-seven. Garth, who passed away on 24th February, was President of the New Zealand Radio-TV and Electrical Traders' Association (Inc.), and his loss will be especially felt in Auckland, where he has played a most valuable and active part in the affairs of the Association for some years.

More recently, he had played a conspicuous part in the re-unification of the retail traders' organizations throughout the country, and it is very sad that he should not have lived to see this work come to its final fruition, which it is about to do very soon. The Association's latest bulletin had this to say about his work for the trade.

"There can be no doubt that the loss of Garth is going to be very severely felt throughout the trade for a long time to come. He had tremendous plans for the co-ordination of the industry as a whole, both within the Auckland Association's scope, and also on a national basis, and although many of us are aware of what he had in mind it will require someone with an equal amount of initiative, drive, and patient understanding if the good work he started is to reach success."

From this writer's own knowledge of him, these sentiments can only be warmly endorsed, and it is much to be hoped that his sterling work for the trade will be carried on as he would have wished. However, with the excellent start, for which Garth was in no small measure responsible, it seems more than likely that this will come about. His many friends and associates throughout the trade will certainly concur in the many tributes that have already been paid him, and will join with us in adding this small contribution to them. Garth's unfailing energy, kindliness, and sense of fun will be very sadly missed at this year's trade functions, at which in the past he played such an outstanding part.

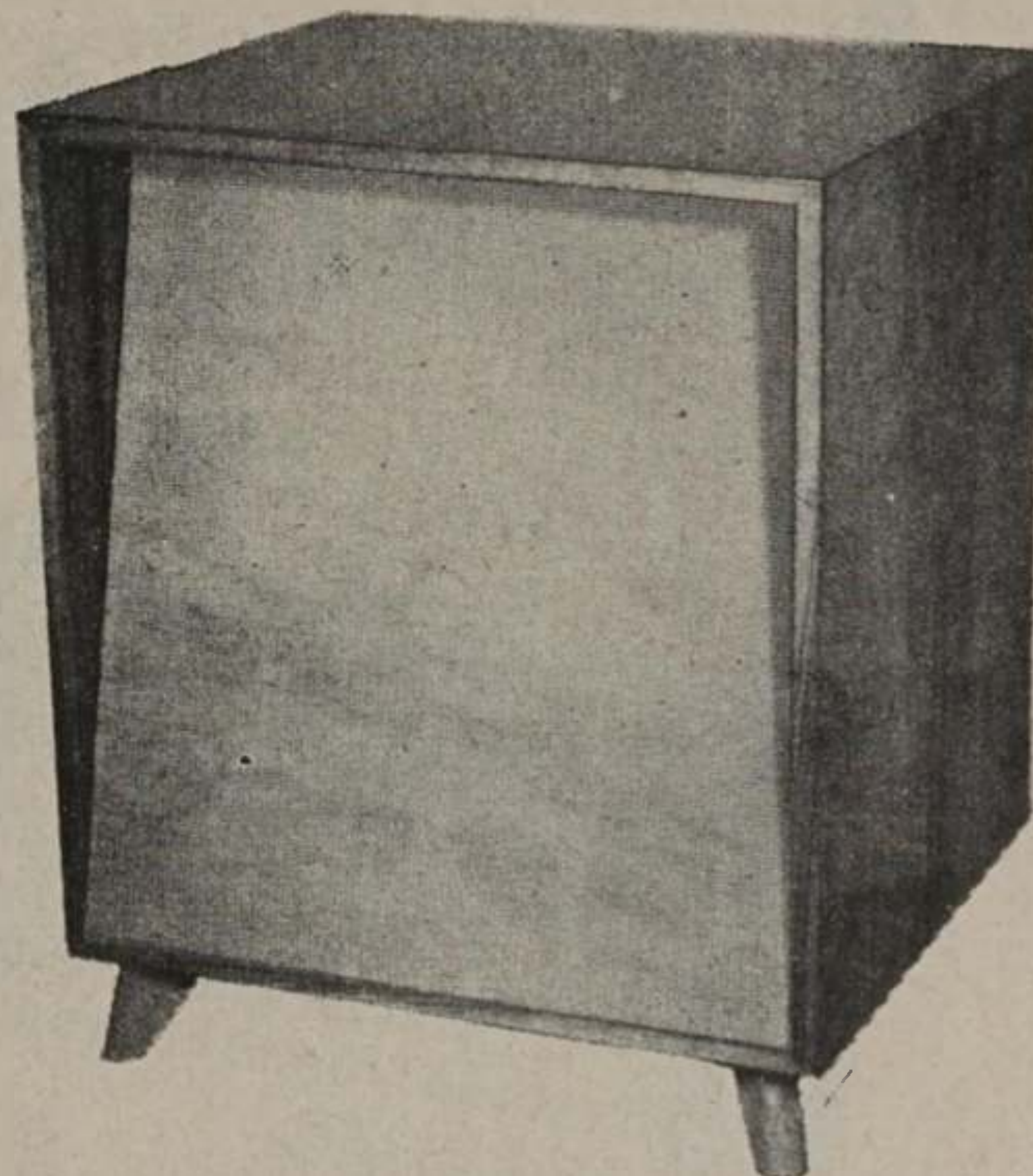
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designed to contain either single or twin unit High Fidelity loudspeaker systems. As a single unit system the Axiom 150 Mk. II (15 watts) or the Axiom 22 Mark II (20 watts) is used. The choice depends upon power handling capacity required. Both are 12 in. twin cone units, with frequency coverage of 30-15,000 c/s. For a twin unit system the Trebax high frequency horn loaded pressure driver is added to the single unit system, together with crossover network XO/5000, the 12 in. loudspeaker being employed as a bass and mid-range reproducer, up to 5,000 c/s., the Trebax handling the remainder of the range up to 16,000 c/s. By this means the response is extended and distortion minimised.

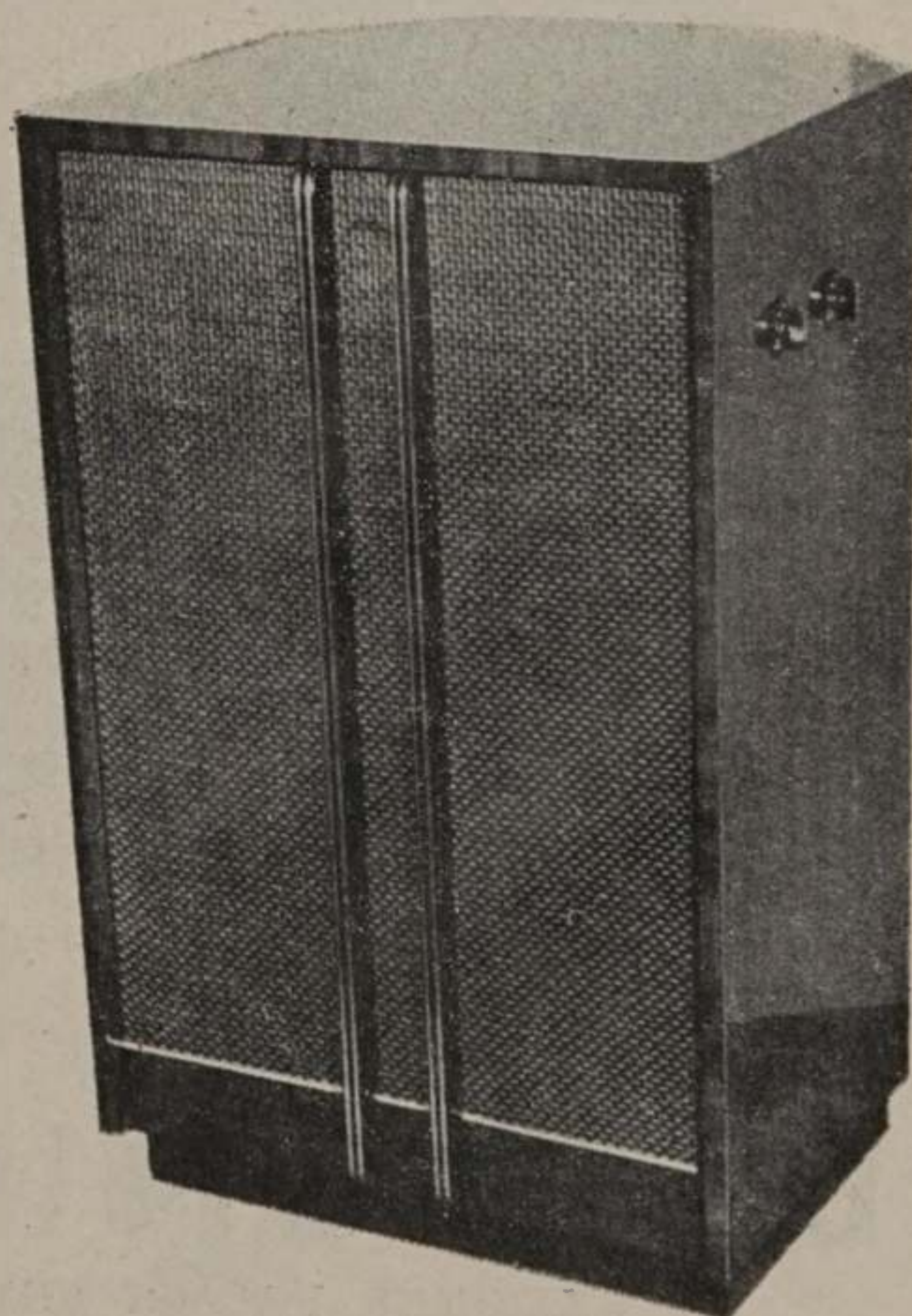
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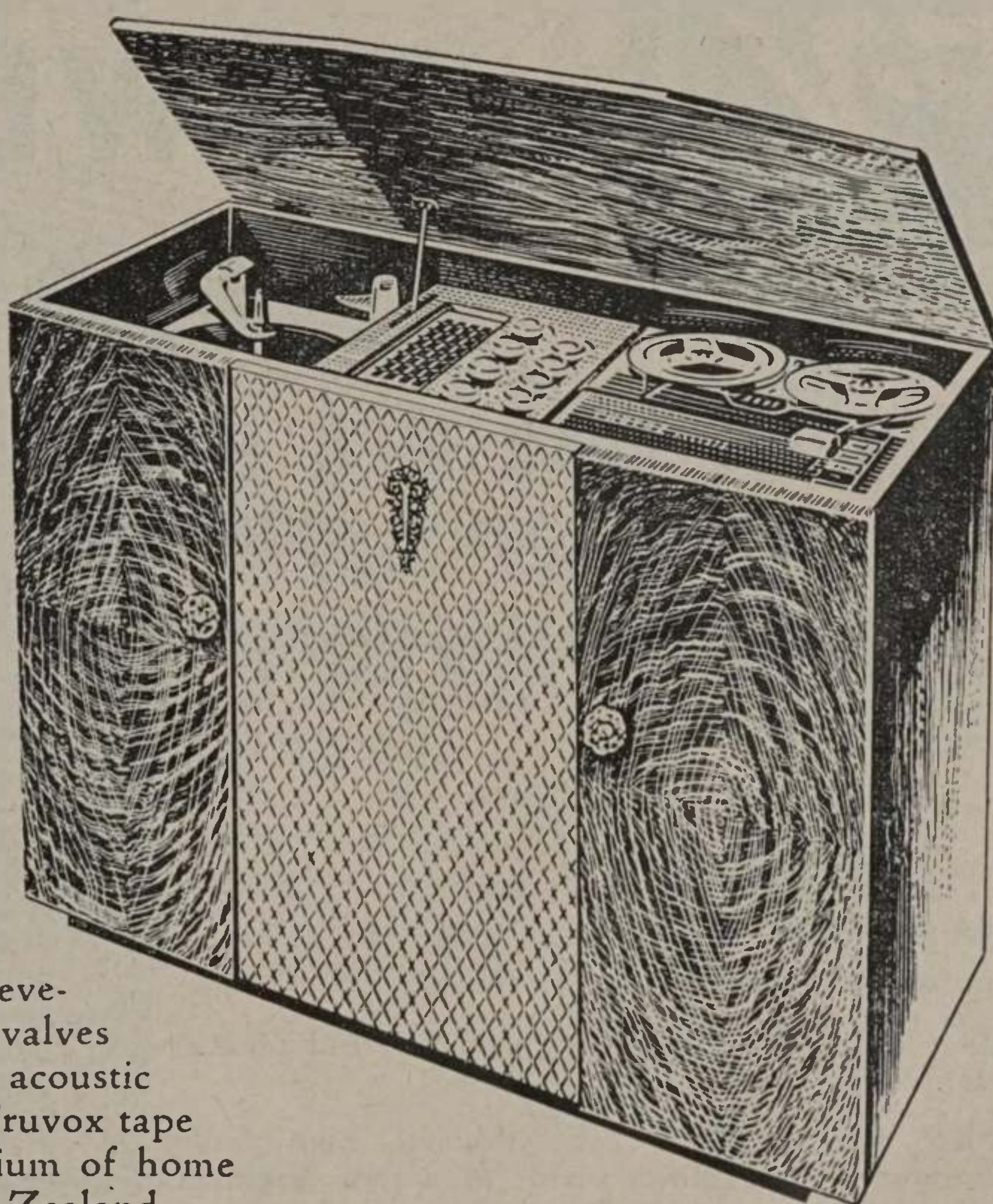
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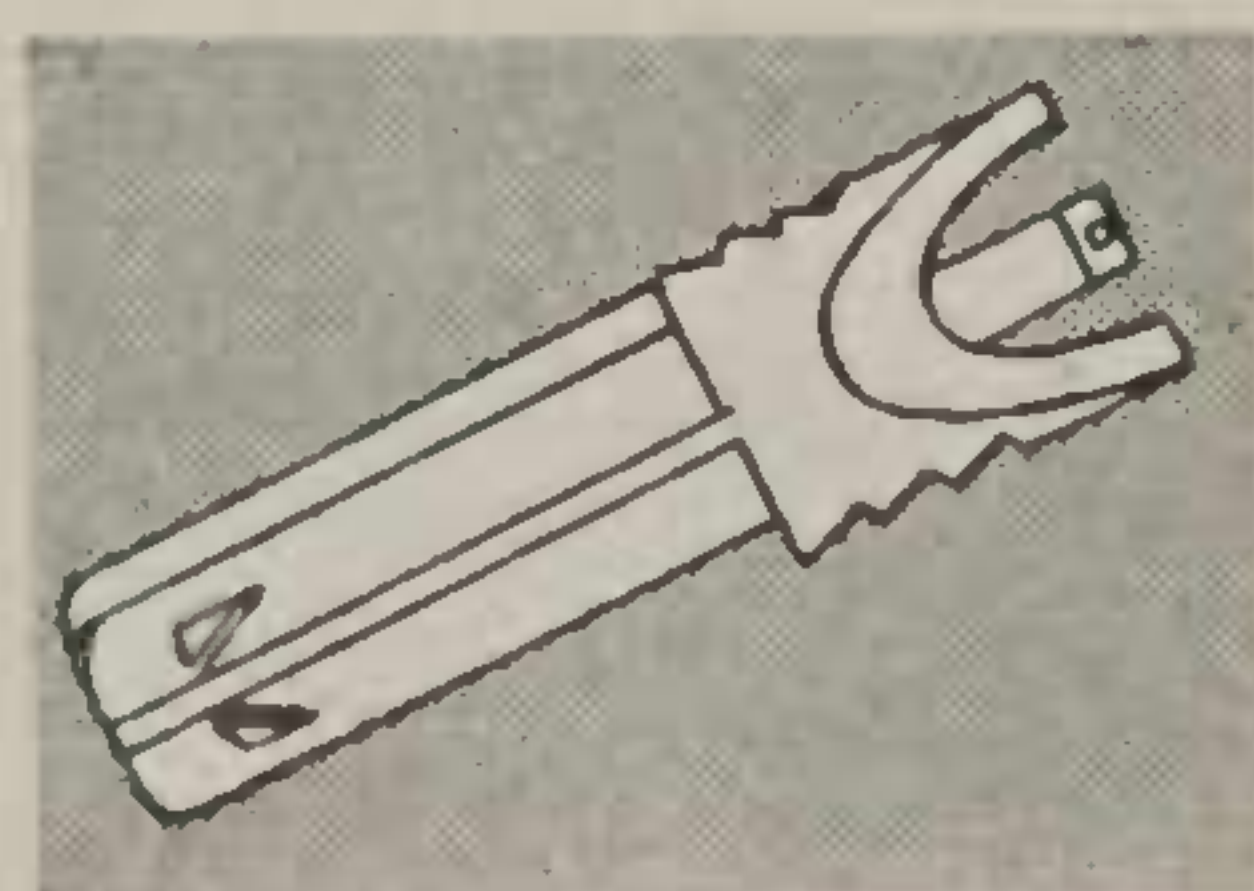
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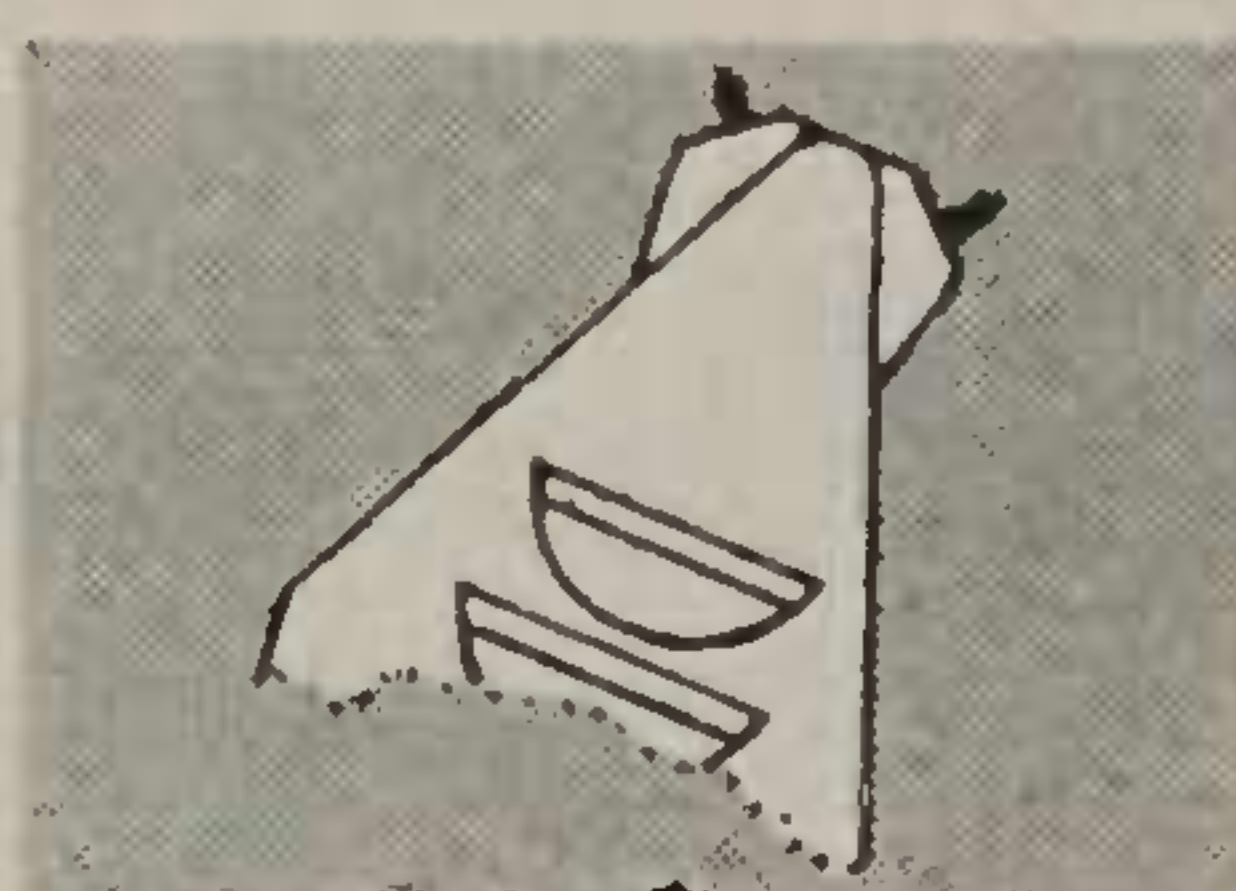
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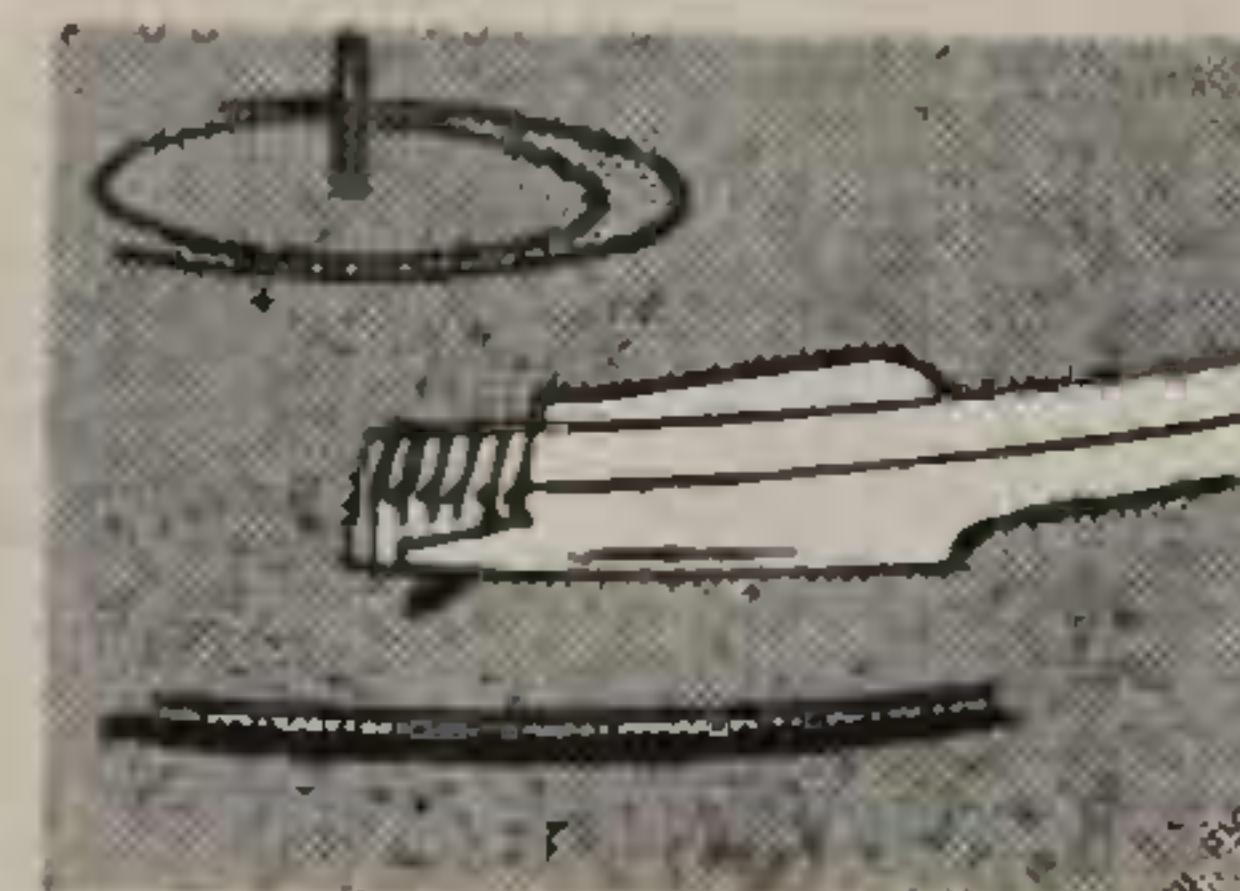
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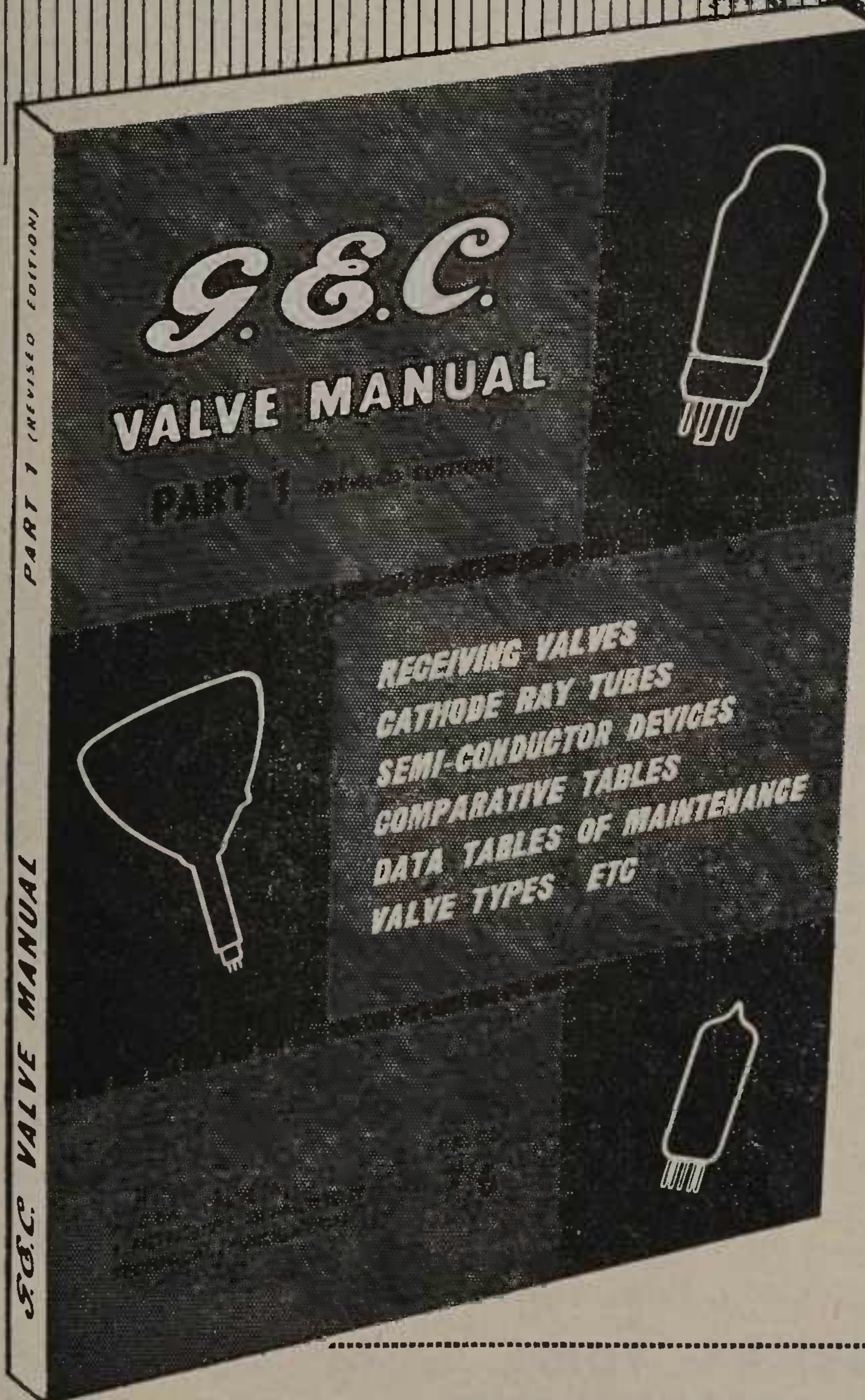
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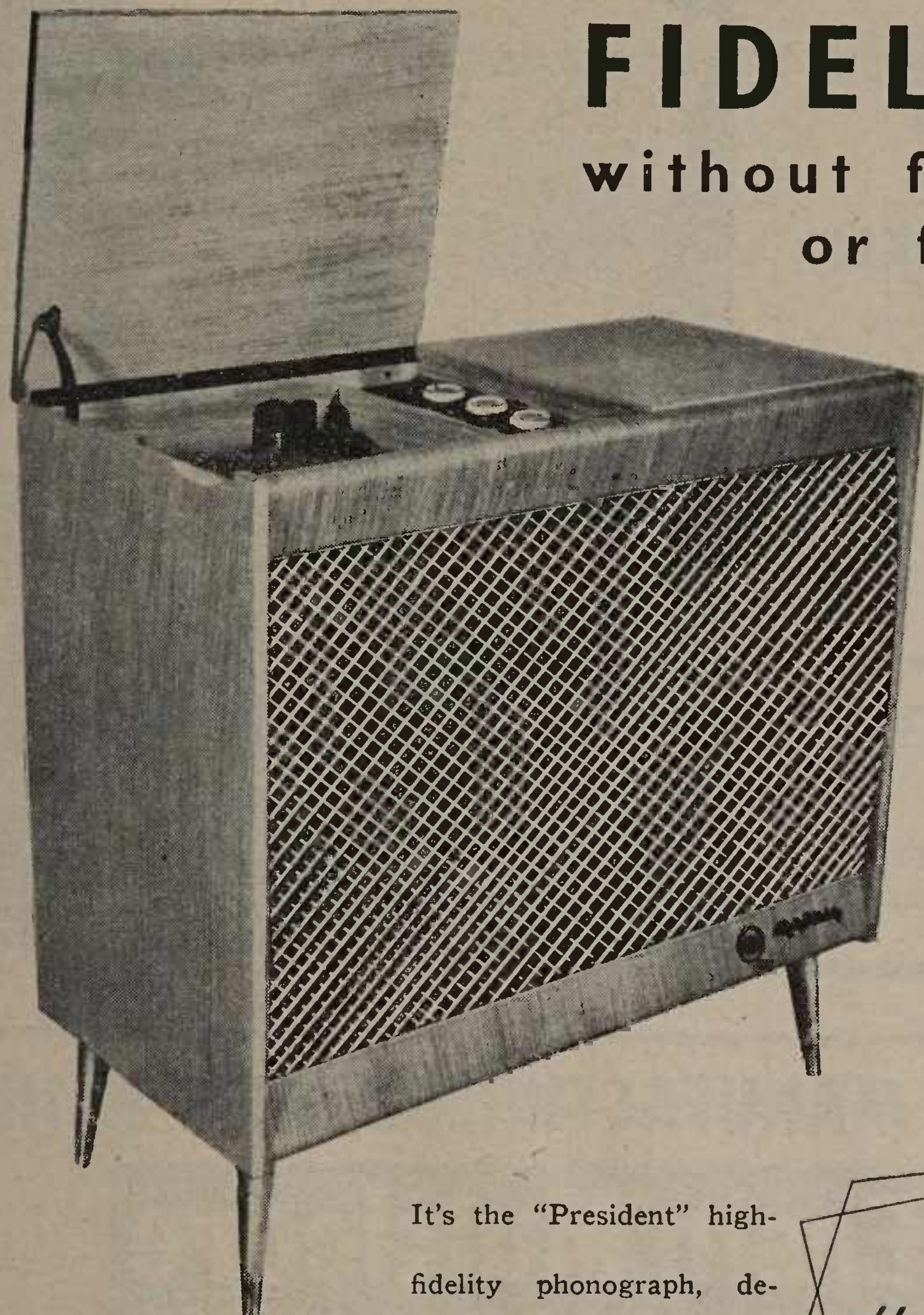
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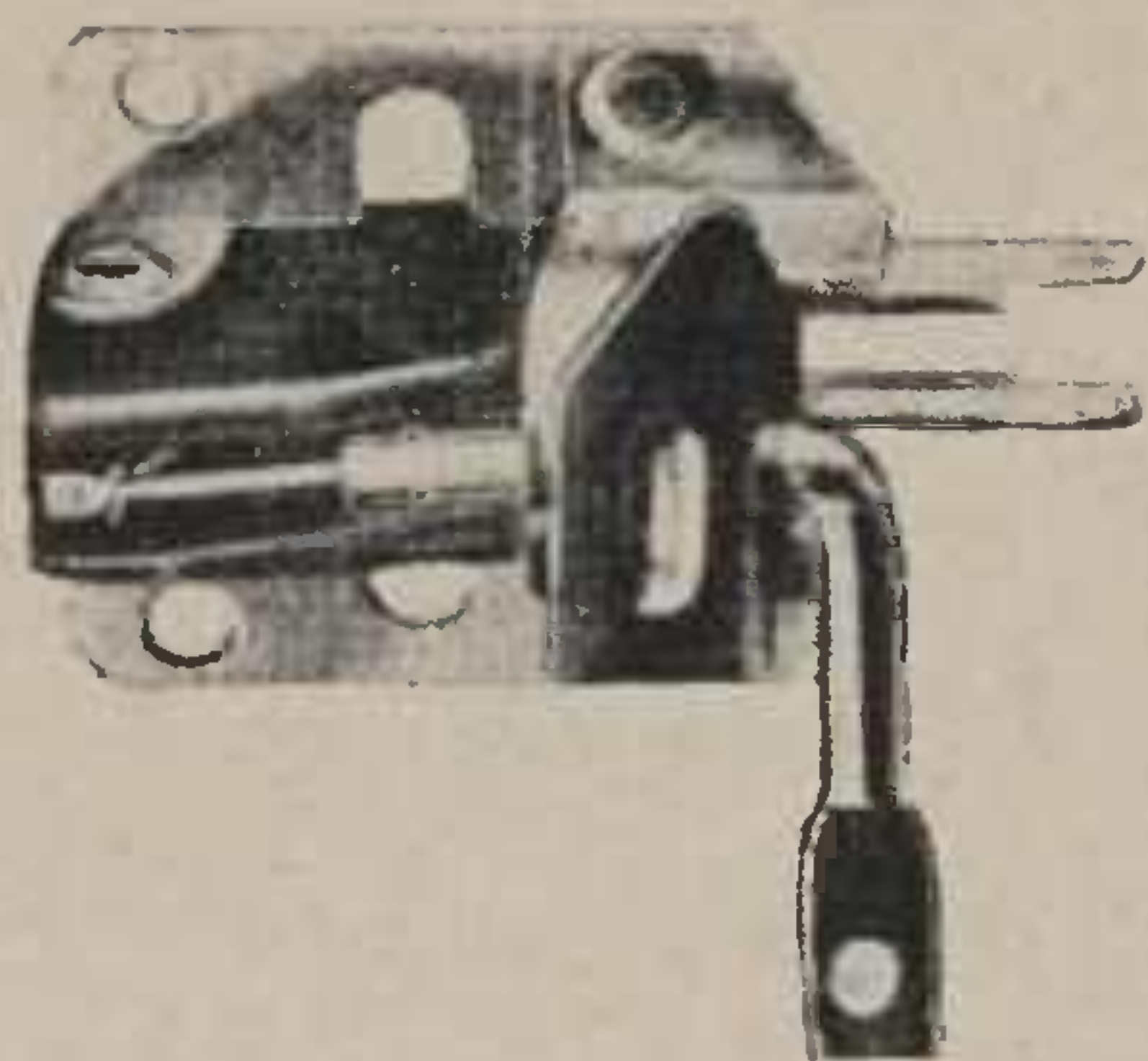
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The bit on the left, as shown in photograph, was used with Savbit Alloy, and has made 10,000 joints. The centre bit, used for 1,000 joints and the bit on the right for 7,500 joints, were each used with a standard tin/lead alloy.

to reduce bit wear!

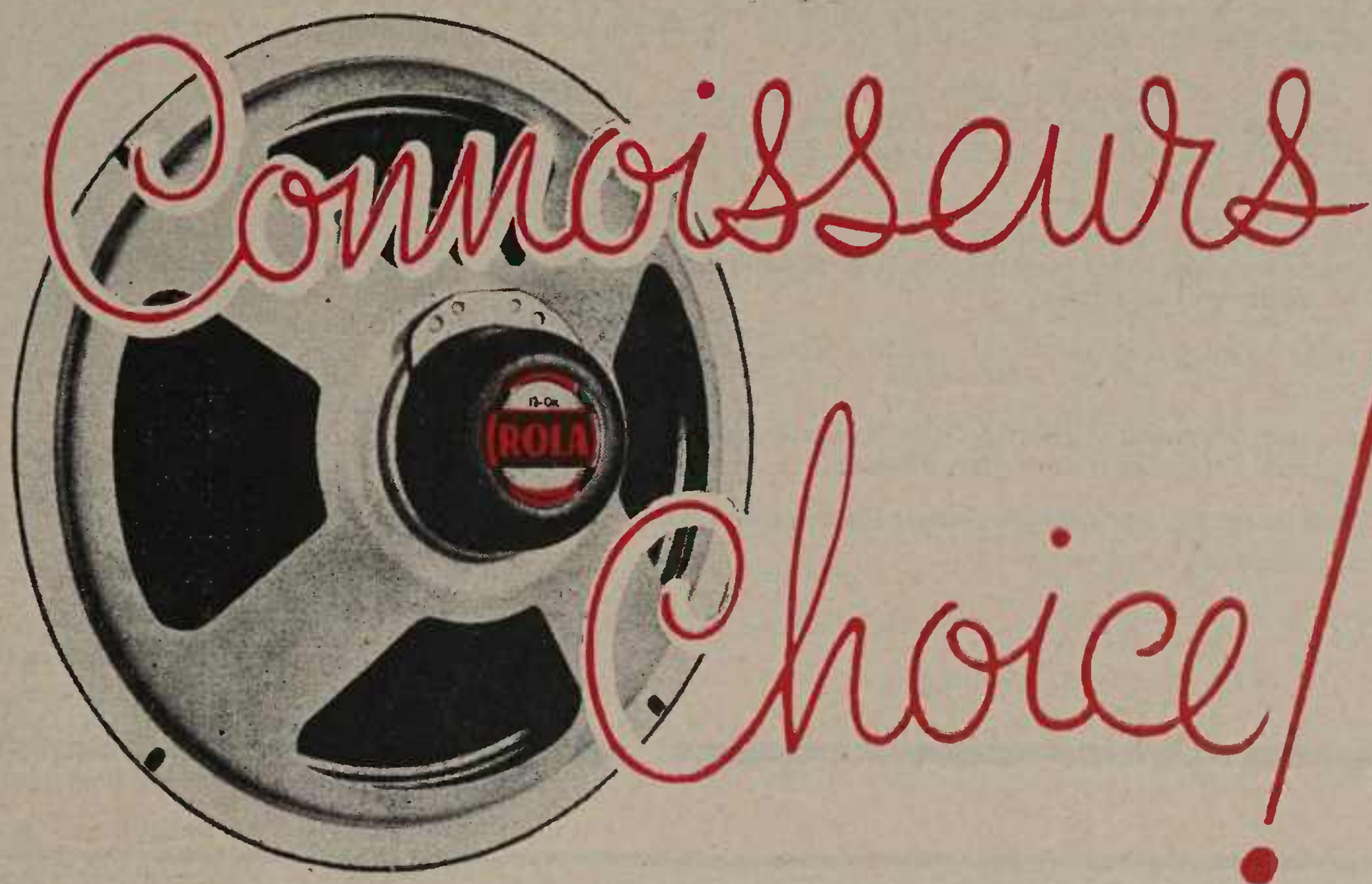
Extensive research has shown that the main cause of bit wear is the absorption of copper from the solder bit into the solder alloy. The new alloy, ERSIN MULTICORE SAVBIT TYPE 1 ALLOY contains such a small percentage of this destructive copper that it extends the life of copper bits up to 10 times, yet it has no effect on the speed of soldering.

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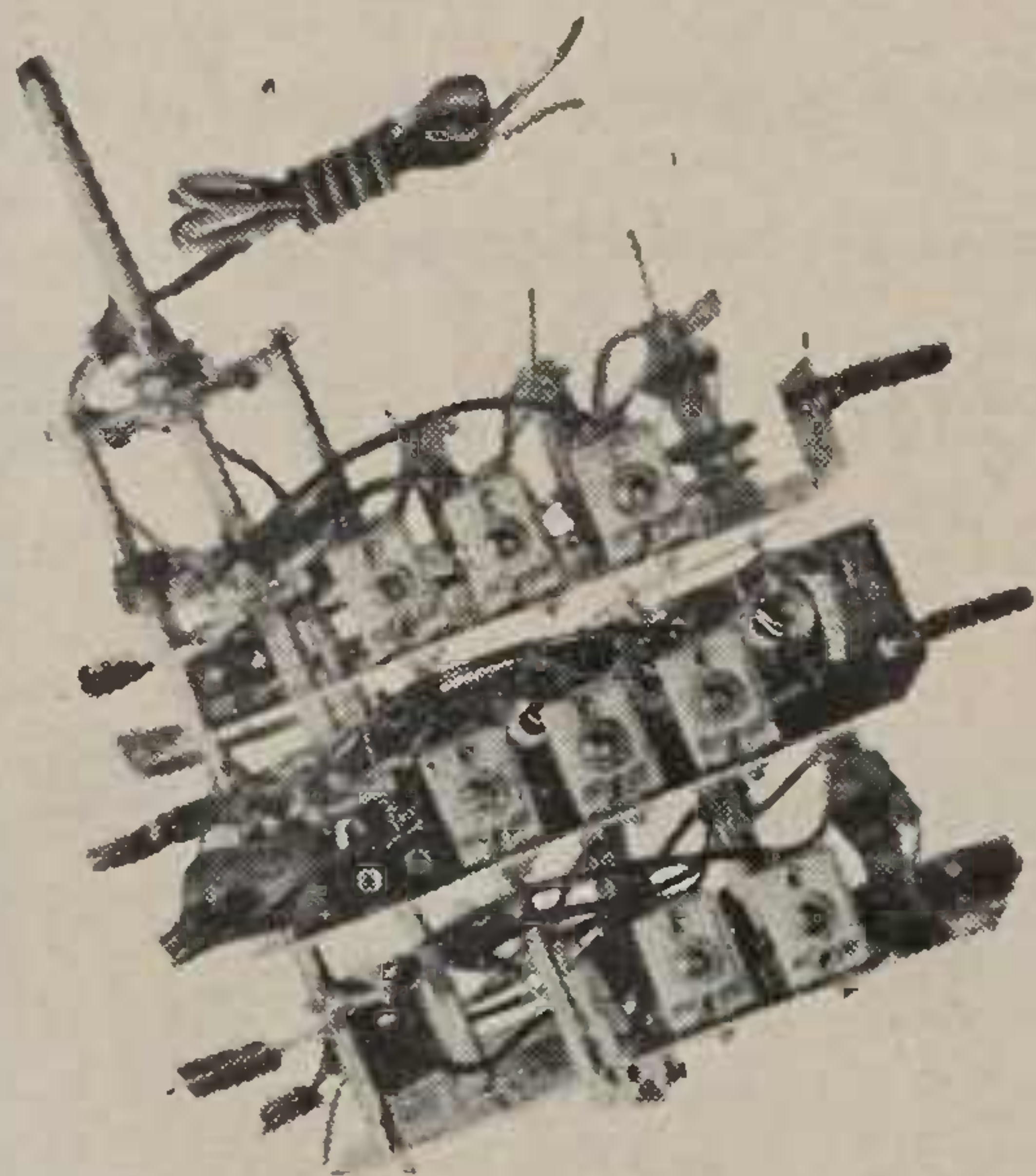
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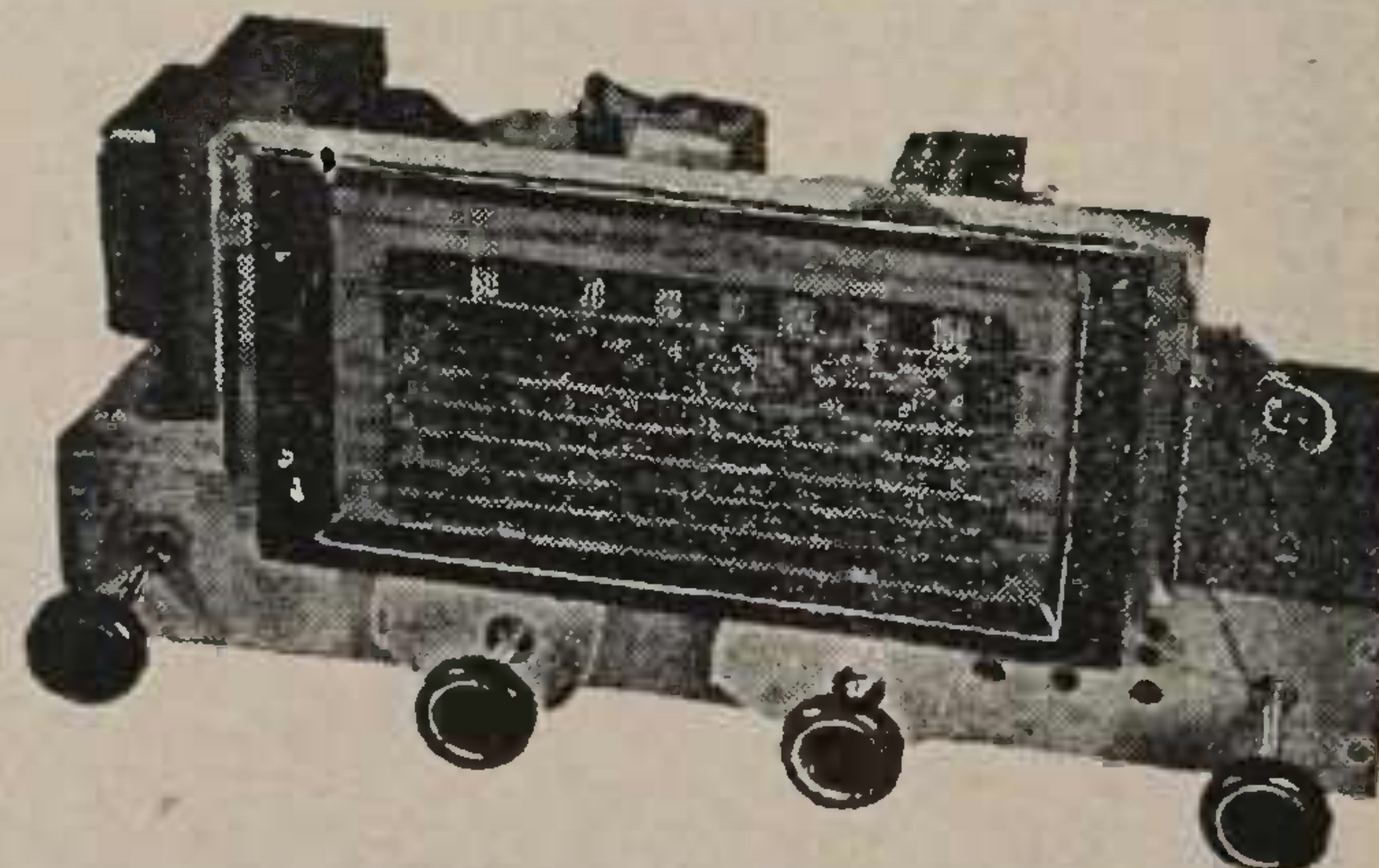
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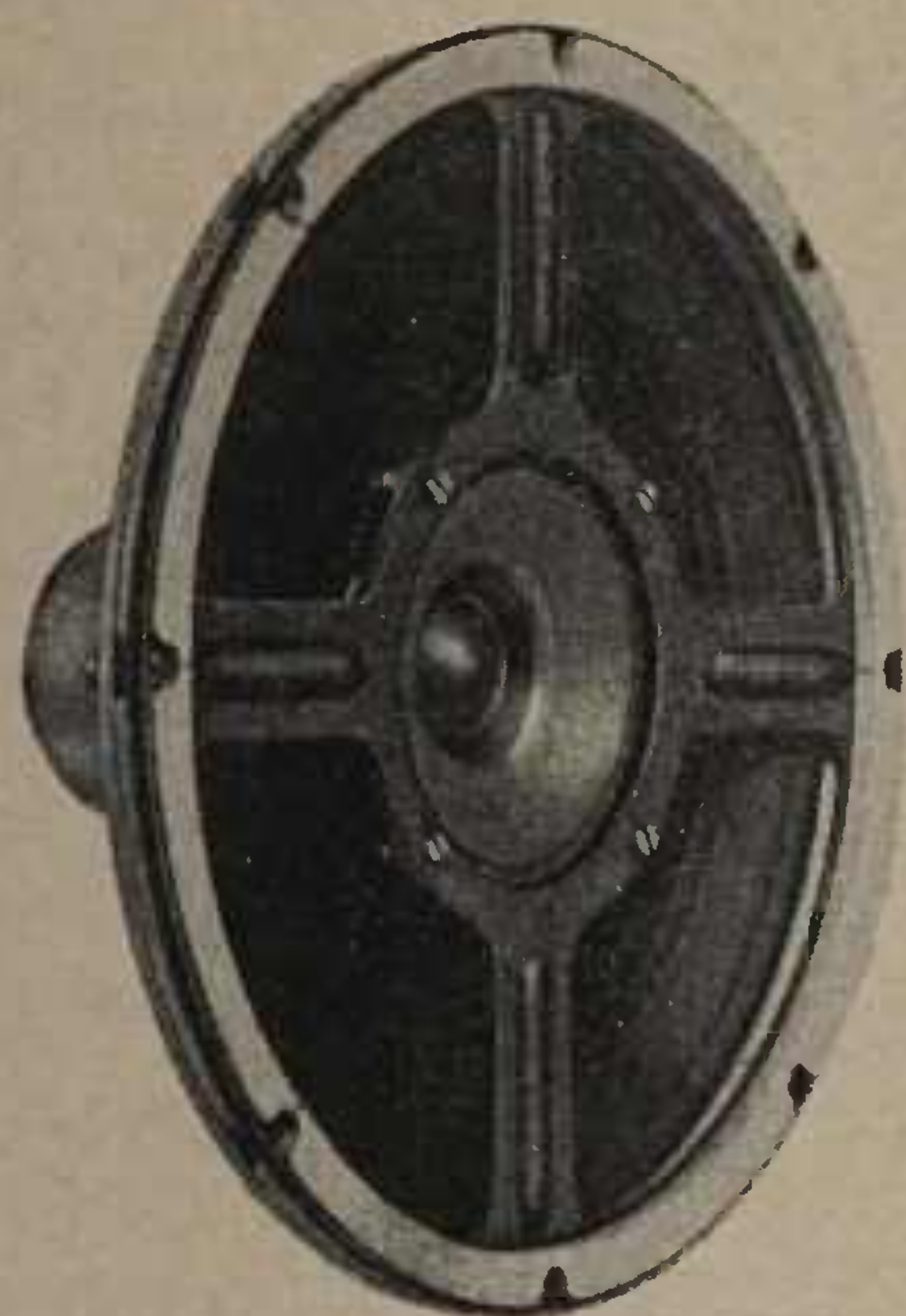
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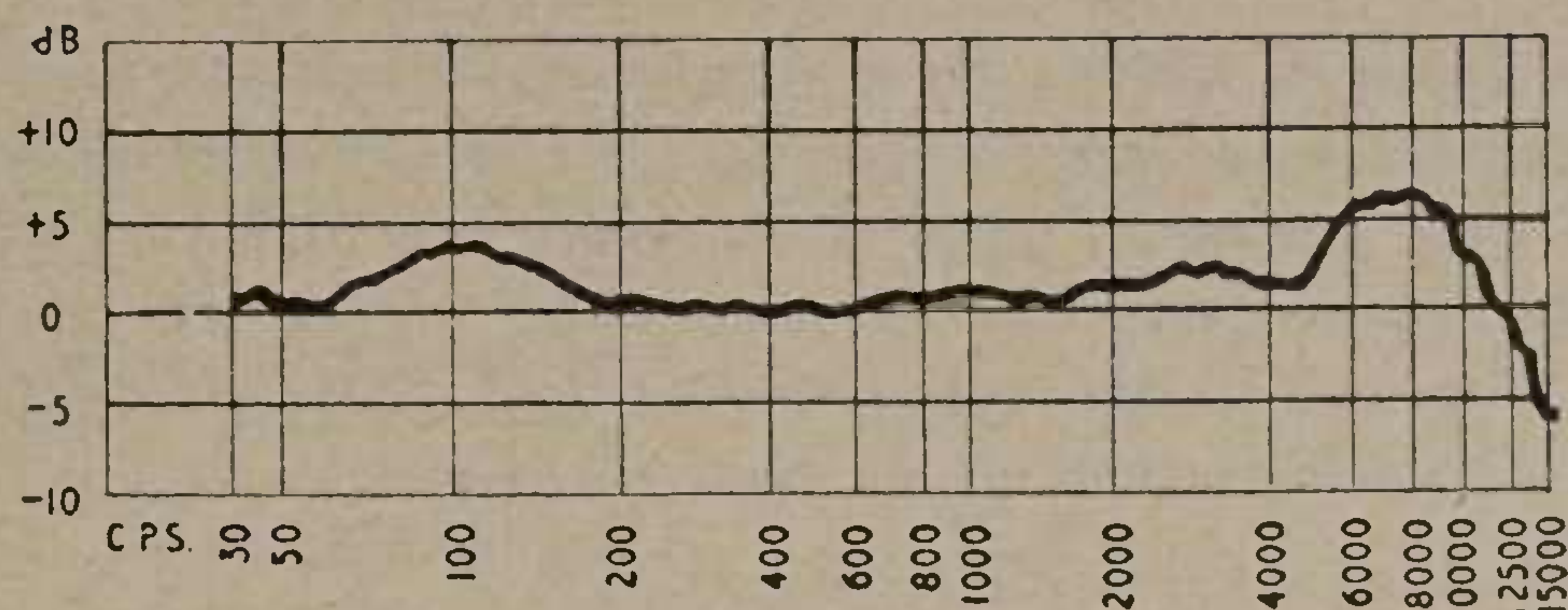
NOTE I: Special assembly type B10 available, covering amateur bands 15/13, 20, 40, 80, 160 metre, plus broadcast.

NOTE II: A limited number of completely constructed receivers incorporating B/9 Basic Kit and including in the I.F. channel variable bandwidth transformers and the well-known Mullard 5/10 High Fidelity amplifier, are available for direct sale. Inquiries invited.



THE R & A TYPE 1251

WIDE-RANGE DUAL LOUDSPEAKER

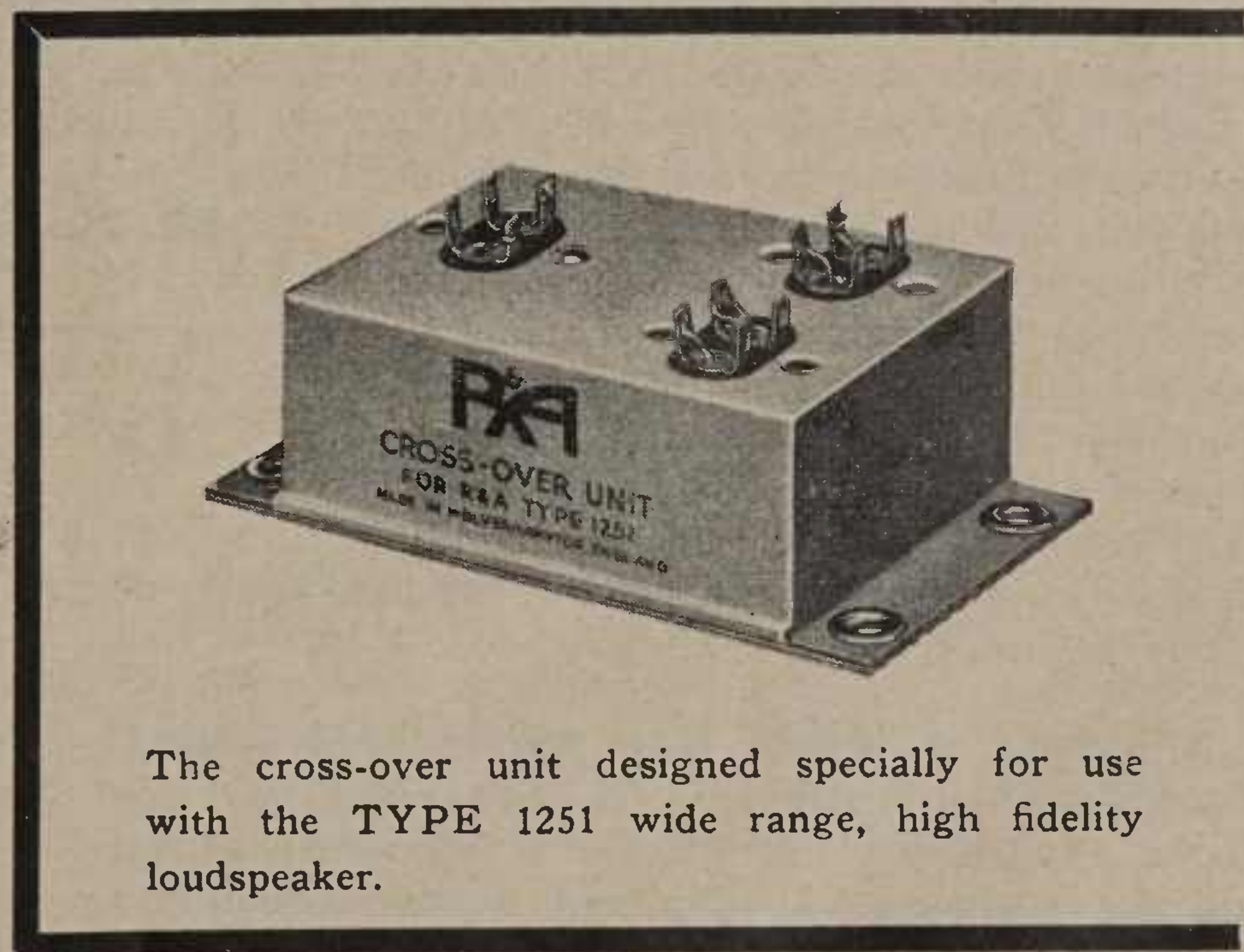


This frequency response curve was taken with the type 1251 mounted in a 6 cu. ft. ported reflex enclosure having a port area of 84 sq. ins. The microphone was mounted on the axis of the speaker, which was fed through the associated cross-over unit.

Reproducers and Amplifiers Ltd., of England, have applied their experience of over 25 years as manufacturers of high-quality loudspeakers for the radio industry, to the production of a wide-range dual unit. The result, TYPE 1251, is a speaker of exceptional performance at a very moderate price.

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The power handling capacity of the TYPE 1251, especially the low-frequency unit, depends upon the acoustic loading, and in a suitable enclosure will provide high-fidelity reproduction, up to a power input of at least 12 watts on programme material. A leaflet describing more fully this very fine speaker and crossover unit will be supplied on request.



The cross-over unit designed specially for use with the TYPE 1251 wide range, high fidelity loudspeaker.

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Circuits for the Experimenter

A CAPACITY SENSITIVE CIRCUIT

Here is an arrangement which is an extremely sensitive detector of small changes in capacity, and which can therefore be used for a variety of unusual applications. Perhaps the most obvious of these is the production of a capacity relay, for which its sensitivity is more than adequate. Other applications can include any process which involves the observation of very small capacity changes, even down to the order of a small fraction of one micro-microfarad.

Introduction

One of the most spectacular applications of electronics has always been to extremely sensitive methods of observing or measuring very minute changes in some physical quantity. This is understandable enough, because it very often happens that it is only by the use of electronic techniques that very high precision in measurement can be obtained. For example, it may come as a shock to many readers to find that the relatively simple and quite ordinary circuit to be described in this article is perfectly able to observe changes in the length of an object amounting to less than one millionth of an inch! Further, if proper constructional precautions are taken, especially with respect to mechanical and electrical stability, changes of this order can actually be measured, with good accuracy.

From this, it can be seen that the system to be described is an extremely sensitive one, which can easily be used for much less exacting measurements, and for purposes which do not involve actual measurement at all. Fundamentally, the method is one of observing very minute changes in capacity, so that it can obviously be used for any purpose in which the effect it is desired to observe can be converted into slight changes in capacity. Our example, given above, shows how this is done, when it is pointed out that a metal rod can be made one electrode of a small condenser of a few $\mu\mu\text{fds}$. capacity. Then, changes in length of the rod cause minute capacity variations which the circuit detects, and converts into voltage changes in the plate circuit of a valve.

It is only a short step from this example to many other applications involving small changes in capacity.

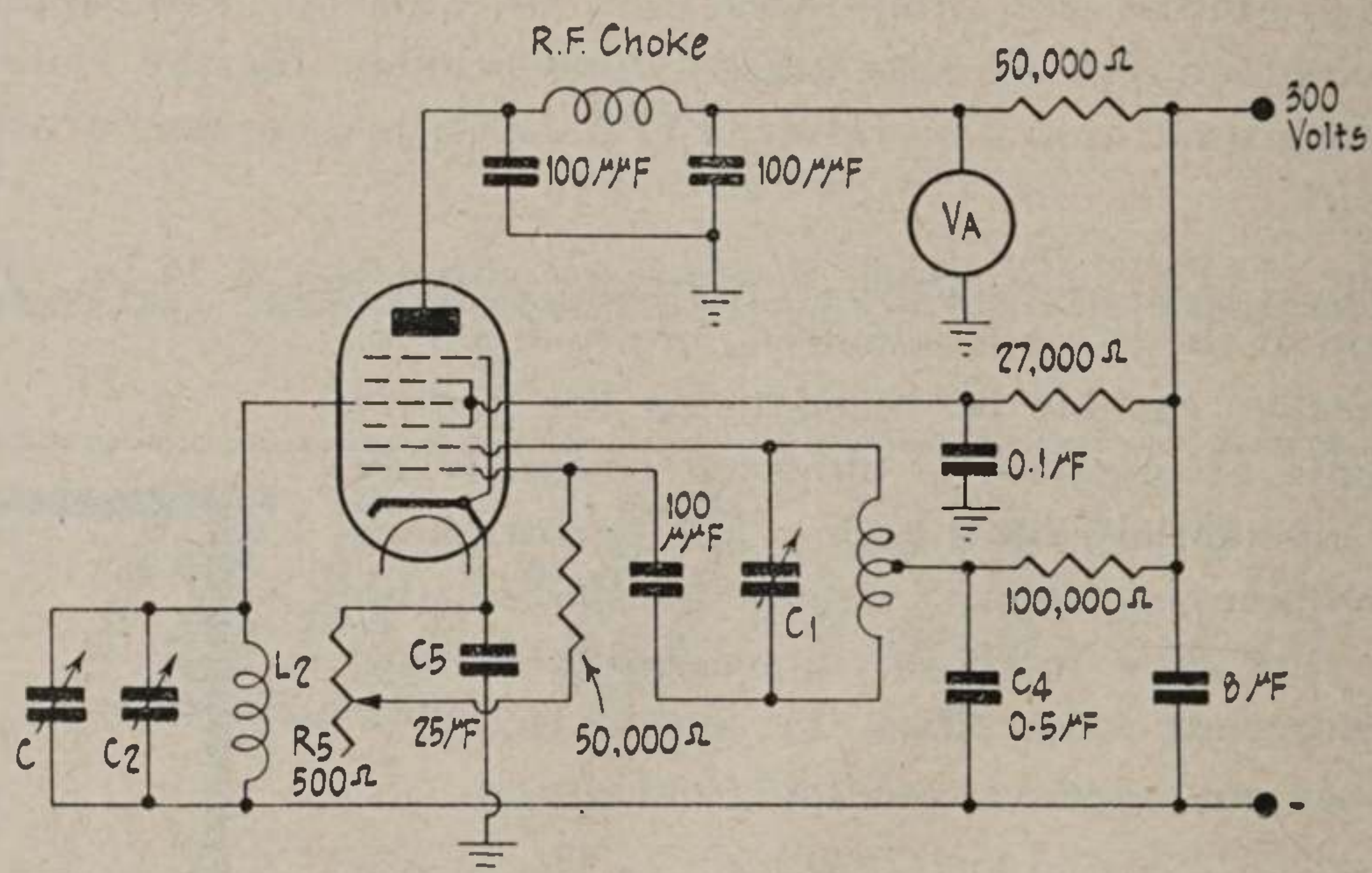


Fig. 1

The arrangement could act, for instance, as a high-gain pre-amplifier for a condenser microphone, or it could be used as a capacity relay, for indicating when any object approaches within a pre-determined distance of a given point. It could be used to measure pressure variations in a very sensitive manner, or as part of a servo system in which an electric motor drives a pointer in such a way that it maintains coincidence with another, whose actuating power is very small. Examples of this would be to move a shaft, with considerable power behind it, in coincidence with the movements of a magnetic needle, or the pointer of a microanimator. It could be used, with the addition of a barometric pressure cell and a pen recorder, to give records of microscopic changes in atmospheric pressure.

In fact, the possible applications for such an arrangement are legion, and limited only by the ingenuity of the user. Thus, without further ado, let us see what kind of arrangement it is that can perform these multifarious feats.

Based on the Octode Frequency Changer

First of all, we should point out that the arrangement we are about to describe is in no way original. It was described by Alexander, in the December, 1951 issue of "Electronic Engineering", and was further dealt with by Hobday, in a Letter to the Editor of the same journal in March, 1952. All that this article is doing, therefore, is to bring the arrangement to the notice of readers who may not be aware of it, and at the same time to make further suggestions as to possible applications for it.

It is based on an effect which takes place in an ordinary octode type of frequency converter tube, when the signal grid circuit is tuned very close to the frequency of the oscillator, which is functioning in the normal manner, exactly as for ordinary frequency conversion.

The basic circuit is shown in Fig. 1, where it can be seen that the valve is working in much the same way as it does in a receiver, except that here, there is no input signal, and no intermediate frequency, and therefore no I.F. transformer in the plate circuit. Also, the tuned circuit in series with grid No. 4, the signal grid, is tuned not to some frequency quite remote from that of the oscillator, but to the oscillator frequency itself.

With a valve of this kind, namely a frequency-changer in which the signal grid lies between the oscillator electrodes and the plate, there is always present at the signal grid a certain voltage at the frequency of the oscillator. In normal use, this voltage is very small, because of the large difference in the frequency to which the two circuits are tuned, so that when this is so, as when the valve is used as a broadcast band oscillator-mixer, there is very little effect on the performance of the stage. At higher frequencies, however, as when the same valve is used on short-wave bands, the frequency difference between the signal circuit and the oscillator becomes quite small, ratio-wise, although the difference in terms of kilocycles remains constant. As a result, the voltage at oscillator frequency which appears on the signal grid is much larger, and can have an appreciable effect on performance.

Naturally, then, the induced oscillator voltage at the signal grid is largest when the latter is tuned to the oscillator frequency. Normally, the effect is not noticed, because in a receiver, such a condition never obtains, except accidentally, during the alignment process. If it does happen, the result is often that the set "takes off" and becomes unstable. Sometimes, however, the set remains stable, but it is noticed that as the mixer's grid trimmer is tuned so that the grid circuit passes through the oscillator's frequency, there is a large "thump" in the loud-speaker, due to some unidentified effect that no radio serviceman ever concerns himself with, except to ensure that it cannot happen when the set is aligned and in operation. It is just this effect,

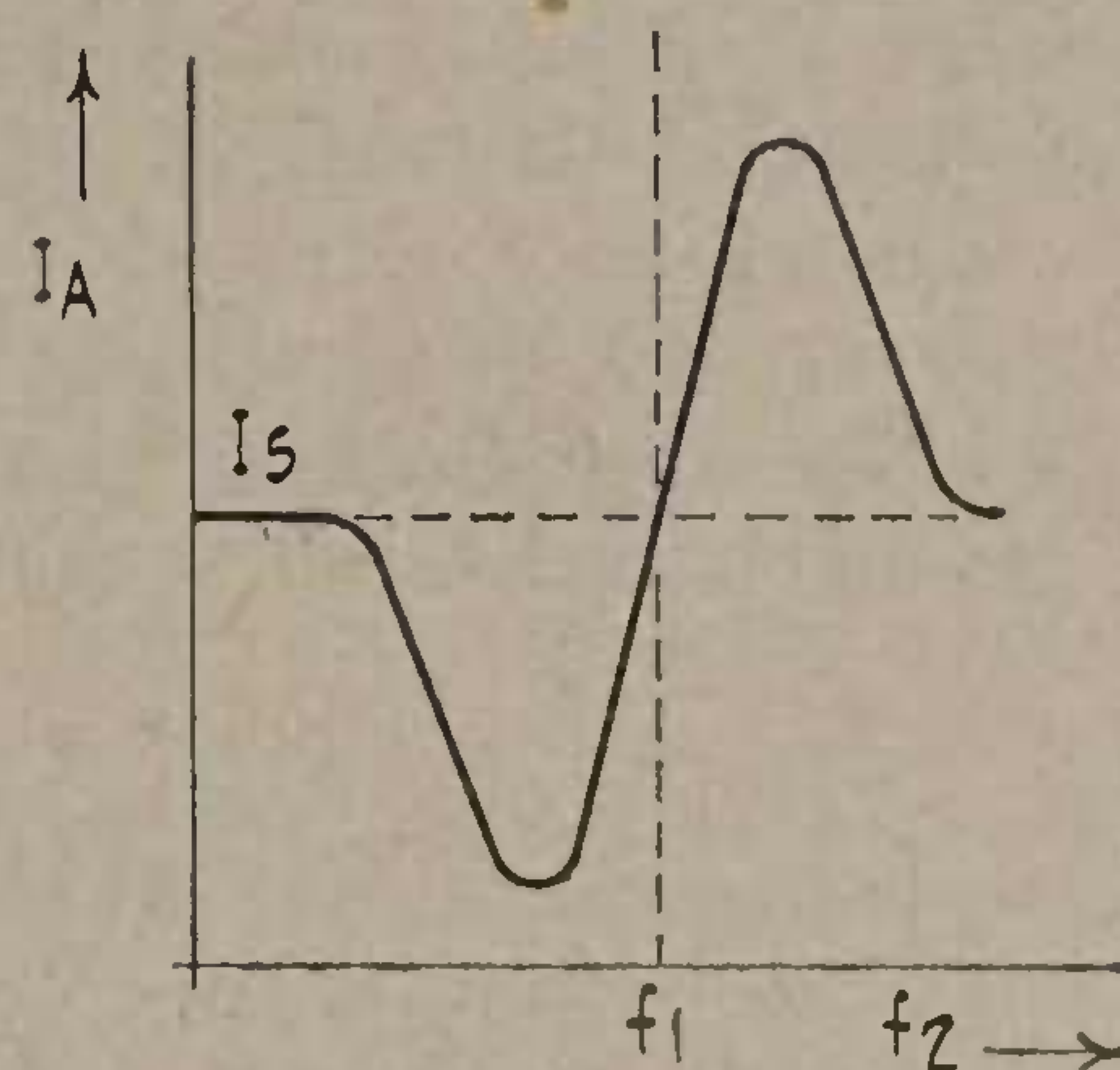


Fig. 2

however, that is put to good use in the present circuit. If the oscillator is fixed in frequency, and if then the grid No. 4 circuit is tuned through the oscillator frequency, there is a sudden and violent change in the valve's plate current as the circuit passes through. At frequencies much higher and lower than the oscillator frequency, the plate circuit is normal, and no variation in the frequency of the signal-grid circuit has any effect upon it.

If we investigate the effect by placing a D.C. meter in the plate circuit of the valve, and plotting carefully the changes in plate current with changes in frequency of the No. 4 grid circuit, we will get a result such as that illustrated in Fig. 2. As the frequency of G_4 circuit is brought up from well below the oscillator frequency, the plate current is at first normal, and then falls, quite rapidly, to a well-defined minimum. As the circuit is tuned to still higher frequencies, and still nearer to that of the oscillator, the plate current rises again, more rapidly than the original fall, until exactly at the frequency of the oscillator, the plate current is back to its original value, obtained with the signal grid circuit either short-circuited or completely de-tuned. If the tuning frequency is raised further, the increase in plate current continues, still at the same fast rate, and reaches a maximum, after which it falls again, until well off resonance at the high-frequency side of the oscillator, the plate current again returns to the usual value.

It will be noticed that the curve is exactly similar to the response curve of an F.M. discriminator in shape. Further, since the slope of the curve between the two peaks is quite steep, there is a large effect on the plate current for only a small change in tuning of the G_4 circuit. This is the same thing as saying that in the immediate vicinity of the oscillator frequency, the effect is very marked, and very sensitive.

So far we have considered changes in the valve's plate current. But if a large load resistor is placed in the plate circuit, these current changes can be transformed into voltage variations, and in practice it is found that with a 50k plate resistor, and an H.T. supply of 300 volts, the change in plate voltage amounts to some 180 volts, measured from the minimum to the

maximum point of the curve, which will obviously have the same shape as Fig. 2, but will be inverted, the rise in plate voltage occurring at frequencies below resonance.

From this we see that the effect is a very large one, but until we obtain some idea of the frequency scale on Fig. 2, we cannot estimate the sensitivity of the circuit.

Practical tests, with an old type Philips octode valve, and the oscillator working at 20 mc/sec., have shown that the full plate current change can be caused by a change in G_4 tuning capacity as small as $2\mu\mu\text{fd}$. The sensitivity can thus be given as 90 volts per $\mu\mu\text{fd}$. for these operating conditions. Alexander found that with the G_4 tuning capacity made up in the form of a two-plate condenser, with a spacing of 0.01 in. between them, and a plate diameter of 2 cms., a movement of 10^{-6} , or one millionth of an inch, gave a change of 1.4 volts at the plate of the tube. This sensitivity is almost unbelievable, but there is no doubt of its accuracy, as the change in spacing of the condenser plates was measured independently by optical means, giving an accuracy of 2 per cent!

It is now easy to see that any claims we may have made in the introductory paragraphs of this article can be quite well substantiated, and even that for many possible applications such extreme sensitivity would be an embarrassment rather than an asset. Similarly, it is not difficult to imagine that if this sort of sensitivity is to be used in a practical device, extremely stable mechanical and electrical construction is essential.

How Does it Work?

So far, we have done no more than indicate what the circuit does, but this has hardly explained how the circuit works. A full explanation would be quite lengthy, and would involve the mathematics of the multi-electrode tube, and we do not propose to go into all this at length. We hope, however, that the following simplified explanation will give some idea of the mechanism involved. Obviously, the plate current of a valve of this nature depends on the signal voltages applied to the various electrodes. It has been shown that in a multiplicative mixer like this one, the plate current is proportional to $E \cos \theta$, where E is the alternating signal voltage on G_4 and $\cos \theta$ is the cosine of the phase angle between the voltage E and the oscillator voltage appearing on G_1 , the oscillator grid. The plate current is also proportional to the signal voltage on G_1 , but as this remains constant for purposes of this circuit, we need not take it into account.

Now, as the G_4 circuit is tuned, the amplitude of E will vary according to the varying impedance of its tuned circuit, and will reach a maximum at the oscillator frequency. The phase of the voltage appearing on G_4 will vary from -90° below the oscillator frequency, to 90° above it, and will be 0° at the oscil-

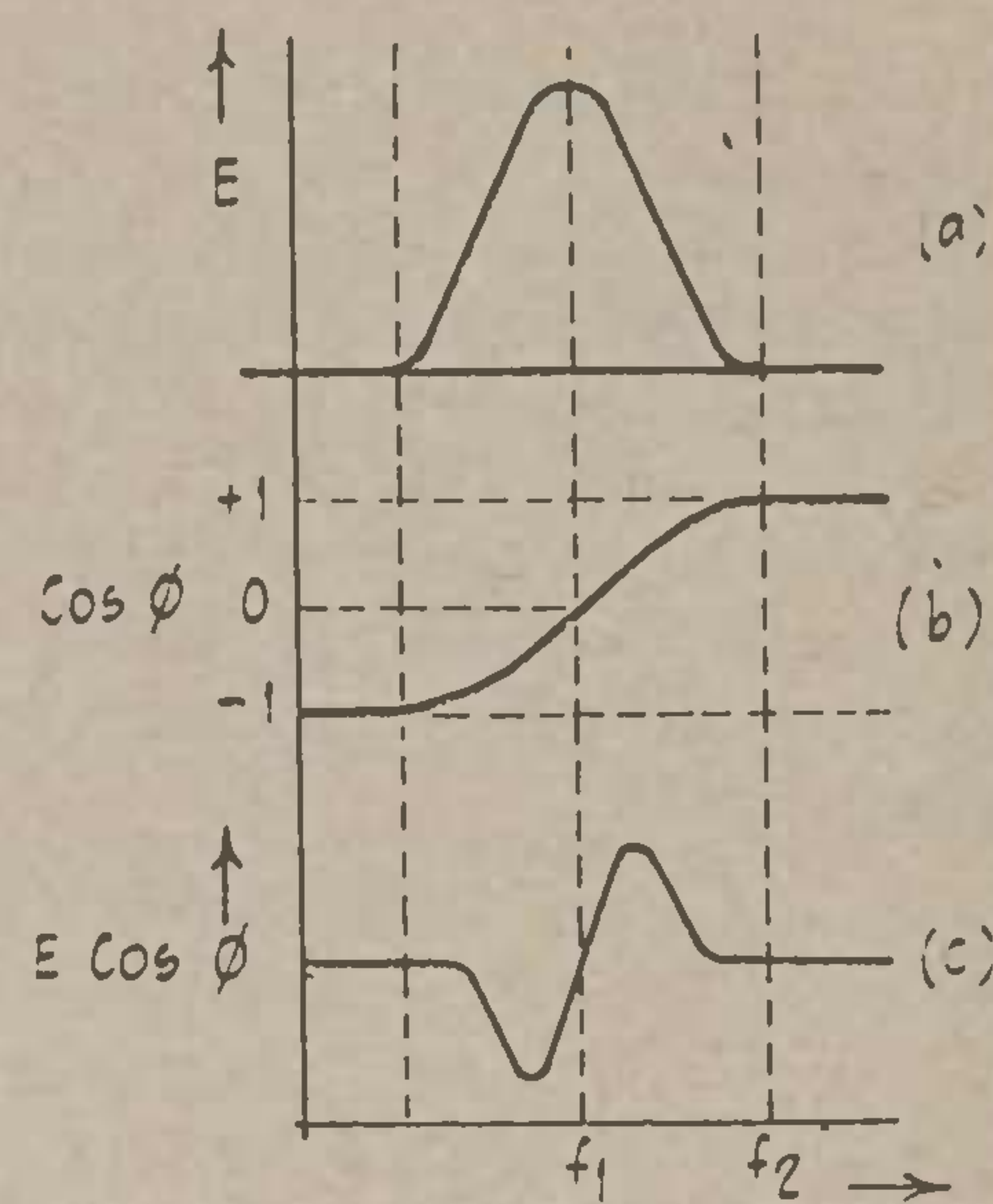


Fig. 3

lator frequency. The variations in amplitude and phase can thus be illustrated graphically as in the first two diagrams in Fig. 3. If these two curves are multiplied together, the resultant will be as in the lower diagram of Fig. 3, and it can be seen that this is of the same shape as the practical curve illustrated in Fig. 2.

Between G_3 and G_4 in a tube of the type under consideration is found what is known as a *virtual cathode*. This means that somewhere between these electrodes, the velocity of the electrons passing through the tube has been slowed down to zero, so that we can imagine the electrons as coming from an imaginary cathode, somewhere between these grids.

In actual fact, the electrons come from the real cathode, and on their journey thus far, they have been modulated in velocity by the alternating voltage on G_1 . Thus, the position of the virtual cathode is not fixed, but is modulated in position at the rate of the variations in potential on G_1 . This means, that at the frequency of the oscillator, the virtual cathode is approaching and receding from G_4 , about its average unmodulated position. As a result of this, a varying potential will be induced on G_4 , and this potential is at oscillator frequency. But the current flowing in the G_4 circuit, owing to this potential will be proportional to the rate of change of the induced voltage, and so will be an alternating current at the frequency of the oscillator, leading the voltage variation by 90° . Thus, if the G_4 circuit is a pure resistance (or a tuned circuit at resonance) the G_4 current will be 90° lagging with respect to the oscillator voltage on G_1 . If the G_4 circuit is purely inductive, its current will be 180° lagging, while if the circuit is capacitive, the current will be in phase with the G_1 voltage. This means that the phase difference varies from -180° to 0° , and the curve for $\cos \theta$, in Fig. 3 shows just how this variation takes place.

Tube Types Usable

As mentioned above, the original tube used in the circuit was the FC4, which is probably unobtainable today. However, the desired effect is obtainable with practically all mixer valves in which the oscillator electrodes come first (going from cathode to plate) followed by a screen-grid, and then the signal grid. Tubes like the 6A8, 6K8, etc., should be quite satisfactory, while those of the same type as the ECH34 and ECH81, in which the signal grid is G_1 , and is followed by the oscillator electrodes or the injection grid will not show the effect. For those interested in battery-operated gear, a probable type is the DK40, or the DK92 with a separate oscillator.

Care in Construction

If the circuit is to work properly, it is necessary to shield the oscillator-tuned circuit from the tuned circuit of G_4 and also to ensure that no stray coupling exists between the wiring of these parts of the circuit. The whole effect can be completely neutralized by $2\mu\mu\text{fd.}$ of stray capacity between G_1 and G_4 , from which it can be appreciated that the matter of shielding is an important one. Otherwise, ordinary constructional precautions will serve to make a worthwhile device. If the best stability is required, as when it is proposed to use the circuit as the basis of a measuring instrument, it would be advisable to use a regulated H.T. supply, and possibly even a crystal oscillator, but for experimental purposes there should be no necessity for these refinements.

Adjustment for Use

One point that has not so far been brought out is that the sensitivity of the circuit varies with frequency, and is higher at the higher frequencies. Frequencies between 10 and 20 mc/sec. are the best to use, as at higher frequencies still, the performance drops off owing to transit-time effects, while below this range, the sensitivity falls.

For greatest sensitivity, it is clearly necessary to have the condenser C, which is the one varied by the effect we want to measure, as great a proportion of the total circuit capacity as possible. However, a certain amount of adjustment is essential, so that it will be necessary either to have the inductance of the coil variable, or to have a small trimmer in parallel with the actuating capacity. If the utmost sensitivity is wanted, the former tuning method would be used, while if it is necessary, as it often will be, to reduce the sensitivity to suit the application, the L/C ratio of the tuned circuit can be reduced by putting in more fixed capacity, and reducing the inductance to suit, remembering that the circuit must be able to tune to the frequency of the oscillator. In this way, a continuous control over the sensitivity can be obtained.

In any event, some variable adjustment of the tuning of the G_4 circuit must be provided so that the

circuit can be properly set up. This is done as follows. First, a milliammeter is connected in series with the plate circuit, or else a high-resistance voltmeter is connected from plate to earth, to measure the plate voltage. Then, G_4 is short-circuited to earth, and the cathode resistor is adjusted until the plate voltage, or current, is approximately mid-way between the extremes to which it moves when the input circuit is tuned through resonance. The grid is now un-shortened, and moving the tuning through resonance should now reveal that the curve of plate current or voltage is symmetrical about the average value, as shown in Fig. 2. The tuning is finally set so that the plate current or voltage is exactly the same as the value to which it was set with the grid shorted. This will put the circuit just at the point where the curve crosses the average line, and will enable capacity changes in either direction to be accommodated. If the effect is one which can only increase the current, it would be better to set the tuning to a point just past the turn-over, so that the range of measurement, or of possible variation from this setting is about double what would be available if the circuit were set to the middle of its characteristic.

Use with Functions Reversed

So far, we have described the use of the circuit with the oscillator frequency fixed, and the tuning of the grid circuit variable. It is obviously equally possible to use the circuit with the G_4 circuit tuning fixed, and with constant-amplitude, but variable frequency input to the oscillator grid, G_1 . If used in this way, the arrangement becomes a sensitive FM detector.

CIRCUITS FOR TRANSISTOR AMPLIFIERS

(Continued from page 18.)

audio end of a hybrid portable receiver, using miniature valves for the R.F. end, and transistors for all audio stages. Such a receiver could also be made using the new low-voltage tubes intended for working from an H.T. of 12 or even 6 volts. Then it would become the ideal set for installation in a caravan or launch, or any place where an accumulator is available. Indeed, the possibilities are just about limitless, even with an amplifier of this relatively low power.

After this the idea is to follow up with more powerful amplifiers using larger transistors, and so catering for different applications.

We do not yet know just when we will have the transformers available for the first amplifier circuit, but we will advise readers as soon as possible, in these pages.

CIRCUITS FOR TRANSISTOR AMPLIFIERS

This journal, after much frustration, has come up with a scheme which will enable us to feature transistor audio amplifier circuits of a practical nature, and readers to obtain the necessary transformers, which at present are not available.

Readers have probably wondered why it is that this journal, even at this comparatively late date, has not yet featured a single transistor audio amplifier, such as might be used in a portable receiver, portable gramophone, or in a hybrid car radio set. Those who read our January Editorial will probably have a clue, however, for in that article we bemoaned the absence from the parts dealers' shelves of transformers suitable for transistor audio amplifiers.

This journal has always done its best to keep its practical, "how to do it" kind of articles as up-to-date as possible, but sometimes, as now, our efforts have had to be postponed for long periods pending the arrival on the market of suitable components, of the sort that the experimenter does not want, or is not able, to make for himself. Audio transformers come into this category more readily than most things, and since transistor amplifiers cannot be "fudged" using transformers that were really designed for some other purpose, it is impossible for the average experimenter to build himself a transistor amplifier unless properly designed transformers are available for him to purchase.

No Sign from Manufacturers

This journal had hoped that some response might have been forthcoming from manufacturers in reply to the Editorial mentioned above, but so far none has appeared. One cannot altogether blame the manufacturers of transformers, for a number of reasons. First, and probably foremost in their minds, is the unknown quantity of the demand. If you are a manufacturer, it is uneconomic to set up machines for winding bobbins, and for stacking laminations for a new range of transformers unless there is a reasonable foreseeable demand. Otherwise, the transformers will have to be sold at a very high price in order to insure the maker against loss. Then again, there is the vexed question of just what transformers to make. One could become involved in an uneconomically large range of transformers, individual types of which would not sell in great enough quantities to make them economic.

However, there is some justification for the view that these are the normal problems of a manufacturer, and it is up to him to keep up-to-date by being able to supply demands that, like these, are triggered off by recent developments.

"R. & E." to the Rescue!

This journal has no desire at all to enter the field of trading in components parts. What we *do* want is to be in a position to offer our readers constructional articles embodying the latest developments in valves and transistors. What we are doing, therefore, is to arrange for a supply of transformers for a particular transistor amplifier, soon to be published in these pages, which should find almost universal application to portable receivers. We propose to hold small stocks of these transformers in our office, and to sell them to prospective builders of the circuit. Should this procedure indicate that there is a real demand for such transformers, we may in this way be able to persuade parts wholesalers to carry them, so that they would then become generally available on the retail market.

If the response to this scheme on the part of constructors is adequate, we will do the same for other transistor amplifiers.

What Kinds of Amplifier?

The first, and most obvious type of transistor amplifier to be featured under this scheme will be one using a pair of OC72 transistors in Class B, from a 6-volt supply, and delivering an output power of something over 250 milliwatts. This has become almost the standard amplifier for portable receivers and gramophone players, and when properly designed and constructed, and used with a reasonably efficient loud-speaker, can produce a surprising volume of sound of quite good quality. We have chosen this because of its immediate utility, and because it would be ideal for experimenters to have on the bench, ready to be excited from the latest experimental receiver circuit, or what no. In this writer's younger days, the same purpose would have been fulfilled by a small amplifier using, say a 6J7 and a 6V6, complete with its own power supply, which usually had milliamperes to spare to run the plate circuits of the valves in experimental hook-ups.

Provided this first amplifier has sufficient voltage amplification built in (as it will have) it can be used, if desired, as a signal tracer for servicing purposes. At any time it can be used as a temporary receiver just by adding on a crystal detector, or other simple R.F. end. Experimenters should find it just the thing for all the purposes mentioned, or for using as the

(Concluded at foot of page 17.)

RADIO RESEARCH AND THE I.G.Y.

By C. M. MINNIS

(Reprinted with acknowledgements to British Communications and Electronics.)

The primary objective of the International Geophysical Year is the collection of scientific data relating not only to the earth itself and to the sea, but also to the different levels of the atmosphere. It would be wrong, nevertheless, to conclude that the knowledge acquired during the I.G.Y. will be of academic interest only, and that it will have no bearing on the activities of practising engineers. This is particularly true of the programmes which have been planned for investigating the atmosphere because radio waves, which play such an important part in the life of present-day communities, travel through the atmosphere and are often profoundly affected by it. In consequence, a thorough understanding of the structure of the atmosphere and its physical properties is of considerable importance to radio engineers engaged in planning and operating radio services of all kinds.

The study of the whole of the earth's atmosphere from ground level up to the highest limits of the ionosphere is such an enormous subject that it must be divided into a number of subsidiary sections which can be conveniently handled by specialist groups. This fact has been recognized from the earliest stages of the planning of the I.G.Y., and has led to the specification of 15 broad fields of investigation which are referred to as "Disciplines" and which are either directly or indirectly associated with measurements of the properties of the atmosphere at different levels.

The programmes which have been planned within each of these Disciplines have intrinsic merits and limited objectives of their own but, from the specialist point of view of the radio engineer, it is convenient to assume that the common objective of all the investigations being carried out is to provide basic data which will help to clarify many of the problems of radio propagation and thereby lead to improvements and developments in radio communication.

In Table 1 the six Disciplines concerned in some way with the study of the atmosphere are set out with a brief explanatory reference in each case. From the restricted viewpoint of the radio engineer mentioned above, the most important Disciplines are Nos II (Meteorology) and V (Ionosphere): these relate to the lower and upper levels of the atmosphere and have close connections with propagation of radio waves in the higher and lower radio-frequency bands respectively. However, both the long-term changes in the ionosphere and the short-lived disturbances called ionospheric storms are controlled by the sun's radiation, and when studying them information on solar activity (Discipline VI) is indispensable. None of this vitally important radiation ever penetrates to ground

level and, in the ordinary way, its existence can only be inferred by indirect methods such as observation of the changes in the geomagnetic field (Discipline III) or the photographic and spectrographic analysis of the auroral light and airglow emitted from the higher levels of the atmosphere (Discipline IV).

In recent years the direct measurement of the solar ionizing radiation has become practicable using rockets (Discipline XI), by means of which suitable radiation detectors can be sent up to great heights where the radiation is still strong enough to be measured. These rockets can also carry other instruments into the ionosphere to make *in situ* measurements which cannot be made at ground level using radio probing methods.

Organization and Planning

The world-wide planning and co-ordination of the whole I.G.Y. programme is the responsibility of the Special I.G.Y. Committee (known as C.S.A.G.I.), which was set up by the International Council of Scientific Unions and has its Secretariat in Brussels. For each of the Disciplines, a C.S.A.G.I. Reporter has been nominated who is responsible for the broad planning, on an international scale of the scientific programme within his Discipline.

So far as the United Kingdom is concerned, the Royal Society has been responsible for the preparation of the many programmes to be undertaken or sponsored by universities, government departments, or other institutions. Since 1952 the detailed planning of this work has been the task of the British National Committee, acting on behalf of the Royal Society, under the chairmanship first of Professor Sydney Chapman and now of Sir James Wordie. This committee includes fifteen National Correspondents, each of whom is an expert in one of the fifteen Disciplines, and three of these also act in an international capacity as C.S.A.G.I. Reporters.

It is fitting that the United Kingdom, as one of the major world centres of radio communications, should play a prominent part in the Disciplines concerned with the atmosphere and therefore with radio propagation. Excluding the numerous stations which will make surface meteorological observations, about 130 temporary or permanent observing stations, sponsored partly or wholly by the U.K., will be making measurements in many parts of the world during the I.G.Y. These range geographically from the Royal Society Base at Halley Bay in the Antarctic to an Ocean Weather Ship stationed between Greenland and Iceland; and from Fanning Island in the Pacific Ocean to stations in the West Indies.

Sounding the Ionosphere

Until very recently, only about 50 observatories in the world issued regular bulletins of ionospheric data. From these data the ionosphere equivalent of the meteorologists' synoptic charts have been built up, but this has been difficult because of the need for interpolating contour lines in parts of the world for which no data are available. During the I.G.Y., it is hoped that the number of ionospheric observations will be trebled. This will undoubtedly lead to more accurate charts of ionospheric data even though the density of stations in some areas will still be less than the ideal. Six observatories of this kind, including two in the Antarctic, have been sponsored by the U.K. and are in regular operation.

Ionospheric Storm Forecasting

The world-wide network of ionospheric observatories provides the basic information on which a few countries, including the U.K., base their monthly forecasts of ionospheric conditions. These forecasts refer to quiet conditions in the ionosphere and do not take into account the possibility that disturbances may occur which are capable of causing interruptions to radio communications lasting perhaps for several days. Attempts have been made in the U.S.A. to give advance warnings of such interruptions, but it is questionable whether the present reliability of these warnings is high enough to justify their use under operational conditions. In the U.K., no serious attempt has yet been made to set up an ionospheric "storm-warning service" of this kind. Ionospheric disturbances are the result of unusual outbursts of solar activity, which cause simultaneous disturbances in the geomagnetic field and are often accompanied by displays of aurorae. Thus, a study of any of these phenomena must include studies of the others and it is also important, particularly during disturbances, that observations should be made concurrently on all of them.

Simultaneous world-wide observations of many different kinds during unusual solar activity have, in the past, not been easy to arrange in spite of the obvious need for them. Great pains have been taken to ensure that when the need arises during the I.G.Y. series of measurements can be made concurrently in all parts of the world. This has been achieved by setting up a World Warning Agency in the U.S.A., the duty of which will be to receive and collate frequent reports on solar activity from all parts of the world and to issue warnings by radio and telegraph to investigators everywhere through the appropriate national organizations.

Solar activity will probably remain very high throughout the I.G.Y. and there will, without doubt, be numerous occasions when these co-operative measurements will, for the first time, result in fully documented descriptions of outburst of solar activity and the resulting ionospheric, geomagnetic and auroral

effects which accompanied them. This type of information can hardly fail to lead to a much clearer insight into the mechanism of ionospheric disturbances and the relation between the different varieties of solar and terrestrial disturbances. It may, in consequence, be possible to use information gained in this way during the I.G.Y. to improve the accuracy of ionospheric storm forecasting, and perhaps to suggest methods of minimizing the interruptions caused to communications.

Ionospheric Absorption

The earliest measurements of ionospheric absorption of radio waves were made in England over twenty years ago, and during the I.G.Y. nine stations sponsored by the U.K. will be in operation. These stations will measure the strength of radio signals received either directly from extra-terrestrial sources or indirectly from ground transmitters after reflection from the ionosphere. Measurements of this kind are difficult to make reliably, and very little information is available at present on ionospheric absorption and its variations in different parts of the world. Absorption in the ionosphere is one of the main factors which determine signal strengths at ranges beyond that at which the ground ray is still important. It is to be hoped that the additional data acquired during the I.G.Y. will make possible more accurate calculation of field-strength in the h.f. band than are possible at present.

It is important to remember that the readability of a radio signal depends not on the absolute field-strength but on the signal-to-noise ratio at the receiver. At many frequencies, the main source of noise is the cumulative effect produced by distant thunderstorms and known as atmospheric radio noise. It is expected that the additional coverage provided by the expanded network of noise-measuring stations during the I.G.Y. will improve the accuracy of the contour maps of atmospheric noise level which are now used when specifying transmitter powers and aerial design.

Winds and "Whistlers"

The ionospheric measurements planned for the I.G.Y. also include investigations which have less obviously utilitarian objectives. Like the lower atmosphere, the ionosphere has a wind system about which very little is yet known. Methods for measuring the speed and direction of these winds have been developed in recent years and used at a few isolated places, but the quantity of data available is too small to allow the results to be presented as a coherent picture. The data from the additional stations being installed for the I.G.Y. will provide the first opportunity for a world-wide analysis of the circulation at the highest levels of the atmosphere. It is even possible that some means may be found of correlating information about ionospheric winds with corresponding data at lower levels.

The recording of "whistlers" has aroused much interest during the last few years. An audio-frequency "Whistle" is triggered off by a lightning flash and travels through the ionosphere into space, but always along a geomagnetic line of force. Hence, a whistle generated at a high northern latitude will reach the earth again at a high southern latitude, but only after having reached a height of several thousand miles. This is far above the electron density peak of the Appleton layer, beyond which normal radio sounding techniques cease to be of any use. The study of whistlers is unique, therefore, in the sense that it can give information about the electron density of the outermost fringes of the ionosphere. It is too soon to say to what practical uses whistlers might be put, but the possibility of using them as a navigational aid has been mentioned.

Tropospheric Propagation

During and since the war, the propagation of radio waves through the troposphere has received considerable attention and the science of radio-meteorology is now well-established. Abnormal propagation due to the refraction suffered by radio waves passing through the lower atmosphere must be allowed for in the design of television services or radar equipment, and in many other applications of radio waves in the higher-frequency bands. A rough correlation between different types of weather and the degree of atmospheric refraction has been established in some parts of the world. Unfortunately, further progress in such investigations is often hampered by lack of precise information on the vertical gradients of temperature and water-vapour content which control the changes in refractive index with height. The use of radio sounds for detecting these

gradients is increasing and the greater frequency with which soundings will be made on certain special days during the I.G.Y. ought to provide the basic material for more detailed investigations into the connection between the different kinds of weather and the refractive properties of the atmosphere.

Handling the I.G.Y. Data

During the planning of the I.G.Y. it has always been appreciated that the efficient use of the vast amount of data which will accumulate as the result of the intensive eighteen-month series of measurements presents a problem. There is always the risk of laboratory notebooks and tables of observations being locked away until some nebulous date in the future when the experimenter expects to have the opportunity and the inclination to analyse them. To obviate this danger, it has been agreed by the participating nations that copies of the data obtained during the I.G.Y. shall be deposited in each of a number of World Data Centres to which any *bona fide* investigator may go for information or from which he may purchase copies of data. The European Centre for ionospheric and atmospheric noise data will be at the Radio Research Station at Slough, and others in corresponding laboratories at Tokyo, Moscow, and Boulder (U.S.A.). Thus, for many years to come, all the essential data will be reasonably accessible to anyone who may wish to investigate the many outstanding problems of radio propagation and allied subjects.

Radio engineers will feel satisfied with the outcome of the I.G.Y. if these investigators can use this great bulk of data to construct a satisfactory theoretical frame-work which can be related to the practical day-to-day problems which confront them.

LETTER TO THE EDITOR

Sir,—I was very interested to read in your January issue, the resolutions of the Radio Manufacturers on television. In my opinion, the motion of Messrs. Harding and Bell did not go far enough. That the Government must take the operative decision is not gainsaid, but the time for defining one of two already explored possibilities has long since passed. The industry surely has enough operational data to take a positive stand and URGE the Government to adopt the C.C.I.R. 625-line standard. The thing seems clear-cut to me—the public has a right to the better picture, other things being equal, as they are today in practice.

A further resolution called for suggestions on a promotional campaign, but it is a pity this was carried as an amendment and not an addition to one proposing a sub-committee to pursue the early inauguration of TV. The public is interested the moment anyone talks commonsense about it; I found this in my election campaign.

The time is ripe for frequent practical demonstrations but it is quite useless letting people "see themselves on TV" at industrial fairs where screens are subject to extraneous glare, giving a completely false impression of the normal product. Last year, Mr Doug. Harris produced a closed-circuit fashion show here which, with the aid of a zoom lens and imagination on his part, was a highly commendable achievement. Public reaction was excellent; indeed, advertisements had to be published apologising for the cessation of showings after the scheduled date.

In my view, the closed-circuit telecast is the best tool in the industry's hands at this stage and overcomes the restrictions of an experimental licence and exclusive audience. The latter undoubtedly serves an excellent purpose, but more can be done and I, for one, hope the conference resolutions will be supported strongly and in practical fashion at the earliest possible date.—I am, etc.,

C. G. COSTELLO

For the Amateur

ANODIZING ALUMINIUM SHEET

Amateurs who may often have admired the finish of commercial aluminium articles do not always realize that it is quite possible for anyone, without special equipment, to perform the anodizing and dyeing of aluminium. The most important function of anodizing is to protect the surface from corrosion, but a colouring process, which can follow the anodizing, can often enhance the appearance or eye-appeal of a well-made piece of equipment.

Introduction

The first step is the cleaning of the material to be anodized. The process is not at all successful unless every trace of dirt or grease is removed. This refers to the minute amounts of grease left by handling with clean fingers, and not to the amount that may be collected by dropping the work into a tin of dripping!

Thus, a good scrubbing with soap and water is the first step of the process. The water is best hot. After this, final traces of greasy substances are removed by washing in some solvent that dissolves oils and greases. The exact solvent used does not matter very much, except that carbon tetrachloride is not satisfactory, nor is turpentine. Perhaps the best and most readily obtained solvent in this country would be Dulux thinners. The work is carefully washed over with a cloth saturated with the thinners, care being taken to hold the work only by edges that do not matter. After this, the work is set on a clean towel or piece of newspaper to dry, and thereafter it should be handled only with a clean dry cloth, and not touched with the fingers.

Next Step, Etching

The next step in the process is to etch the surface of the aluminium to give it the desired degree of matt finish. This can be controlled simply enough merely by the length of time the work is allowed to stay in the etching bath. The etching is done with a strong solution of caustic soda or caustic potash. Either will do, and there is no need to use material of "A.R." (Analytical Reagent) quality. Ordinary household caustic soda, such as is obtained in 1 lb. tins is quite satisfactory. The main requirement is a vessel large enough to take the work, so that it can be totally submerged during the etching process. An ordinary tin or enamel bucket is ideal for the job. A pound of the caustic is dissolved in as much warm water as is needed to submerge the job, which is then suspended in it with a string tied round it in any convenient way. As soon as it is immersed, the aluminium starts to bubble, and as the etching progresses, the surface of the job takes on a velvety matt appearance. From time to time, the work can be removed for inspection, and the etching is allowed to go on until the desired

degree of matt finish is achieved. At this stage, it is removed and washed in running water to remove excess caustic soda. It is a good idea to time the etching process, and to take a note of the exact dilution of the caustic solution. If both these things are known, it is a simple matter to obtain exactly the same result subsequently with another piece of work, so that it will match the appearance of the first, if this is desired.

Precautions During Etching

There are only two precautions to observe during etching. One is to remember NOT to use an aluminium saucepan or dish to hold the work. The dish will get etched away too, and it does not take much of that treatment before it no longer holds water! The second is to treat the concentrated caustic solution with respect. It does not need to be long in contact with the skin before a painful burn results, although a little on the hands will cause no trouble as long as it is not allowed to stay there. Above all, protect the eyes from splashes.

The Anodizing Process

This consists in providing the work with a thin, but very tough outer covering of aluminium oxide. This is accomplished by electrolysis of the work in an acid solution, with the work itself as the positive electrode. Hence the term "anodizing", since the work is the anode in the cell used for the electrolysis, the negative electrode, or cathode, being any piece of scrap aluminium. Not only is the coating of oxide very tough; it is also an excellent insulator, and this prevents the use of anodizing when a good electrical contact is required between two pieces of aluminium, as, for example, when these form part of a chassis whose individual pieces must be electrically bonded together. However, where electrical contact is needed, it is possible to scrape off the anodizing, while self-tapping screws make intimate contact to the interior of the aluminium, and do not rely on a surface contact, which will hardly ever succeed in breaking through the film of oxide. Since anodizing is used mainly for front panels, for the sake of appearance, and protection from scratching, this question of electrical bonding need not be taken to heart too much, except where good electrical contact to the anodized part is essential.

Sulphuric Acid Used

A fairly strong solution of sulphuric acid is needed for the electrolysis, and this is best made up from concentrated acid, which can be obtained from some garages, who use it to make up their own battery acid, or from any factory which makes car batteries. It can also be obtained from scientific suppliers. The concentrated acid is a very heavy, viscous liquid which requires **VERY CAREFUL HANDLING**. If concentrated sulphuric acid is spilt on the clothes, there will be no hope for them, because even if it is washed out immediately, it will have bleached spots on the material, and if it has *not* been properly washed out of the material, the latter will just disappear after a day or two, where the acid touched it. Therefore, **ALWAYS** use a stout protective apron. Like strong caustic soda, concentrated sulphuric acid also attacks the skin, and once more one should be very careful not to get it in the eyes.

The acid is not used in concentrated form, but must be diluted in the proportion of one part by volume of the acid, to eight parts by volume of water. It can thus be seen that no very large quantities of the concentrated acid will be required.

Mixing the Acid—Take Care!

When diluting sulphuric acid, *THE ACID MUST ALWAYS BE POURED INTO THE WATER*, and *NEVER* the other way round. Those who have had any dealings at all with the substance will no longer require this warning, but those who have not should heed it well. It is not an old wives' tale.

When the dilution of sulphuric acid takes place, a great deal of heat is generated in the solution. When the acid is added to the water, this heat gradually spreads through the solution, and no harm is done. But if water is added to concentrated acid, local heating where the water impinges on the acid, is so great that steam is generated, and vicious spitting takes place. If one is lucky, all one gets is damaged clothes, but should a spot of the acid get into an eye, then it is as good as lost.

We have not said all this to put readers off, but merely to indicate that there is a very good reason for our warning above. As long as the acid is diluted as directed, namely by pouring it slowly into the water, there is not the slightest danger of any untoward happening.

Performing the Electrolysis

The electrolysis must be carried out with direct current. Only 6 volts is enough, but the process will be slower than if a higher voltage is used. 12 volts is plenty, and the car battery can be called in for unscheduled duty.

For this process, an aluminium saucepan is an ideal container in which to carry out the work, since otherwise, a separate piece of scrap aluminium is needed for the cathode. With an aluminium container for the work, this forms the cathode, and is connected to the negative battery terminal. The work is suspended in the acid, not touching the container, if this is a metal one, and is connected to the positive battery terminal. There is no need to measure the current passing. It will not be great enough to worry any storage battery. The progress of the anodizing is followed with the aid of an ohm-meter.

Initially, give the electrolysis half an hour. Take the work out of the bath, rinse it liberally in warm water to remove the acid, and then dry it over a warm stove, or in the oven. When it is quite dry, take the ohm-meter, and touch the two prods lightly on the work. If the ohm-meter, on its high range, indicates an open circuit, and continues to do so as the prods move gently about over the surface, then the job is complete. If a small amount of current flows here and there, more electrolysis is needed, so put the job back in the bath and give it some more. It is a good idea to use a small scrap of material as a control for the main job. The small piece can be tested for completeness of anodizing, thus avoiding unnecessary handling of the main work piece.

When the anodizing is complete, there will have been little change in appearance, other than the addition of a light varnish sheen to the matt surface.

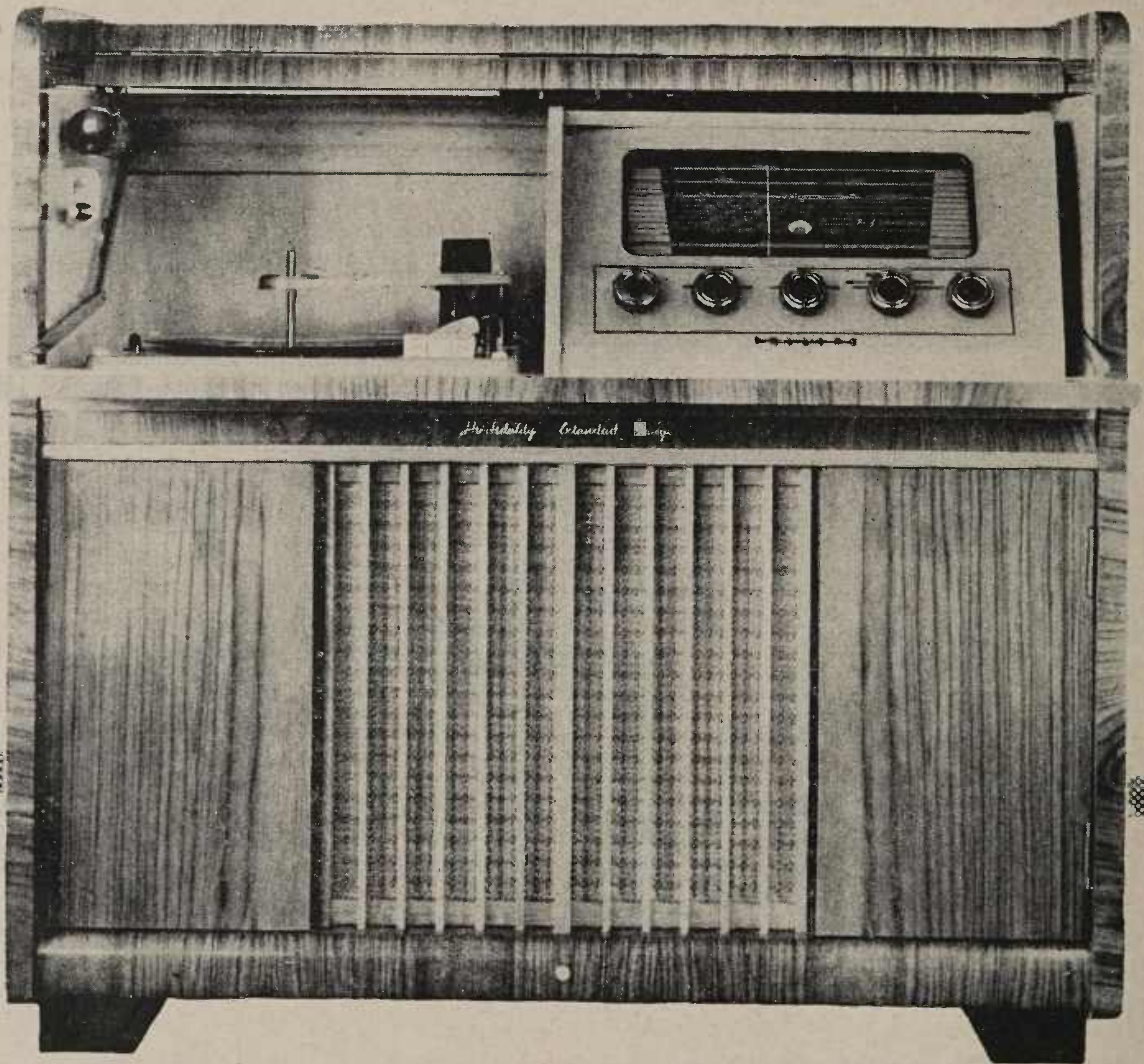
For protecting the surface, the colourless anodizing that has been carried out is perfectly effective, and apart from washing and drying, no further treatment is needed, especially if you like your work the colour of matt aluminium. However, it is also quite a simple matter to dye the film of oxide just produced, and produce almost any desired colour.

Dyeing the Aluminium

Of course, this heading is not quite true, because it is the film of oxide that takes the dye, and not the aluminium itself. First of all, obtain a packet of household dye of the required colour, and make it up to twice the recommended strength. Then add about a tablespoon of dilute acetic acid—ordinary white, or even brown vinegar will do—and immerse the work (previously washed free of the acid bath) in the dye. Half an hour will be enough to impart the requisite colour. Now all that remains is to steam-treat the work, and set the dye. For steaming, place the household bucket on the stove and boil a small quantity of water in the bottom of it. Suspend the work in the bucket, just clear of the water, cover with a cloth, and allow to steam for a quarter of an hour.

For fixing the dye, dissolve nickel acetate in water, to a strength of $1\frac{1}{2}$ oz. per gallon, and immerse the steamed work in this solution for fifteen minutes. Remove, wash, and dry.

Discover **HI-Z**, the great



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- ★ Luxurious cabinet, with Philips exclusive Glide-O-Matic opening and closing action; a gentle push to open, a touch to close.
- ★ Three PHILIPS high impedance speakers developed for use with an output circuit virtually free from intermodulation distortion.
- ★ PHILIPS fully automatic Maestro Golden Touch-O-Matic record changer; push buttons to start, stop, repeat*, reject and select your record size.
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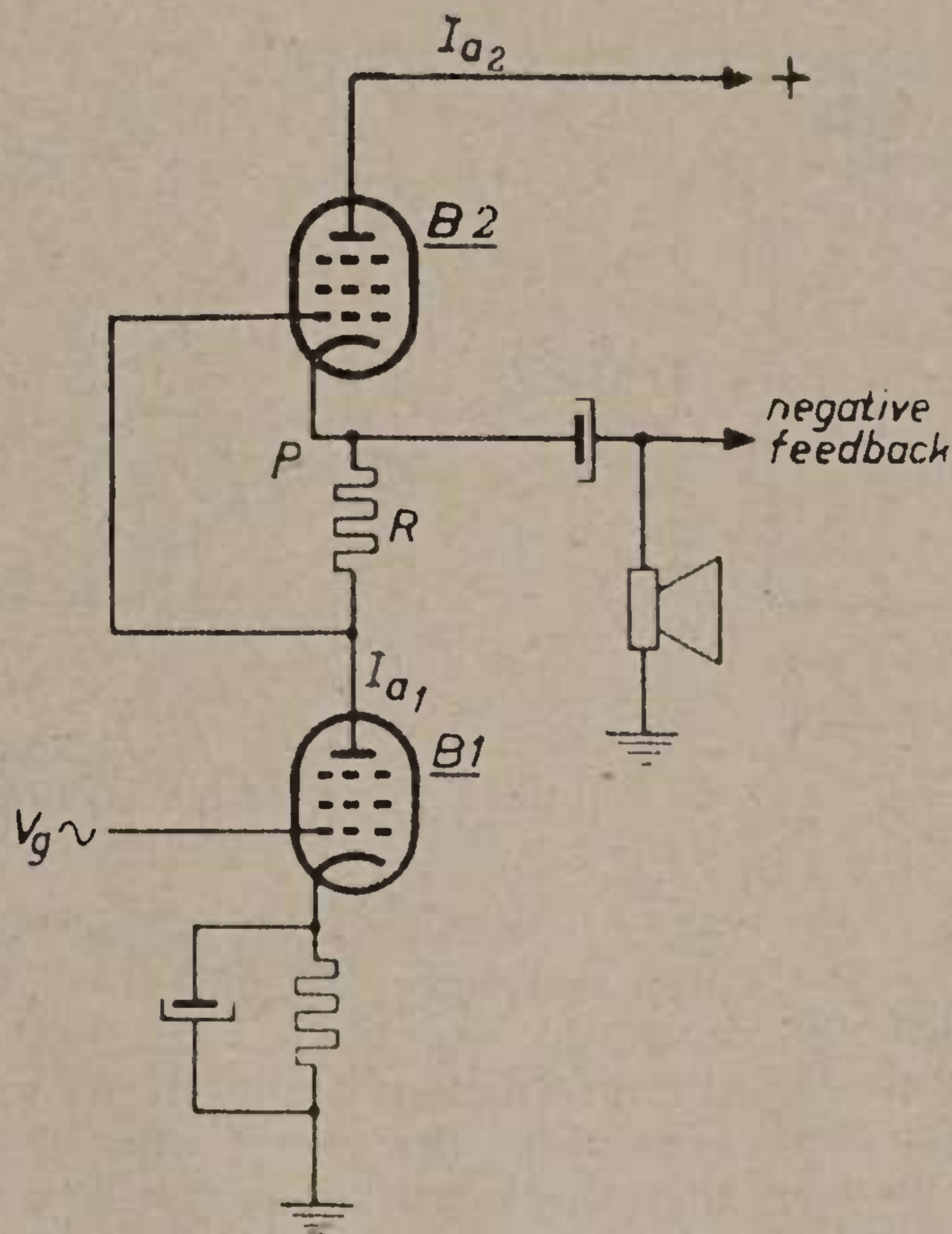
st development since HI-FI

WHAT IS HI-Z?

has just made its appearance in New Zealand, here are some facts concerning this greatest development in HI-FI.

In conventional receiver design, a loudspeaker transformer is a necessity in order to match the low impedance of the loudspeaker to the output valve, requiring a high load impedance. Unfortunately, the use of a transformer, however well designed, has serious limitations which result in a poor frequency response of the audio being adversely affected.

PHILIPS HI-Z musical equipment does not use a transformer. The loudspeaker itself is directly connected as a load to the specially developed output circuit, eliminating the major cause of distortion. For this purpose the high impedance loudspeaker is used in combination with the PHILIPS special single-ended push-pull output circuit. This combination is known under the name HI-Z (Schematic diagram in the diagram at left).



ADVANTAGES OF HI-Z

1. Better frequency response curve, especially for low note reproduction, due to the absence of a loudspeaker transformer—the weak link in conventional HI-FI equipment.
2. High efficiency of output stage, since the full electrical output of the power valve is dissipated in the loudspeaker.
3. Less distortion.

The future will undoubtedly show the HI-Z output stage to be one of those basic PHILIPS developments that have more than once in the past re-shaped sound-reproduction design.

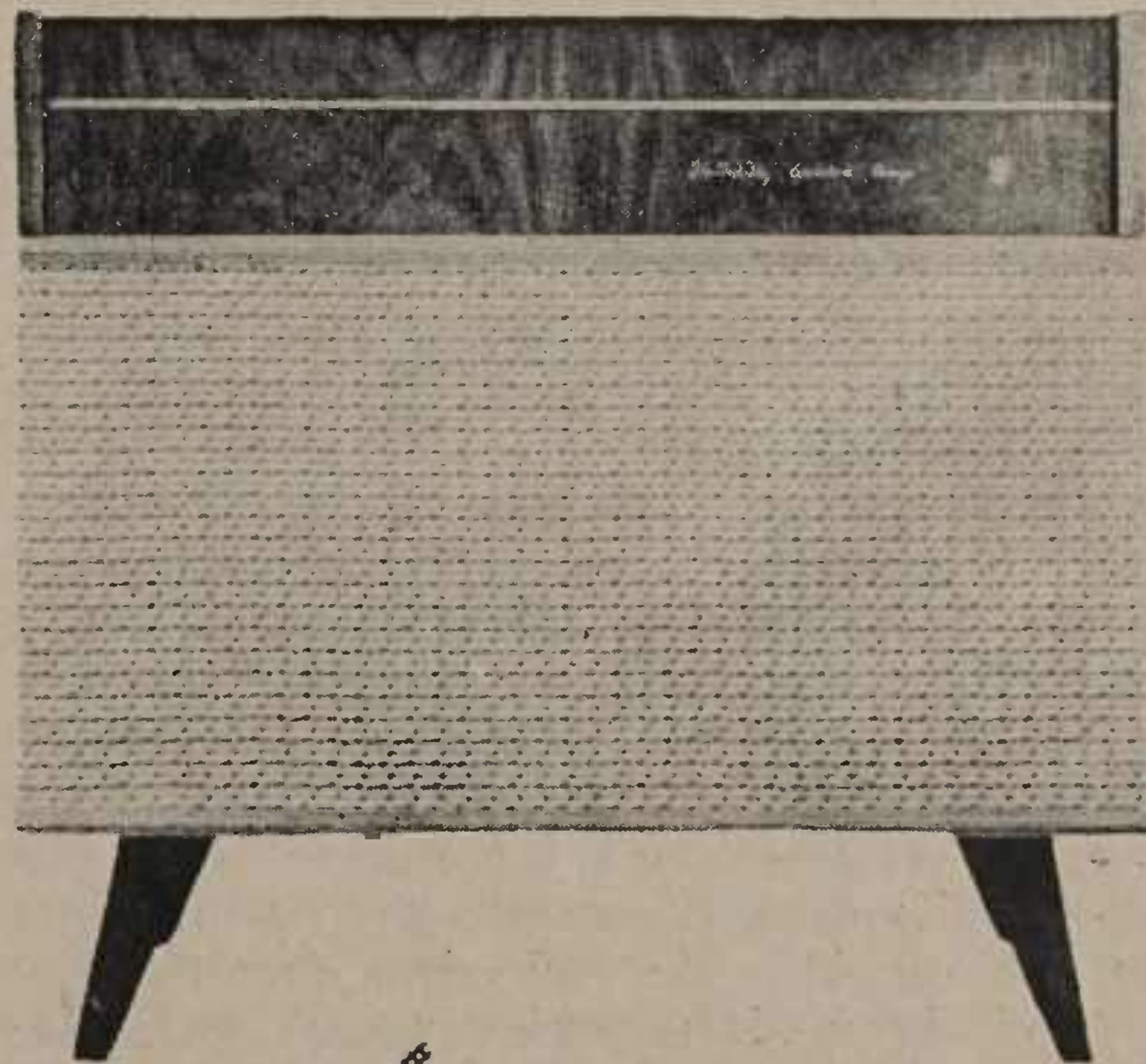
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- ★ 10-valve performance from 7 multi-function valves, giving outstanding world-range reception.
- ★ Attractive Surrey-Walnut solid-core veneer for extra strength and permanent beauty.
- ★ Utilises the most advanced "push-pull" circuitry.

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Transistors

TRANSISTOR AUDIO AMPLIFIERS—Part 3

In last month's instalment of this series, we discussed at some length the impedance relationships existing in both valve and transistor amplifiers, when resistance-capacity coupling is used. In this instalment, the argument is extended to include transformer-coupled transistor amplifiers, and it is shown why these give much more gain than does the same line-up with R-C coupling.

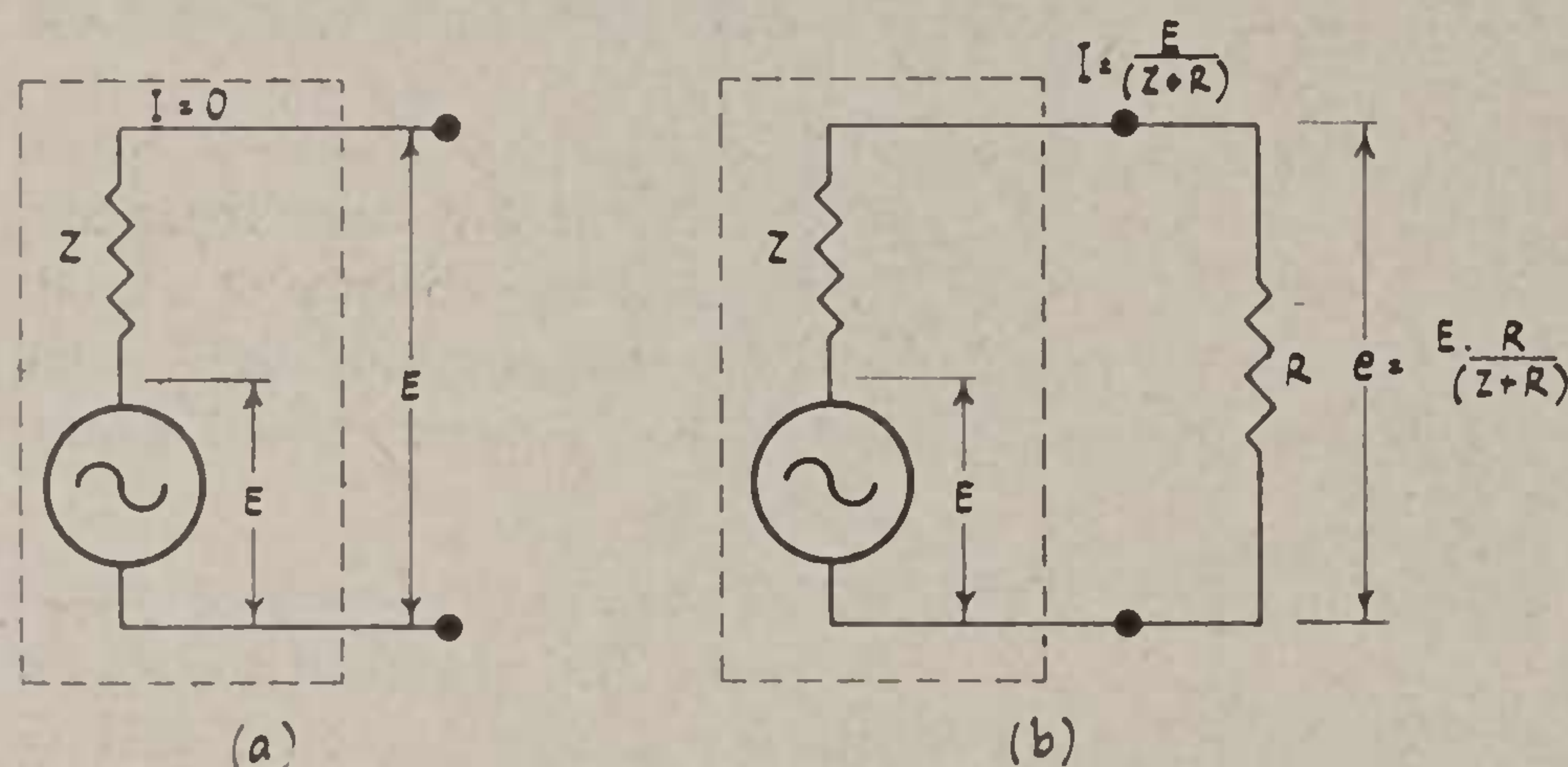


Fig. 8

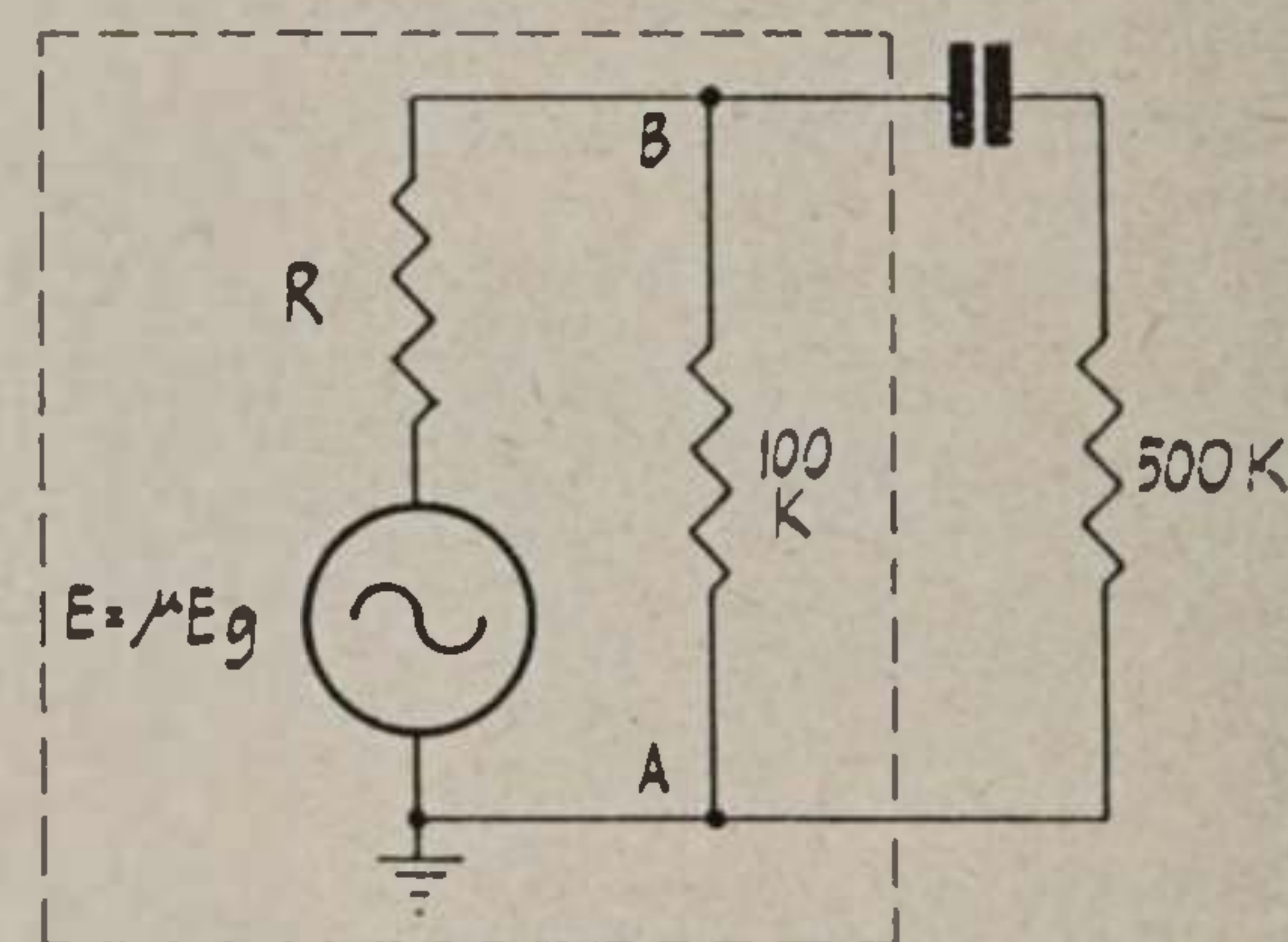


Fig. 9

Impedance Matching Between Stages

A good deal of the last instalment was taken up with the consideration of fundamental ideas, such as the output impedance of any source of voltage, and in particular, the output impedance of transistor amplifier circuits. First of all, let us go back just a little and see where we got to.

In Figs. 8 and 9 (which are re-printed here for convenience) we had examples of what the text-books call *equivalent circuits*. This technical-sounding name is merely a disguise for a notion that is very simple indeed. The equivalent circuit of a valve or transistor amplifier stage is nothing more than a *simplified* circuit, in which such extraneous matters as the D.C. supplies, and biasing circuits, are omitted, and only the essential, signal-handling part of the circuit is shown. The transistor (or valve) is shown as an imaginary generator, of zero internal impedance, in series with an impedance equal to the actual internal impedance of the transistor or valve concerned. Across this series combination we have the load resistor, across which the output voltage is actually developed, and its two ends form the output terminals of the amplifier stage. We now have a very simple circuit that represents in all important respects, the circuit under discussion. So simple is the equivalent circuit that it can very easily be used for such purposes as finding out the effect of connecting any particular external load to the amplifier.

Fig. 9 is perfectly general, which is to say that it can apply equally well to any valve, irrespective of

type. If we know its amplification factor, μ , and its plate resistance, R_p , and if we know, as we obviously must do, the size of the load resistor, we have all the information needed if we are to work out the behaviour of the circuit when the load is connected. If the valve is a pentode, R will be much larger than 100k, so that the internal impedance (the impedance we see if we measure the impedance of the output terminals before the load is connected) is very nearly equal to the value of the load resistor, 100k, in this example.

It was mentioned earlier that the behaviour of a transistor was in some ways very like that of a pentode. This is because, like the pentode's, the transistor's internal impedance is high compared with the value of load resistance customarily used with it. To illustrate this we have Fig. 10. Here, we have labelled the generator $I_c = a' \cdot I_b$. This is simply a statement of the fact that in the grounded-emitter arrangement, the collector current I_c is equal to the base, or input current, multiplied by the current amplification factor a' . This last is a figure that is given in the data sheets on transistors, just as for a triode valve, the amplification factor is always given. As we have said before, it is more usual, simply because it is easier, to talk about the current amplification of a transistor stage rather than its voltage amplification, although the latter undoubtedly takes place. This is why we have changed the imaginary generator into one whose current output we know, rather than its voltage output.

The generator is in series with the internal impedance of the collector, and this we have given a value

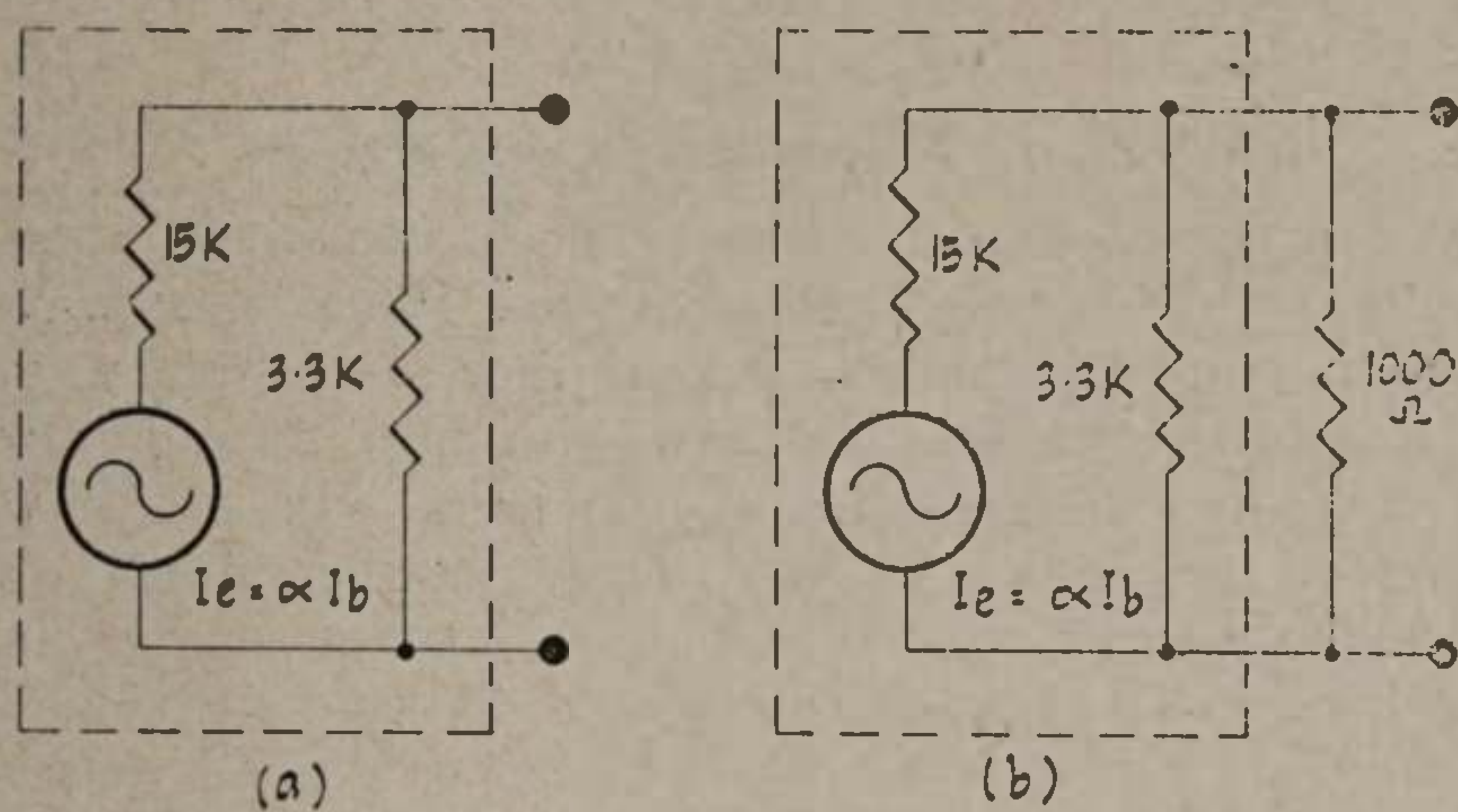


Fig. 10

of 15k., which is typical of many actual transistors. The load resistance has been shown as 3.3k., which once more, is typical of the loads used in actual transistor amplifiers. In Fig. 10 (a) we have drawn the equivalent circuit of the stage as it appears when no external load is connected to it. Since the load resistor is much smaller than the internal resistance of the transistor, the output impedance of the amplifier is just a trifle lower than 3.3k., actually, the numerical value of 3.3k. in parallel with 15k. For approximate working-out purposes, we can therefore say that the stage's output impedance is actually 3.3k.

Input Impedance of Transistor Stages

The input impedance of a grounded-emitter transistor stage is likely to have any value between, say, 200 ohms and 2000 ohms, for small transistors. Let us assume a value of 1000 ohms, for purposes of illustration. When the next stage is connected, therefore, its input impedance will be connected directly across the output terminals of the amplifier represented by Fig. 10 (a). We will now have the arrangement shown in Fig. 10 (b). We can see that the output current, or voltage, of the transistor must be quite drastically affected by attaching the load, unlike connecting the grid circuit of the next valve in a valve amplifier. We can easily prove this by working out the output voltage of the first stage before and after attaching the load, and comparing the results.

We do not have to work out actual values to do this. The collector current flows through the internal resistance of the collector, and the 3.3k. load resistor in series with it. The total resistance is thus 18.3k. When the load is connected, we place 1000 ohms (the input impedance of the next stage) in parallel with the 3.3k. resistor, so that now we have a resistance of about 800 ohms (3.3k. and 1k. in parallel) in series with the collector's internal resistance. The total is now 15.8k., which is not very different from the original figure of 18.3k., so that to a first approximation we can say that the collector current remains constant even after the load is connected. We thus have two cases, in which

the same output current flows in the first, through 3.3k., and in the second, through 800 ohms. Thus, the voltages across the output terminals must be in the same ratio in the two cases. Therefore, the output voltage *after* the load is connected will be approximately a quarter of the output voltage *before* it was connected.

So What?

In case you are wondering just why we have gone to all the bother of proving this, it is simply to show that when dealing with transistors, it is NOT possible to work out what each stage will do, without reference to those before and after it, and then multiply the separate stage gains together. For a three-stage amplifier, resistance-coupled, this procedure would tell us a very wrong answer, and would in fact predict a gain as much as eight times higher than the actual gain achieved. **THIS IS A DIRECT CONSEQUENCE OF THE LOW INPUT IMPEDANCE OF TRANSISTOR STAGES.**

It is for precisely this reason that when transistor amplifier stages are cascaded by means of resistance-capacity coupling, it is not possible to obtain the maximum gain of which the stages are capable. If we want to do this, transformer coupling must be used. To give some idea of the magnitude of this effect, it may be stated that a transistor audio amplifier stage used with transformer coupling may have a gain of some 40db., while the same transistor, with resistance-coupling will have a gain of only about 20db. A loss in possible stage gain of 20db. is a high price to pay for the convenience and cheapness of resistance coupling, so that in applications in which it is important to obtain the greatest gain from the smallest possible number of stages, transistor amplifiers always use transformer coupling, in spite of the expense of the coupling transformers, compared with a condenser and a resistor. If readers have sometimes wondered why transformers are used so much more in transistor circuits than with valve circuits, this is the real answer.

Transformer Coupling

First of all, we should point out that in discussing transformer versus resistance coupling, we are referring only to low-level stages. These correspond closely to voltage amplifier stages in valve amplifiers, in that neither are expected to produce appreciable power output. Power amplifiers using transistors, like those using valves, almost always employ a transformer between them and the load-speaker, modulated R.F. amplifier, or what have you. Unlike valve circuits, they almost always have a transformer as the input coupling device. Thus, it is really only in low-level stages that a choice exists between the two forms of coupling.

Earlier, you will remember, we pointed out that the input impedance of a transistor stage is quite low—somewhere between 200 and 2000 ohms, while the

output impedance of a similar stage is of the order of 15,000 to 25,000 ohms. With valves, the input and output impedances are high and low respectively, so that when tubes are cascaded by R-C coupling, there is only a minute and negligible effect on the stage gain of each. With transistors the situation is reversed, so that if maximum stage gain is to be obtained, it is necessary to indulge in impedance matching, between stages. Now the only way to do this is to use inter-stage transformers. Suppose, for example, we have a first stage with an output impedance of 20,000 ohms, which is to feed a second stage whose input impedance has a value of 1000 ohms. In order to match the one to the other, the coupling transformer must have an impedance transformation ratio of 20:1, and this is given by one with a turns ratio of 20:1, approximately 4.5 to 1. In practice, it is as simple as that, although for the designer of the circuit things are not quite so easy. The reason is that it is not a simple matter to find out just what the output and input impedances of a transistor are, for the output impedance depends on that of the previous stage, while the input impedance depends on the load impedance connected to the stage. However, these things are the worry of the circuit designer. But if you (and the writer) wish to design our own transistor amplifiers, it will affect us too. Even if we are knowledgeable enough to use the published characteristics of the transistors to work out the required transformer ratios, it does not follow that we can build our amplifier, so designed, unless we have special transformers made, or else wind them ourselves. This is a distinct drawback, so that for amateur purposes, and also for applications in which price is a consideration, one often finds resistance coupling used instead, with one or even two more stages than would be needed had transformers been used.

Some of the advantages of resistance coupling in valve circuits still apply when transistors are used. A most important one is the relative ease with which a given frequency response may be attained with R-C coupling. Similar considerations apply to phase shift. This is not very important in audio amplifiers, as such, but it is important when we propose to use negative feedback round the amplifier. Since a transistor amplifier is very likely to contain two transformers (input and output of the output stage) even when the low-level stages are resistance coupled, it is not difficult to see that only a limited amount of negative feedback can be applied without incurring the danger of oscillation. In fact, this is one of the reasons why really low-distortion amplifiers are difficult to build with transistors. In the first place, they produce more distortion than valves, and secondly, the circuits, containing as they do more than one transformer, prevent us from effecting as much improvement as we might, by limiting the allowable degree of negative feedback. However, there are some special dodges that can be used to produce transistor amplifiers of very low

distortion, and some of these will probably appear in a later article.

Different Transistor Connections

We started off our discussion of transistor audio amplifiers by showing how there are three basic ways of connecting transistors, just as there are three ways of connecting valves. Readers who have browsed to any extent through transistor circuits will not have failed to be struck by the almost universal use of grounded-emitter circuits. Indeed, except in special circumstances, grounded-base and grounded-collector circuits are hardly ever seen. There is a good reason for this, which our previous discussion of input and output impedances will help to elucidate.

In grounded-base circuits, the disparity between input and output impedances is much greater than with grounded-emitter arrangements. Typical values for the input impedance are 20 to 50 ohms, while the output impedance is usually of the order of 1 Megohm. In fact, the difference is so great that IT IS NOT FEASIBLE TO CASCADE GROUNDED-BASE STAGES, WITH RESISTANCE-CAPACITY COUPLING. In brief, the very low input impedance of the following stage reduces the gain of the preceding stage so much that what is left is not worth having. For a different, but related reason, even transformer-coupled grounded-base stages are not much used.

This comes about in the following way. The output impedance of the grounded-base stage is so high that it is not practicable to build an inter-stage transformer which has enough primary inductance to give a reasonable low-frequency response. Exactly the same effect occurs with pentode valves, which also have an output impedance of about a megohm, and it also explains why pentode voltage-amplifier stages have never been used with transformer coupling.

With transistors, however, the situation is not quite the same. What we have just said refers to any attempt to couple grounded-base stages on an impedance-matching basis. Because of this difficulty with the transformer design, it can't be done. But it is possible to use transformer coupling, by purposely mismatching the output impedance of the first transistor. A transformer is used which reflects back the input impedance of the following stage so that it looks to the previous collector circuit like a load of some 25,000 ohms. In this way, useful gain can be had, but because of the large mis-match, it is not as great as can be obtained from the same transistors in grounded-emitter connection. Incidentally, when this mis-matching is done, the primary inductance of the coupling transformer need only be chosen to suit a load of 25,000 ohms, so that a practicable transformer design results.

Grounded Collector Circuits

We mentioned earlier that grounded-collector circuits resemble a valve cathode-follower rather closely.

That is to say, there is no phase inversion of the signal, the input impedance is high, and the output impedance is low. When we say that the input impedance is high, we mean high for a transistor circuit; however, it can reach as much as 50,000 ohms, while the output impedance is often very low indeed—about 25 ohms in a typical case. These properties of the circuit are sometimes useful in special applications, but are not very useful in transistor audio amplifiers, so that the grounded-emitter stage holds the field.

It might be thought that considerable difficulty might exist when one wants to feed a transistor amplifier from some device, such as a crystal microphone or pick-up, which has a very high internal impedance. The latter property means the same as saying that the device in question can deliver only a very small input current, on account of its own high internal resistance, and this is quite true. But the difficulty can be easily overcome by the simple expedient of placing a high value of resistance in series with the pick-up and the transistor's input circuit. This prevents the low input impedance of the transistor from short-circuiting the pick-up's output altogether, and allows the two apparently incompatible devices to be used together. It is in a case like this that one might expect the grounded-collector's high input impedance to be of value. That it is not is due to the following.

First of all, although high, the grounded-collector stage's input impedance is still much too low to enable the crystal mike or pick-up to be connected across it, as is usual with valve circuits. This means that a series resistance must still be used to prevent undue shunting on the input device. This, with the input impedance of the stage forms a potential divider, so that it is still not possible to apply the whole output voltage of the device to the transistor stage. Secondly, the maximum stage gain of a grounded-collector amplifier is a good deal less than that of a grounded-emitter one.

The result of all this is that when faced with this particular problem, the method of the grounded-emitter stage with series resistor can still give as much gain as the less conventional stage, and so we might as well have the convenience of making all stages similar in form.

Power Amplifier Stages

It is not intended to say a great deal here about transistor power amplifiers, but rather to leave them to an instalment of their own. However, this paragraph should serve as a mild introduction to their advantages and peculiarities.

The first and most important thing about transistor power amplifiers is that they are much more efficient than valve amplifiers. Thus, a transistor Class A power amplifier can actually have an efficiency of almost 50 per cent. (which is the theoretical limit) while a transistor Class B amplifier can have an efficiency of as much as 70 per cent. This is very important, in

itself, but when compared with valve circuits, the efficiency is much greater than a comparison between plate efficiency of the one, and collector efficiency of the other would indicate. This is simply because of the fact that transistors have no heater supplies, so that the over-all power efficiency of the transistor amplifier is very much higher than that of valve amplifiers.

Then again, the ability of transistor amplifiers to operate from low-voltage power supplies also contributes to over-all efficiency, since the losses associated with transformer-rectifier-filter types of power pack are avoided altogether.

As against these advantages, transistor power stages almost always need two transformers, each handling appreciable amounts of audio power. As a result, frequency response and phase shift characteristics are more difficult to attain satisfactorily than with valve amplifiers. This arises because the advantages of Class B operation are such that Class B amplifiers are almost always used for output powers of more than a few milliwatts, and therefore at power levels where valves would certainly be operated in Class A. Again, distortion in Class B amplifiers is always greater than that of Class A.

At the present time, the cost of transistor amplifiers is quite high, because transistors are more expensive than valves. However, some of this is often offset by the fact that no special power supply components need to be bought. However, the cost of transistor amplifiers is great enough to make it worth while to use them only when a valve amplifier will not do the job satisfactorily.

Even so, there should be a great future for transistor amplifiers in the public address field. Even now, ten-watt amplifiers are quite easy to build, so that installations requiring more power than this can easily be built up by using a number of small ten-watt amplifiers each feeding its own speakers, or with the outputs in series or parallel so that all amplifiers deliver their power to the same load. Since transistor amplifiers can be made very compactly, the use of only as many small units as a particular job requires will result in the possibility of carrying and setting up quite large P.A. systems in small cars or other vehicles that would have no hope of housing equipment of similar capability, but using valves. Already, one local manufacturer has produced a self-powered pre-amplifier unit employing transistors, specially for use in public address systems, and illustrations of this may be found elsewhere in this issue.

Transistors, too, should find a ready-made application in the audio stages of such things as mobile transmitter-receivers for taxi work. Using transistors for the pre-modulator and modulator stages will greatly reduce the power needed from a vibrator or rotary converter, which would then have to supply only the valves in the R.F. section of the equipment.

(To be continued.)

Receivers**WHAT MAKES A COMMUNICATIONS RECEIVER?—Part 5**

Previous instalments of this series have described some of the special features that are incorporated in communications receivers, and attention has been drawn to performance characteristics which assume greater than usual importance in this kind of set. This month we discuss several important matters which do not each require an article to themselves.

Selectivity and Fidelity

Since a communications receiver, as its name implies, is designed for a specific purpose, it is possible to do without all features that do not contribute to that purpose. In this way, the designer's job is sometimes made considerably easier than it might otherwise be. For example, there is no need at all to strive for a wide, flat-topped pass band in the R.F. and I.F. sections of the receiver, since even when used for speech communication, it is not essential to pass audio frequencies higher than, say, 3000c/sec. without attenuation. Such a bandwidth gives perfectly good intelligibility, as any user of a carrier toll telephone line will have noticed, and, since there often exists a very stern requirement for high selectivity, in order to combat interference, it is usually found that selectivity is the designer's aim rather than bandwidth. In recent years, the cry has been for more and yet more selectivity, and all sorts of schemes have been tried for achieving it. Commercial receivers have frequently failed to provide the sort of selectivity that amateur operators want, so that many of the schemes have been used by amateurs as attachments to existing receivers. We refer to such things as Q-multipliers, "Q-5ers" and so on, throngs of which have been described in the amateur literature.

Now, the more we manage to increase the selectivity of a receiver, the more important do certain apparently unrelated features become. For instance, there is the question of oscillator stability. If you are a CW man, for instance, and have managed to build into your receiver the sort of selectivity that most people dream about, you find out in no uncertain manner that the receiver contains at least two oscillators (possibly more), each of which is able to drift; as a result, your vastly improved selectivity is fine, as long as you are able to hang on to the signal. But with all this selectivity it is an almost superhuman job to find your signal again when once you have lost it, especially if the selectivity was being used not for fun, but to get away from some interfering signal right next door to him. Some super-selectivity schemes take very careful adjustment, and almost require a "ticket" to drive them, and this business of your selectivity being so great that oscillator drift nullifies the fact that the signal is crystal-controlled, does make rather special problems at once, but the addition of a not-too-complex

demands on the stability of all oscillators in the receiving system. From this, if you haven't thought much about it before, you can begin to appreciate that making very great improvements to the selectivity of commercial sets is not going to make only a few pounds difference to the price—it can easily double it. For another example, think of the dial drive mechanism. Under the heading of bandspreading, we said that increasing the mechanical bandspread at the expense of a little backlash produces no dividends at all. But if you try to operate a set with any form of super-selective attachment, and a dial with even the slightest bit of backlash, your only hope is to give up trying before the attempt impairs your reason permanently! Thus, additional selectivity makes increasing demands on the quality of almost everything in the receiver.

Variable Selectivity

Set designers have long realized that users want not only very high degrees of selectivity, but controllable selectivity as well. Back in the early 1930s, it did appear that the application of quartz crystals to selective filters had found the answer to both these problems at once by the addition of a not-too-complex or costly circuit to the set's I.F. amplifier. Indeed, it was not long before all the best and most expensive sets, commercial as well as home-brewed, sported a 455kc/sec. filter in the I.F. department. This was able to give what the CW men called "single-signal reception". That is to say, when the B.F.O. is turned on, and a signal is tuned through it, the heterodyne is heard only on one side of the carrier frequency, that which normally is heard on the other side having been cut off by the extremely sharp fall in response produced by the crystal. Receivers still come out with this same type of crystal filter, with its "Phasing" control, and another, usually called "Width". They really do work, too, when the associated circuits are properly designed, but they have one great drawback. You have to know something about them, and to adjust them very carefully, before you really get any results with them. Consequently, many who in the past were proud to show their friends that their set had a crystal filter, hardly ever actually used it, either through ignorance of its principles, or because it was too much trouble.

It might be said that this was bad engineering on the part of the designers, in that a feature that is inconvenient or difficult to use just remains unused—that is human nature—but at least in the earlier days of crystal filters this was not so. To make the multi-crystal receiver filters that are sometimes found today would have cost a king's ransom, and too few would have been able to afford it.

The complication of building a simply-controlled variable selectivity device, especially when crystal selectivity is wanted as well, has restricted their use to very few types of sets. Because of this, most sets make the selectivity as great as can be tolerated, by conventional means, and leave it at that. Under these circumstances, the degree of selectivity finally arrived at depends on the compromise decided on by the designer as the best. This really amounts to the fact that if you want both 'phone and CW reception, there is at least some justification for thinking in terms of a separate and specially designed receiver for each!

It is at this point that we come back to the thought of the double-superheterodyne.

Selectivity by Double Shift

In case readers may think that we have an excessive regard for the double superhet, having extolled its virtues before, we would point out in self defence that by far the greatest number of amateur-built "outrigger" attachments do no more than convert the conventional receiver into a double-shift one, so that if anyone is considering building a set rather than buying it, it seems not illogical to think of this type from the beginning. So far, our summary of its advantages has not included the fact that it is an excellent scheme for obtaining additional selectivity.

In the article on image interference, it was pointed out that the difficulty of obtaining good enough image rejection is what prevents us from using a very low intermediate frequency in the first place. Furthermore, if we use double conversion, we can have a high first I.F., giving good image rejection without difficulty, and a low second I.F., giving high selectivity more easily than at the original high I.F. Also, to complete the picture, the choice of 455kc/sec. as a standard figure is a compromise between these conflicting requirements.

In a communications receiver, we are less prepared than usual to accept compromises where none are necessary, so that the double-conversion set has an immediate appeal. At this point, however, we are discussing selectivity, so that some indication of how a low I.F. aids in obtaining selectivity is in order.

The Exact Significance of "Q"

Suppose that we have a choice of intermediate frequencies, and that we know that at any one we may

choose, we can have tuned circuits with Q-values of 100. This figure is easily attainable at any frequency we are likely to pick. Now there is a very simple formula which relates the bandwidth of a tuned circuit to its Q and the frequency to which it is tuned. It goes:

$$Q = \frac{f}{\Delta f}$$

in which f is the frequency in cycles, kilocycles or megacycles per second, and Δf is the frequency difference between the points on the response curve at which the response is 3db. lower than at the peak. More briefly, Δf is the 3db. bandwidth, and by rearranging the formula we have it that $\Delta f = f/Q$. With the aid of this simple bit of information many interesting things can be worked out.

For example, it tells us that the bandwidth depends directly on the centre-frequency, as well as inversely on the Q. Thus, if all tuned circuits have the same Q, their bandwidth is in direct proportion to their centre frequency. Suppose, then, that we have a single I.F. amplifier stage containing four tuned circuits, as most do. If we keep the circuit the same, but halve the frequency to which the stage tunes, we will have exactly half the bandwidth that we had before. It is very clear from this that if we have an I.F. stage working at 90kc/sec., its bandwidth will be exactly one-fifth that of a similar stage working at 450kc/sec., other things being equal. But other things are not equal, and in this case they favour the lower frequency quite strongly. For instance, it is possible to make circuits at 90kc/sec., or round about that figure, with much higher values of Q than can readily be obtained at 455kc/sec.

This explains why there was once a great demand for I.F. transformers from certain surplus equipment, with the magic frequency of 85kc/sec. We have always suspected that some people attributed some peculiar magic to this particular frequency, but this was only because they knew what sort of an I.F. amplifier could be built with three or four of these transformers, without realizing why!

Incidentally, there are some fairly common misconceptions about the selectivity obtainable with circuits of a given Q value.

Some Things to Know

While the inclusion of really high-Q I.F. transformers is an essential part of the design of any I.F. amplifier, many people do not realize the importance of other things in the same amplifier. For instance, when the Q value of a winding is specified by its manufacturer, or by anyone else, this always means the Q measured in the absence of any other components, such as valves, valve sockets, and so on. Thus, as soon as the circuit is wired into position, the Q

falls by an indeterminate amount because of the sundry losses connected in shunt with it. Also, when this is one winding of a double-tuned I.F. transformer, the quoted Q may well be 200, as stated, but the effective Q is only half of this if a secondary winding, of equal Q , is coupled to it with critical coupling. Thus, the selectivity of two coupled circuits in a transformer is not as great as if those two circuits were separated by a valve. It is for these reasons, that the phenomenal selectivity that can theoretically be realized by applying the above formula is not quite attained in practice. This does not mean that the formula is incorrect, merely that it takes only the single coil itself into consideration, and not any of the parts associated with it.

The general conclusions that may be drawn from the formula are still quite correct, however, namely that it pays to use a low frequency where a given amount of selectivity must be achieved with as few tuned circuits as possible. Similarly, a given degree of selectivity is obtained with fewer tuned circuits, the lower the frequency we use.

Beat Frequency Oscillations

The B.F.O. is a feature that none but communications receivers sport. Its requirements are that it should have its frequency controllable from the front panel of the receiver, that it should be very, very stable, and that it should not interfere in undesired ways with the normal operation of the receiver.

Its centre frequency will be the nominal centre frequency of the last I.F. amplifier in the set, should there be more than one I.F. The required variation is very small, especially when the I.F. is fairly high, but becomes a greater proportion of the centre frequency as the I.F. is made lower. This is because the required frequency variation of the oscillator remains the same at, say, plus and minus 5kc/sec., while the frequency of the I.F. can range from 1500kc/sec. or even higher, to 50kc/sec.

Very often even commercial receivers pay too little attention to the design of the B.F.O. It must inject the required amount of signal at the right point in the receiver—usually at the second detector—but it must not get into the early stages of the amplifier, which is tuned to its own frequency. This means that the B.F.O. circuit must (a) be well shielded, (b) must run at the lowest power level needed to ensure that it does its job properly, (c) must be as free from harmonics as possible.

Provided that (b) above is complied with, shielding is not as a rule too difficult. How much is needed in a give example will depend to a large extent on the mechanical design of the receiver. For instance, it is obviously desirable to have the B.F.O. tube and its circuit situated as far as possible from the input of its I.F. amplifier, so that whatever stray radiation or

capacitative coupling exists will have as small an effect as possible. If the B.F.O. runs at as low a level as possible, both the shielding difficulty, and the generation of harmonics are minimised. It should be mentioned that if the harmonic output of the B.F.O. is high enough, it is quite possible for harmonics to be picked by the signal-frequency stages. If this happens, they appear as steady unmodulated carriers, and can obviously cause considerable trouble by interfering with wanted signals or by pretending to be a signal themselves. In stubborn cases, it may be necessary to completely enclose the B.F.O., and to filter all supply leads entering its compartment.

B.F.O. Stability

Stability of the beat frequency oscillator is obviously important if constant adjustment is to be avoided when it is in use. Also, the greater the selectivity of which the set is capable, the more stable must both the B.F.O., and also the frequency-converter oscillators (if more than one) be made. Otherwise, a small amount of drift in the final frequency of the signal (i.e., the last intermediate frequency) will be enough to put the signal right outside the narrow pass-band.

The order of stability required can be great enough to necessitate the use of the most stable oscillator circuits. For example, it is not out of the way to use a Clapp oscillator circuit for the B.F.O., thus automatically ensuring both excellent frequency stability and small, harmonic-free output.

An important point is the manner in which the output is taken from the B.F.O. With the Clapp circuit, any of the normal output-coupling methods can be used, but perhaps the best, if a trifle unusual, is to take a co-axial output lead from across the lower of the two large condensers in the Clapp circuit. Similarly, it is quite feasible to mount a small variable condenser on the front panel, connected by means of a length of co-axial cable, as portion of this capacity. In this way, quite a large capacity variation is needed to give a small frequency shift, and the setting becomes very stable and simple to effect.

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A RECORDER-GRAM CIRCUIT FOR AMATEUR CONSTRUCTORS—Part 5

We must apologise to readers for not having been able to continue this series last month, through circumstances outside our control. This month, on the next page, we feature the circuit diagram of the high-quality tuner, and the chassis diagrams for the main amplifier, and for the tuner-pre-amplifier. The sockets on the latter marked A have numbers attached to them for ease in identifying the valves that are to go into them. These are as follow: A₁ and A₂, tape playback pre-amp.; A₆, tuner output cathode-follower; A₃ I.F. amp. and Det.; A₄ Osc. Mixer; A₉ R.F. Amp.; A₅ Pick-up Pre-amp.; A₇ Tone-control Amp. and cathode follower; A₈ microphone pre-amp.

The holes marked C are for Belling-Lee connector sockets, and these also have been numbered. C₁ is the tape playback input; C₂ microphone input; C₃, output to main amplifier; C₄ output to record amplifier; C₅ pick-up input.

On the main amplifier chassis, the blank space at the left is for the power transformer, with the rectifier socket and a large hole for a multiple electrolytic

behind it. The output transformer mounts between the sockets A-A in the middle of the chassis, which are for the output tubes. The smoothing choke is fixed under the chassis, directly beneath the power transformer.

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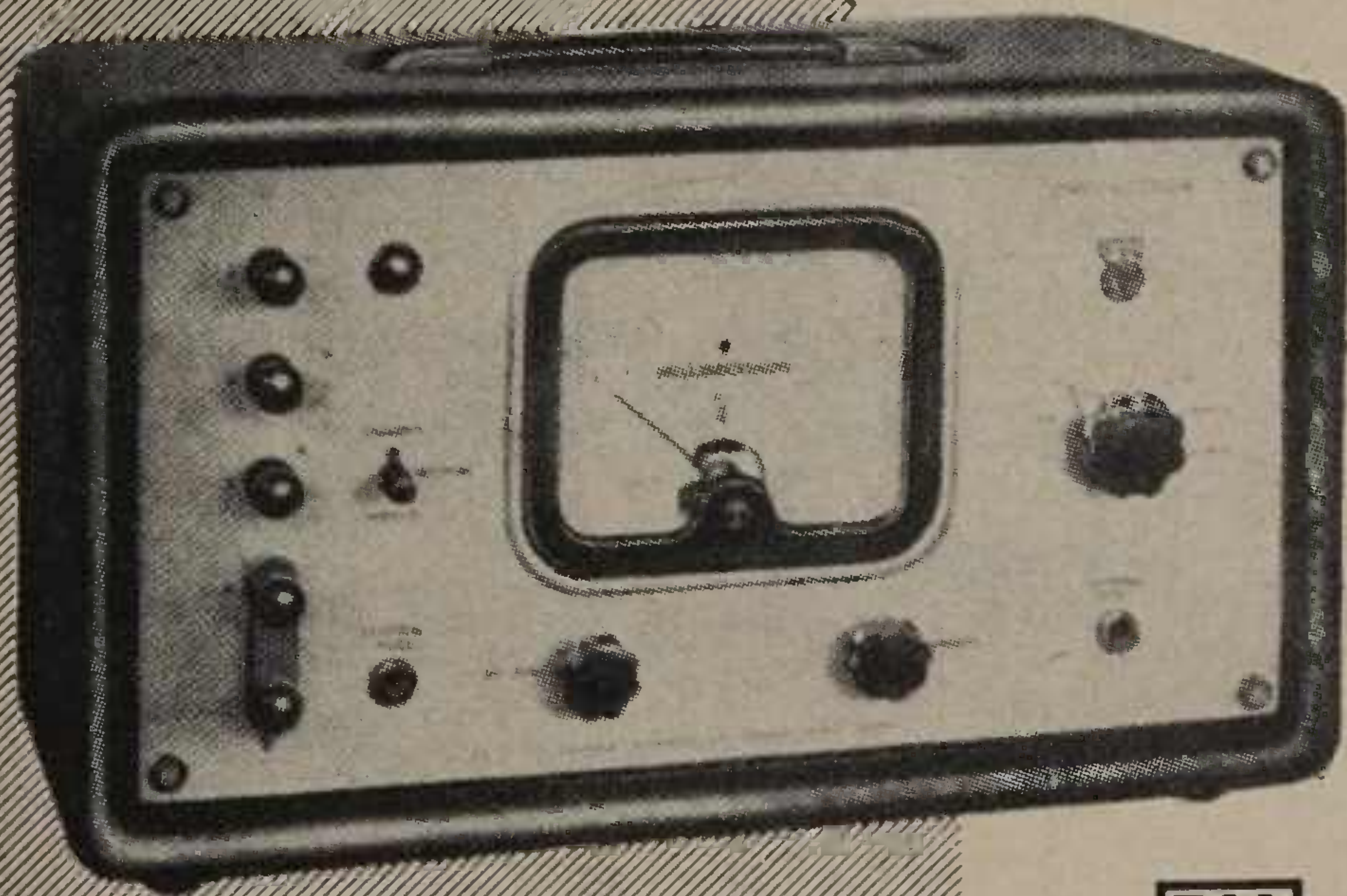
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ELECTRICAL AND TRADE SECTION

Technical Trade Matters

AMENDMENT TO ELECTRICAL WIRING REGULATIONS

In a circular letter to electric supply authorities dated 5th February, 1958, the general manager of the State Hydro-Electric Department brings to their notice Amendment No. 5 to the Electrical Wiring Regulations, 1935. Since this affects many electrical and radio dealers, we have pleasure in publishing the following short account of the amendment, and its effects on current practice.

Safety in Use of Portable Appliances

The purpose of Amendment No. 5 is to provide for greater safety in the use of portable appliances, and also to permit the use of certain types of safeguard not previously provided for in Regulation 47-92.

There is also an amendment to Regulation 47-11 (washing machines), but this is merely consequential to the amendment to Regulation 47-92. It provides that washing machines may be protected by means other than the 3-pin plug and s-core flexible cord or fixed wiring, as previously prescribed.

The amendment to Regulation 47-92 now covers any portable appliance in any likely situation. A table included in the regulation divides situations into three broad categories, and specifies the types of safeguard that may be employed. These types of safeguard are described in the regulation, and are designated by the letters (a) to (h). For readers' information these definitions are quoted below.

Types of Safeguard for Portable Appliances

Paragraph 3 (2) of the new regulation reads as follows:

"(2) The following types of safeguards for portable appliances are approved for the purposes of this regulation:

- (a) The fact that the portable appliance is of the all-insulated type, where that is the case;
- (b) Direct earthing by means of the earthing lead of a flexible cable or flexible cord not having a braided metallic covering.
- (c) Direct earthing by means of the earthing lead in a flexible cable or flexible cord having a braided metallic covering, installed in accordance with the provisions of Regulation 54-24 hereof, and fitted with approved accessories.

(d) Double insulation complying with an approved standard;

(e) Supply from a source isolated from earth and having a pressure not exceeding 250 volts.

(f) Supply from a source connected to earth in such a way that the voltage to earth under fault conditions will not exceed 55 volts.

(g) Supply from a monitored earth circuit arranged to cut off supply automatically in the event of the earth-continuity conductor to the portable appliance breaking or becoming disconnected;

(h) Supply at extra low pressure."

Types (a), (b), (e), and (h) have all been in common use for a long time, and should require no explanation.

Type (c) introduces a more exacting requirement for earthing, in that, in addition to the earth lead in the flexible cord there is to be a further earthing and a mechanical safeguard in the form of a braided metallic covering on the flexible cord.

Type (d), double insulation is a relatively new development, and is dealt with in a ruling on pages 517 and 518 of Interpretation Circular No. 137.

Type (f) requires the use of 110-volt appliances.

Type (g), monitored earth circuit, insofar as ordinary appliances are concerned, is a modern application of a long-standing safety measure used in the mining industry. Two earth-continuity conductors are necessary in the flexible cord or flexible cable supplying the appliance, and a small circulating current is passed through these conductors. Supply to the appliance is automatically interrupted should the earth-continuity circuit become broken.

(Concluded on page 44.)

TRADE WINDS

Philips Show Hi-Z Record-playing Equipment for First Time

Early in March Philips made good use of "Carnegie Hall", in the new Wellington premises in Wakefield Street, to turn on what the programme described as the "Philips Hi-Z Proms". On both evenings a large muster of Philips dealers assembled at eight o'clock to hear a long programme drawn from (of course) Philips, Coronet, and Polydor records, and played on the new packaged Hi-Z equipment that was being shown in public for the first time.

In the absence of managing director Dirk Hudig, who has been ill for some time, the honours were done by Maurie Harding, sales manager, and Bill Farquharson, Wellington branch manager, ably assisted by other staff members too numerous to mention.

Three packaged record-playing systems were being shown, the "Fantasia", a table model, with self-contained speaker system, the "Concertgebouw", a console model, with separate speaker system entitled and the AG9006 amplifier, which was also played into a separate speaker system. All three systems use one of the latest Philips changers-cum-automatic-single-player turntable and pick-up unit. The latter uses the new Philips magnetodynamic pick-up, with separate heads for standard and L/P records, the L/P ones having a diamond stylus as standard equipment.

A wide range of programme material was used for demonstration purposes, ranging from standard orchestral works to Les Elgart and some quite astonishing vocalists. At the back of each programme was a questionnaire which those present were asked to fill in giving their comments about the equipment, its performance, and the musical selections. Judging from the furious scribbling that went on during the intervals when the lights were turned up to enable comments to be written, most people had something to say about each item, several of which merited spontaneous rounds of applause from the audience.

As technical readers will probably have realized for themselves, the "hi-Z" label is being applied by Philips to equipment using high-impedance loud-speakers, and output-transformerless amplifiers. Naturally, the publicity material makes much of this feature. It is certainly one of the most modern developments to be applied to the audio frequency field, and has apparently enjoyed considerable success overseas, as well as in New Zealand. Its major drawback appears to us to be that the user is tied down to the use of a particular type of loud-speaker, and if he is at all critical in his listening, he may not appreciate being so limited in the choice of perhaps the most important item in the system.

However that may be, on the evening on which this journal attended the demonstration, the audience was

enthusiastic, and we can certainly expect to find Hi-Z featuring in many dealers' shops.

* * *

New Premises for Gurney Electric

The latest and most up-to-date radio and electrical shop in the capital is Aub. Gurney's new premises in Cuba Street. The other day this journal visited him while he was yet in the throes of shifting in, but even at that stage it was apparent that this is to be something out-of-the-way. In the very spacious basement, reached from the main shop by a wide stairway, is to the Hi-Fi listening lounge and record department. An innovation here is a coffee-bar, so that prospective customers can sip their afternoon cup in comfortable surroundings while listening to their choice of records. This journal has been promised photographs when the premises are quite complete, but in the meantime, we believe that Aub. is doing excellent business already, as well he should with his excellent position and attractive lay-out.

* * *

Microgroove Records More Popular

The popularity of microgroove recordings and the response of the industry to satisfy the demand is reflected in the statistics for the production of gramophone records during 1957.

According to figures released by the Department of Statistics, the number of records produced in New Zealand during 1957 increased by more than half a million to 2,394,000. Of these, 292,000 were long-playing records, compared with 111,000 in 1956 and 15,000 in 1955.

Figures for the production of "forty-fives" (45 r.p.m. recordings) were—extended play type: 1957, 127,000; 1956, 35,000; 1955, 4,000; single play type: 1957, 376,000; 1956, 20,000; 1955, 2,000.

In the same period the number of pressings of normal speed recordings (78 r.p.m.) has decreased. The figures for the last three years are: 1957, 1,599,000; 1956, 1,679,000; 1955, 1,620,000.

A sharp increase in the production of console model radiograms—from 12,236 in 1956 to 19,209 last year—compared with a decline in the output of radio receivers, from 101,000 to 98,000.

The gross value of production in the radio assembly industry in 1956-57 was £2,680,000 compared with £2,787,00 in 1955-56.

* * *

A New Transistor Pre-amplifier for Public Address

This pre-amplifier, designed and built by Collier & Beale Ltd., of Wellington, is one of the first items of transistor equipment to be offered to the public

address operator. Its compact nature, and high gain, with low hum and noise make it an attractive proposition for adding at will to existing P.A. amplifiers.

Performance Data

The main features of this pre-amplifier are as follows:

Output Impedance: 200ohms.

Output: 6 mW.

Input Impedance: 250 ohms.

Input for rated output: — 66dbm.

Maximum Input (1st stage overload): — 40 dbm.

noise Level below rated output: —50 db.

Power Supply: 9 volts, from No. 973 battery.

Current Drain: 4.4 to 8 ma.

Frequency Response on 200 ohm resistive load:

30c/sec. — 4.6 db.

50c/sec. — 2.2 db.

100c/sec. — 1.2 db.

1000c/sec. 0 db. = 5 mW.

5000c/sec. — 1.5 db.

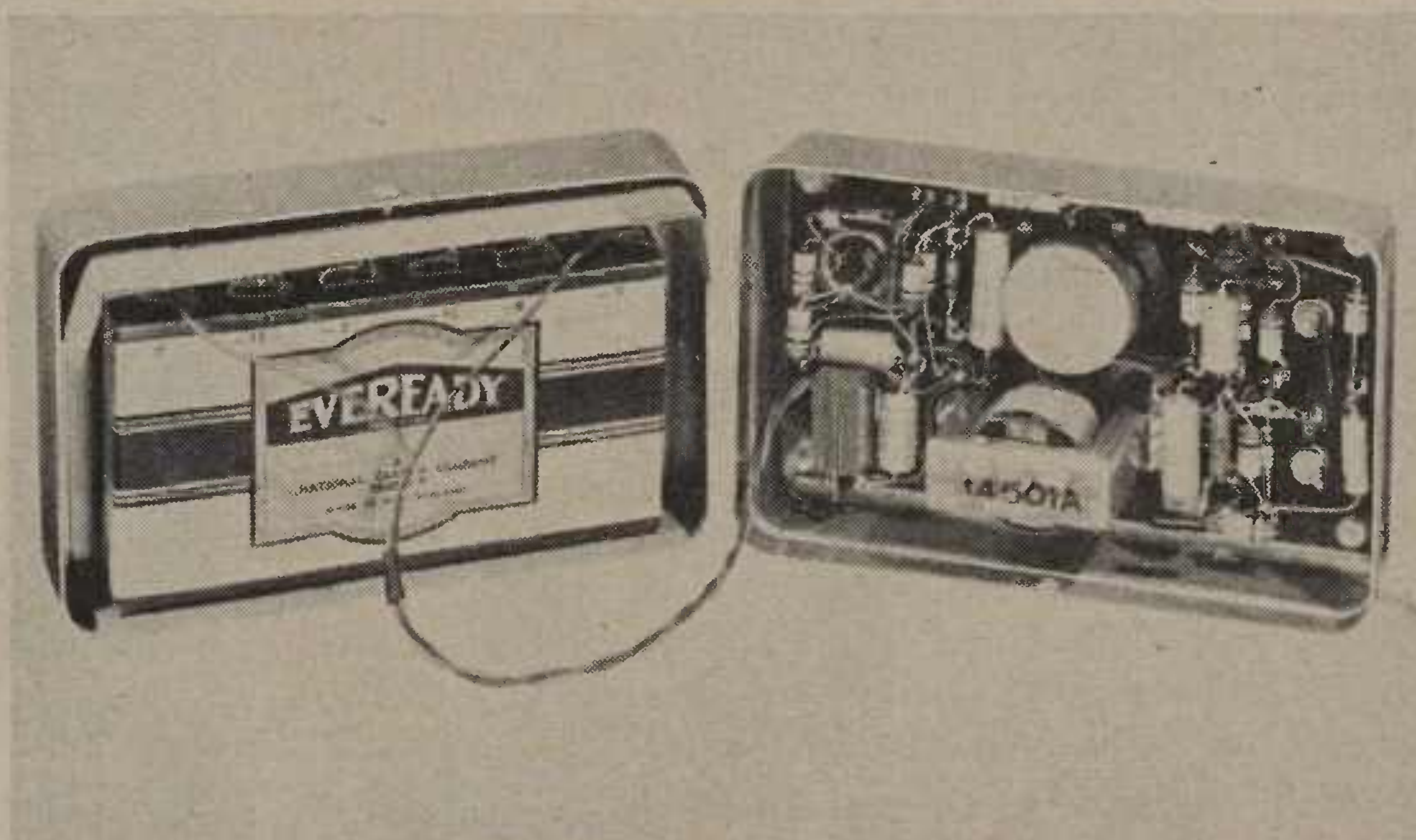
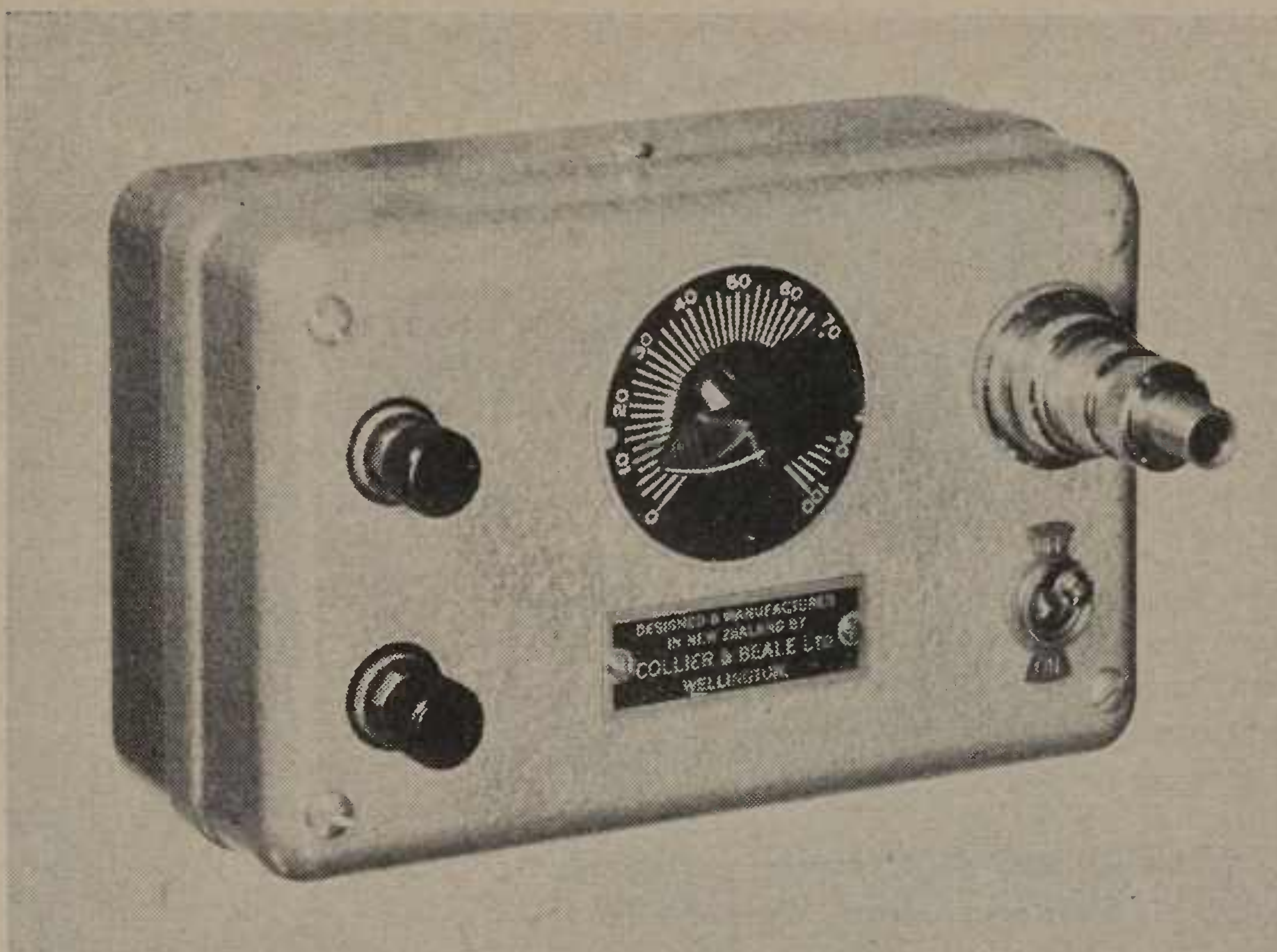
10,000c/sec. — 4.82db.

From the above list it can be seen that the pre-amplifier will cope with a large range of microphones, provided only that their output impedance is low. The output, of 6 mW into 200 ohms represents a signal of just over 1.1 v. R.M.S., from which it can be seen that the pre-amplifier is suitable for connecting low-level microphones to even a low-gain amplifier. Battery usage should be excellent, as should the serviceability, which is always excellent with transistor equipment.

New Multicore Subsidiary

Multimusic Ltd., the new wholly-owned subsidiary company of Multicore Solders Ltd., is to manufacture and market specialized magnetic tape recording equipment. The new company announces that it has acquired the patents, goodwill, and trade marks, in respect of tape recording, of Rudman Darlington & Co. Ltd. and Rudman Darlington (Electronics) Ltd. of Wednesfield, Staffordshire.

It is stated that the manufacture of the professional type reflectograph tape recorder is being transferred to a new factory at Hemel Hempstead adjacent to the Multicore Works.



The controlled output of reflectograph recorders from Wednesfield was distributed practically exclusively to broadcasting stations, recording studios, and laboratories at home and overseas. Re-styled models of the reflectograph tape recorder will be introduced to the trade and public at the Audio Fair in April, where Multimusic is exhibiting.

Richard Arbib, chairman and managing director of Multicore Solders, holds the same positions in Multimusic. He has been a tape recorder enthusiast for many years, and is the patentee of the Bib tape splicer.

Mr Arbib stated: "It is not our intention to enter the mass production market for tape recorders, which we believe is adequately served by many well-established manufacturers. A survey we have undertaken indicated that there is a limited unfulfilled demand for the similar type of professional recorder for use in industry and the home and we hope to enjoy a share of this market."

"We also intend to develop the sales of the reflectograph continuous player, which was shown at the B.S.R.A. exhibition in November last. This machine, which is the first of its kind to be manufactured in this country, enables up to four hours of music to be played and repeated continuously."

Although details of the Multimusic marketing policy are not finally settled, it is likely that the reflectograph recorders will be distributed through specialized retailers and the continuous player will be handled exclusively by manufacturers of public address equipment as part of their installations.

J. Cunningham-Sands, A.M.Brit.I.R.E., who has been associated with the reflectograph instrument for some years, is joining the reflectograph division of Multimusic Ltd. as technical manager.

* * *

Radio and Electronic Component Show Features and Trends in 1958

Many of the new radio components which will be exhibited at the Radio and Electronic Component Show at Grosvenor House and Park Lane House, London, from April 14 to 17, will be smaller, more robust, and able to withstand higher temperatures than ever before.

The trend to miniaturize components continues, particularly for those to be used with the very small transistors now being manufactured, and also in connection with printed circuitry.

Components for use in guided weapons need to be sub-miniature, of extreme ruggedness, and able to operate in high temperatures. Some of the new transformers and chokes are suitable for working in temperatures up to 200° C and even 250° C and there is an exploratory design suitable for 500° C.

Certain components have also been designed to withstand the strong vibration and enormous acceleration due to high "G" values in guided missiles.

Improvements are to be found in even the more stereotyped components, such as wafer switches and small relays, both sealed and unsealed.

Developments in ferrites and dust iron cores include the introduction of new materials with new properties, especially for memory devices for computers.

Made for the first time in this country are sintered glass preforms for glass-to-metal seals in hermetically sealed components. These are cheaper, less laborious to use, and available with closer tolerances than the glass tubing they replace.

There are 171 stands in the Component Show, compared with 164 last year.

Admission to the exhibition (from 10 a.m. to 6 p.m. daily) is by invitation only, applications for tickets to be made to the Secretary, Radio and Electronic Component Manufacturers' Federation, 21 Tothill Street, London, S.W.1.

The Radio Component Show overlaps this time with the Instruments, Electronics, and Automation Exhibition (Olympia, London, April 16 to 25) in which members of the Radio Communication and Electronic Engineering Association will be exhibiting as well as many component manufacturers.

Exports of British electronic components, excluding sound reproducing equipment and valves and cathode ray tubes, were valued at £10.1 million last year, compared with £8.7 million in 1956 and represents steady progression from year to year with increasing exports to the dollar countries. The January, 1958 figures continue to show an increase.

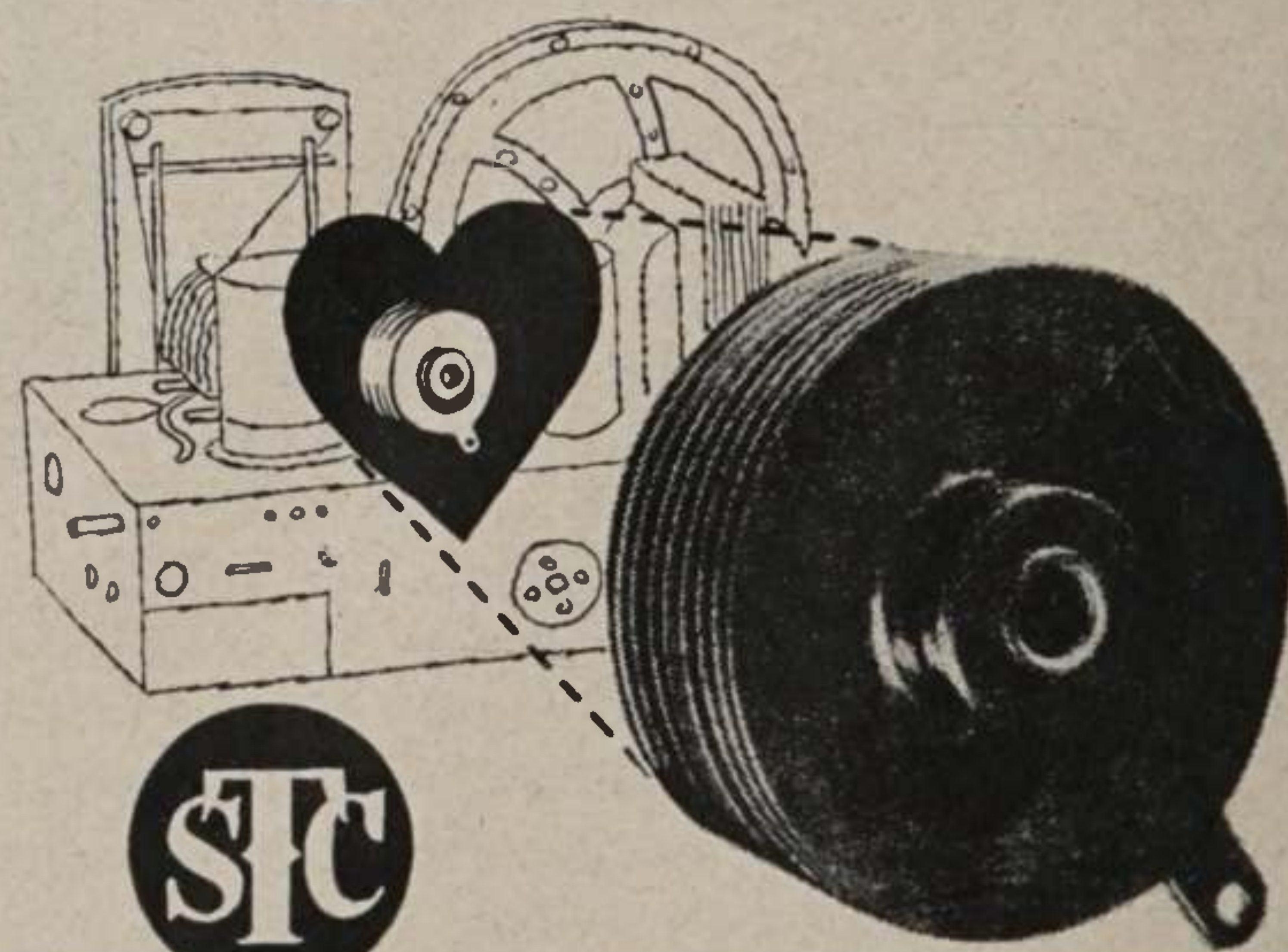
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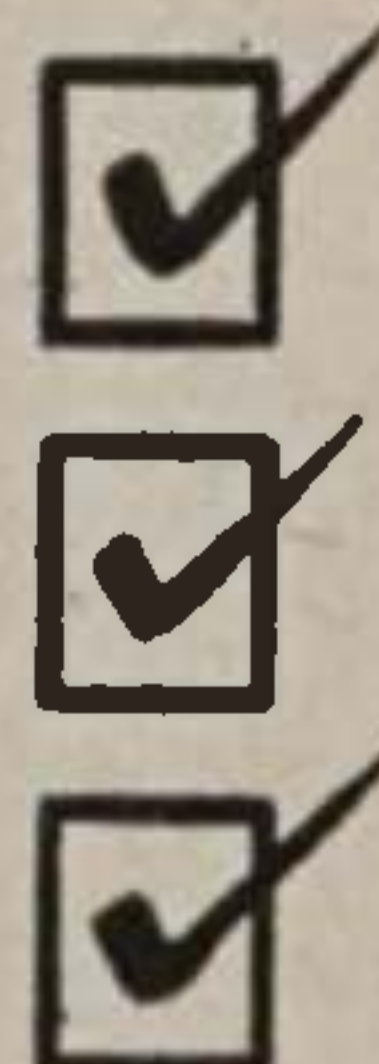
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TV ROUND THE GLOBE

The First Television Engineers

Mr D. C. Birkinshaw, chairman of the Television Society Council, and Mr T. H. Bridgewater, the honorary treasurer, have this year completed 25 years in the B.B.C. Television Service. This may fairly establish their claim to be the first television engineers in this country, as they joined the B.B.C. in order to operate the first low-definition 30-line television developed by the Baird Company.

Mr Birkinshaw is now superintendent engineer television, and Mr Bridgewater is superintendent engineer of television outside broadcasts.

TV IN RICHMOND, NELSON



Who says we have no TV in New Zealand? These pictures were received on December 3rd last by Mr R. Fairbairn, of Richmond, Nelson, on a modified Pye V4 television receiver. They clearly show the quality of the reception that can sometimes be had from the Australian TV stations. Mr Fairbairn informs us that he has had reception like that illustrated, on no fewer than twelve occasions, between 21st November, 1957, and 10th February, 1958. It seems that for anyone who feels he **MUST** experiment with TV receivers, the signals are often there to see.



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John Gray

JOHN GRAY'S RECORD PAGE

RECORD OF THE MONTH

FRANCK: Symphonic Variations. **RIMSKY KORSAKOFF:** Piano Concerto. Paul Badura Skoda, with Philharmonic-Symphony Orchestra of London conducted by Artur Rodzinski. W & G.W 18004 (12-inch LP).

RECORD OF THE MONTH

Considering the popularity of the Franck Variations, it cannot be said that the record lists are overburdened with rival versions, in fact this is the first for quite some time. The performance by one of the most cultured of the younger pianists is all that could be desired and the recording does it justice. Rimsky Korsakoff's concerto on the reverse shows this master in unfamiliar light and the result should please all who admire his more flamboyant efforts in the realm of orchestral colour. Badura Skoda has previously recorded this charming trifle, but the older version (coupled with Scriabin's fascinating if rambling concerto) is probably unobtainable by now in any case. For his new record the pianist has the powerful support of Artur Rodzinski, one of the most vital of conductors, the man who, in fact, was chosen with Toscanini's approval to whip the N.B.C. Symphony Orchestra into shape before the maestro assumed control of it in 1937. Once conductor of the Chicago Symphony and the New York Philharmonic, Rodzinski now free-lances in Europe and here confronts us with the "Philharmonic-Symphony Orchestra of London", which is apparently the name chosen by the Royal Philharmonic when it records for this particular label. Whatever the name, it is the music that counts and each work is done handsomely by all concerned on this attractive recording, even if it does give short measure by today's notions of value for money.

Records bearing the "Supraphon" label have occasionally appeared in local shops, but their versions of standard

FROM CZECHOSLOVAKIA classics have never stood up to comparison with discs pressed further west, even the otherwise unobtainable native music on them has been heard only through a barrage of surface noise. Recently, however, improved pressings have been most favourably reviewed in England and this should encourage the more fastidious to investigate the latest ones available here through Norman Wright's agency, though I have not so far seen any of them and have no information as to where they are pressed. There is of course the unrivalled Prague performance of "The Bartered Bride", one of the most toothsome and enjoyable of all operas, and a melodious rarity in Dvorak's "Roussalka", though this spreads itself expensively over four records (LPV 94-97). For the rest there are several standard works by Schubert, Beethoven, Brahms, etc., and an interesting symphony by the composer Fibich, otherwise known to the world as the creator of one tiny salon piece, "Poeme", or, if it is sung as it used to be by Richard Tauber, "My Moonlight Madonna". Fibich's symphony makes an attractive and melodious record as performed by the Czech Philharmonic Orchestra under Karel Sejna (LPV 81).

It is good to encounter the name of Harpo Marx again. Almost the only moments of repose in those crazy Marx

Hi-Fi FROM HARPO— AND OTHERS

Brothers films of hallowed memory used to come when the indefatigable Harpo, temporarily abandoning his tomfoolery, would sit at his instrument with results that held the most jaded audience spellbound. Now he appears on a disc in his own right and all who joyously rush to procure Mercury MG 20232 (called, of course, "Harpo in Hi-Fi") will doubtless soon be under the spell of those flying fingers. The titles are such as appear on all such records—there are "Yesterdays", "My Funny Valentine", "Autumn Leaves" and the rest of them—but there is only one Harpo Marx and the background support from Freddy Katz and his Orchestra completes an enjoyable programme. There is equally brilliant and more virile sound from the latest Eastman Symphonic Wind Ensemble disc, "Music for Twirling", which features a further quota of the deathless marches of Sousa and others (Mercury MG 50113).

Further Hi-Fi "music for relaxing" is available from a variety of performers; no one need be without a good supply of background music nowadays! Among the more soothing are the piano playing of George Feyer, as heard in his "Echoes of Italy" (Vox AVX 620), or the singing of Continental songstress Liane, the latest of whose fine series on Vanguard is labelled "Cape Continental" (PPT 12013). Richard Hayman and his Orchestra are on hand with "Music for People Who Can't Sleep", which is the latest of the "peace of mind" series, on Mercury MG 20184. Appropriately this begins with "All Through the Night", which is presumably as long as you are supposed to play it. When waking up time comes round, however, you should switch to MG 20186 on which the Gaylords make a comeback with a melange entitled "Italia!" which gives a number of the better-known Italian and Latin tunes in irresistible style and swing. Everyone should enjoy this. Finally, there is a party disc by Don Costa, Sid Feller, and their "Friend and Neighbours", though this should perhaps be approached with caution in view of its title which is "Music to Break a Lease"; those inclined to risk landlord trouble will want to know the number, which is W & G WG-BPN-386.

Philips have put out a magnificent catalogue (they tell us firmly that it is a "Record Buyers' Guide", though I maintain, if not overvehemently,

FROM PHILIPS AND CORONET

that it is nonetheless a catalogue) which is the most elaborate work of its kind so far produced in New Zealand. It summarises in handy form the excellent repertoire, on all rungs of the musical ladder, made available on the Philips and Coronet labels. But no company can rest on its laurels and the first supplements for 1958 carry the enterprise still further. Perhaps the most interesting, certainly the most unusual item, is an extended play

"R. & E.'s" HIT PARADE LIST

We are indebted to the publishers of "Musical Express" for the lists below, which we hope will be of considerable assistance to dealers as a guide for their "pop" record buying.—Ed.

WEEK ENDED 8th FEBRUARY

Title	Artist	Position last week	Record Make
1 The Story of My Life	Michael Holliday	2	Columbia
2 Jailhouse Rock	Elvis Presley	1	R.C.A.
3 Magic Moments	Perry Coma	16	R.C.A.
4 At the Hop	Dannie and the Juniors	5	H.M.V.
5 Oh, Boy	Crickets	3	Coral
6 All the Way	Frank Sinatra	4	Capitol
7 April Love	Pat Boone	7	London
8 Love Me Forever	Marion Ryan	8	Pye/Nixa
9 Peggy Sue	Buddy Olly	9	Coral
10 You Are My Destiny	Paul Anka	12	Columbia
11 Great Balls of Fire	Jerry Lee Lewis	6	London
12 My Special Angel	Malcolm Vaughan	13	H.M.V.
13 Bonie Moronie	Larry Williams	15	London
14 Ma, He's Making Eyes at Me—Johnny Otis Show	Marie Adams	10	Capitol
15 Kisses Sweeter than Wine	Jimmie Rodgers	13	Columbia
16 Raunchy	Gill Justis	—	London
17 Jailhouse Rock (E.P.)	Elvis Presley	17	R.C.A.
18 The Story of My Life	Gary Miller	20	Pye/Nixa
19 Kisses Sweeter than Wine	Frankie Vaughan	10	Philips
20 Raunchy	Ken Mackintosh	—	H.M.V.

45 of operatic arias sung by Mr Harry Secombe of the "Goonies". One of his numbers is "On with the Motley", but the motley he dons is quite different from his usual, since he appears before us in the role of a quite serious operatic tenor. The handbill refers to him as "very competent", and so he is. The other items are two from "Tosca" and one from "Turandot", and the number of the disc is 425018. Seemingly there is no limit to the appeal of the Vienna Boys' Choir, and that organization returns on Philips N 00726 with a fine galaxy of items by the standard composers, nearly all German of course, and featuring some attractive and unhackneyed Schubert. Another disc (S 06066) has a further selection of pieces, none of which has been available here before. Some traditional songs are included and, like its companion, this is a 10-inch LP.

The version of Tchaikovsky's first piano concerto played by Alexander Uninsky and the Hague Philharmonic under van Otterloo is proudly referred to as "the only version on a 10-inch disc", which is a valid reason for recommending A 00672. Connoisseurs may be directed to another Russian work on A 01312, whereon Vladimir Golschmann directs the St. Louis Symphony Orchestra in what is probably the best all-round version of the Shostakovitch Symphony No. 1. This utterly original work, produced in 1926 when the composer was a mere youth, is one of the most piquent and enjoyable of modern symphonies: many will have heard it broadcast last year when the National Orchestra played it under the baton of Nicolai Malko the world-famous conductor who had first introduced it in Leningrad thirty years previously. I have always thought Shostakovitch one of the most approachable of the advanced composers of today, and there is by now nothing in this symphony which should scare anybody.

On the reverse is a suite from Kabalevsky's opera "Colas Breugnon", best known for its rousing overture, of which odd versions have previously been current: this again is modern Russian music at its most vigorous and colourful and the whole record is in addition a gift to the devotee of Hi-Fi.

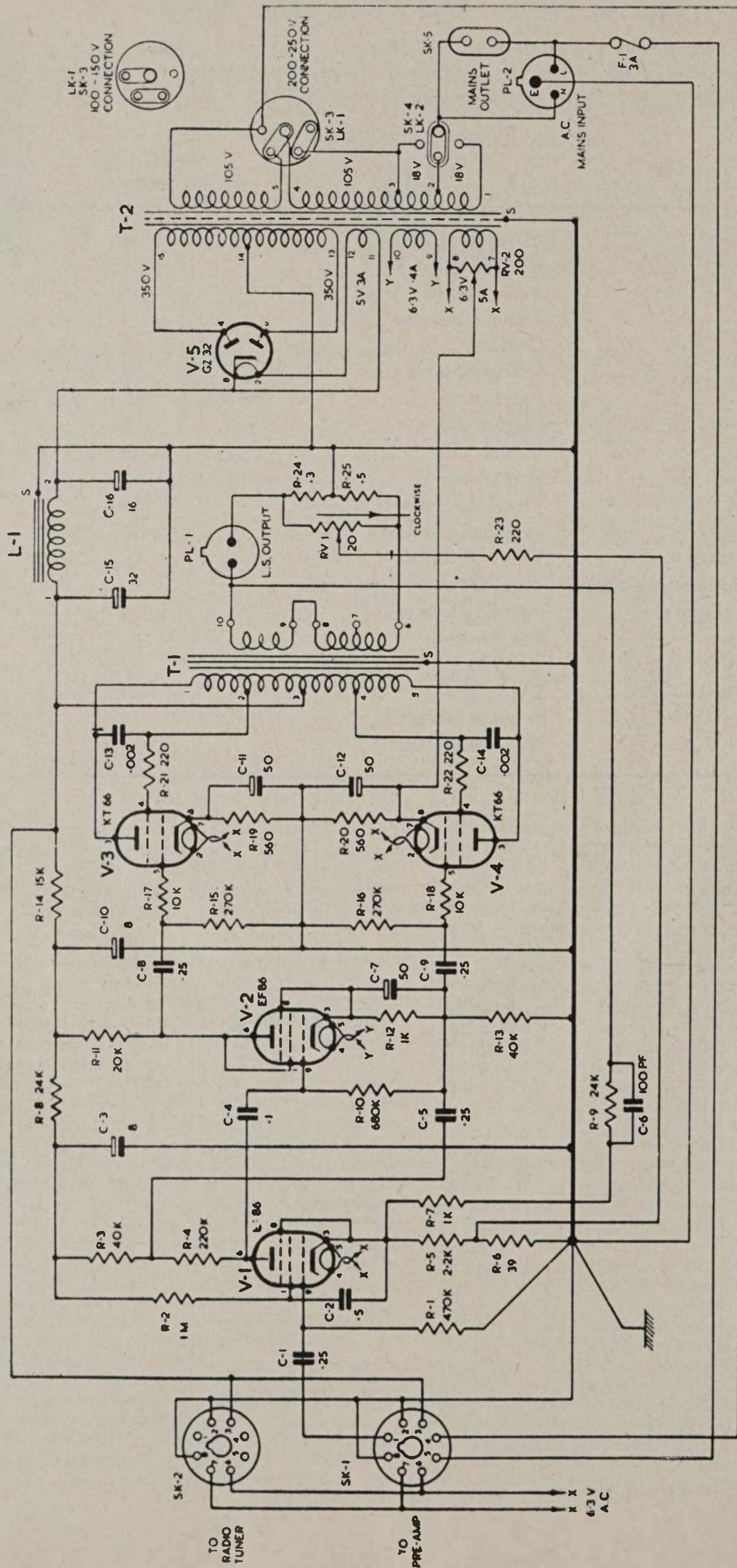
The latest Deutsche Grammophon list is once again largely classical and features a disc of operatic choruses sung by the Bavarian Radio Choir (LPM 19048); there is the expected quota of Wagner, and a most unexpected inclusion in a chorus from Nicolai's "Merry Wives", simply listed as the "Moon" chorus. Likewise, the opening chorus from Smetana's "Bartered Bride" can scarcely be called hackneyed. The habit of endowing LPs with fancy titles has now spread to this most aristocratic of companies. Thus, we have "How to know and love Chopin", backed by "How to know and love Listz", on LPM 19016, whereon some of DGG's most prominent pianists play popular snippets from those masters. These include excerpts from Liszt's concertos, and those undismayed by such a miscellany may find the record much to their taste.

With the "season" now getting underway, record producers have been drawing attention to those issues which tie up with current attractions on both stage and screen. "The Pajama Game", to be seen here in both forms, is well represented by the H.M.V. organization with LPs of both the British and the American stage productions. The latter, featuring Archie Bleyer, is on

(Concluded on page 43.)

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JOHN GRAY'S RECORD PAGE

(Continued from page 41.)

London HAM A 2001 the English disc, H.M.V. MCLP 1062, is of the London performance with Joy Nichols and Edmund Hockridge. Those seeing the unpretentious but refreshing film about Tommy Steele (who, however dubious the nature of his "talent", is one of the freshest personalities to emerge in this era of teenage worship) will be interested in his two Decca LPs, LFM 1287-8. The Borovansky Ballet's repertoire takes us to a higher plane, and Tchaikovsky fans will find renewed interest in the two of his ballets which are being given in full. For full-length recordings we must go to Mercury, with their magnificent (if expensive) sets of "Swan Lake" and "Nutcracker" by the Minneapolis Symphony Orchestra under Antal Dorati. Less full versions of each can be had on H.M.V., CLP 1018 ("Swan Lake" by the Philharmonia under Robert Irving) or Decca LXT 5371 (a generous selection of "Nutcracker" by the Paris Conservatoire Orchestra under Fistoulari). Of the many versions of "Les Sylphides" the most economical, and one of the best, is that by the Ballet Theatre Orchestra on a 10-inch Capitol. Not having seen "Serenade Classique" at the time of writing these notes, I cannot say whether the Lalo music to which it is set is available on records, but this is as good a time as any to remind you of Lalo's distinguished ballet "Namouna", excellently recorded by the London Philharmonic under Jean Martinon on Decca LXT 5114. David Oistrakh, announced as coming here this year, plays Lalo's enduring "Symphonie Espagnole" on Columbia 33CX 1246.

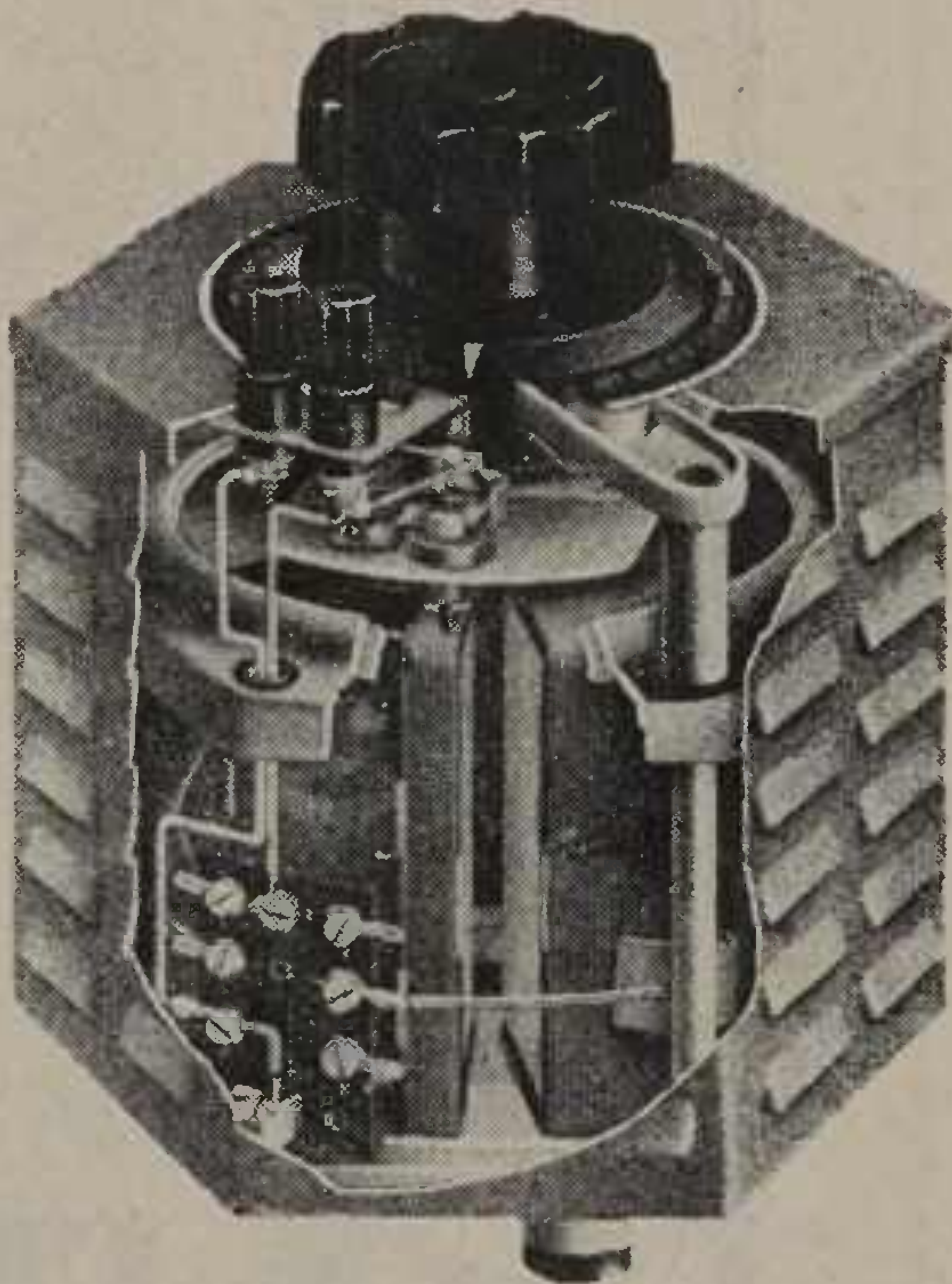
Though headed "Classical Records", the H.M.V. group's first releases for 1958 are predominantly on the light side, and drawn largely from their Capitol branch. "Concertos under the Stars".

LP FOR RELAXATION is the alluring title of a record by virtuoso pianist Leonard Pennario, with the Hollywood Bowl Symphony Orchestra under Carmen Dragon. Most of the items are commendably short and the title of the disc is really a courtesy one, in fact the nearest approach to a genuine concerto on it is the well-known Scherzo by Litolff, which is the only portion we ever hear of a piece called by the composer "Concerto Symphonique". For the rest, there are dressed-up versions of the adagio from Beethoven's "Moonlight" sonata, there is Listz's "Liebestraume", Rachmaninoff's C sharp minor prelude and those old standbys, "Warsaw Concerto" and "Cornish Rhapsody". It is useless to be superior about a disc such as this. One's only quarrel could be with its title and one wonders if it is not too much to hope that experience of these "concertos" may eventually lead people to the real thing (Capitol P 8326). At any rate, the real thing is represented in the latest version of Tchaikovsky's violin concerto, resplendently done by Campoli with the London Philharmonic Orchestra under Ataulfo Argenta on LXTM 5313. Back to the Hollywood Bowl, we find Grofe's colourful "Grand Canyon" suite, coupled with his lesser-known "Mississippi" Suite, both performed by the orchestra under Felix Slatkin (P 8347), and Carmen Dragon takes over again for a vivid collection called "La Danza", of which the tunes are largely of Latin-American origin, though Rossini's piece of that title has of course been included.

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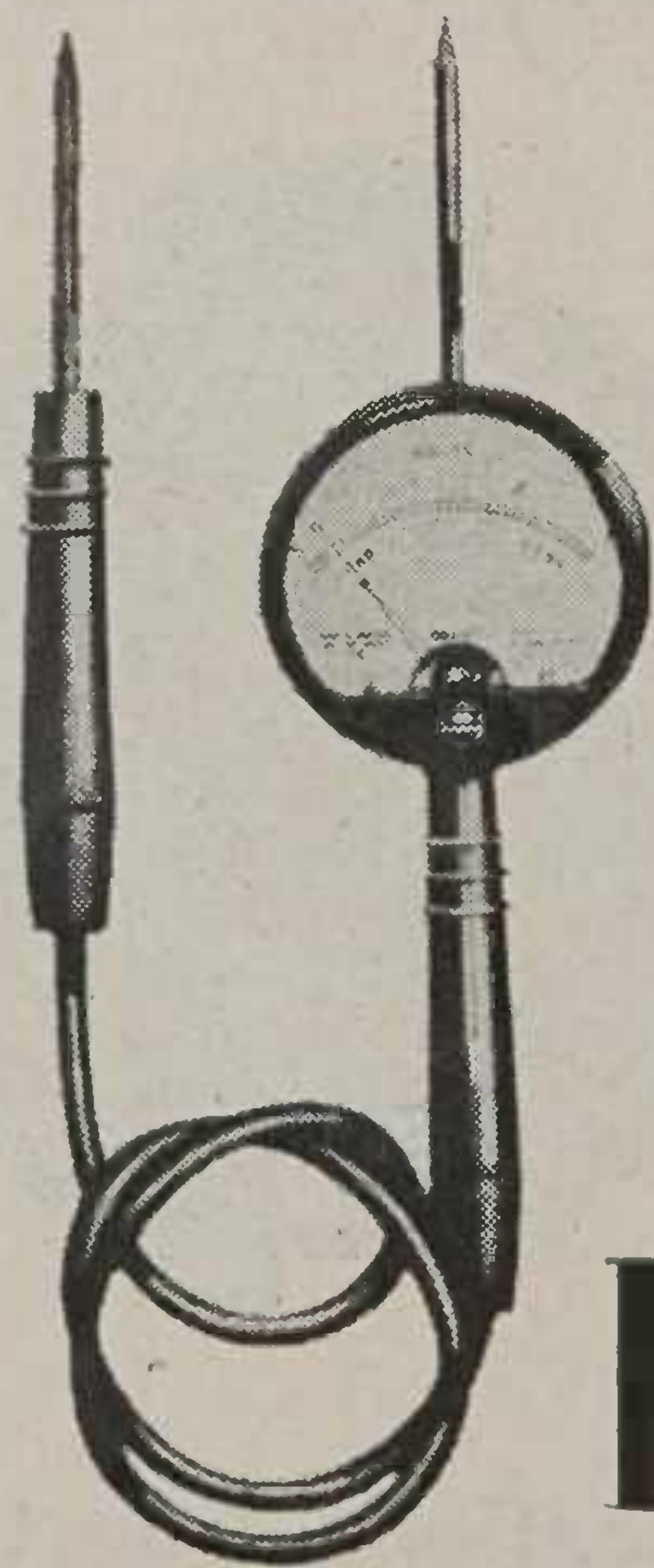
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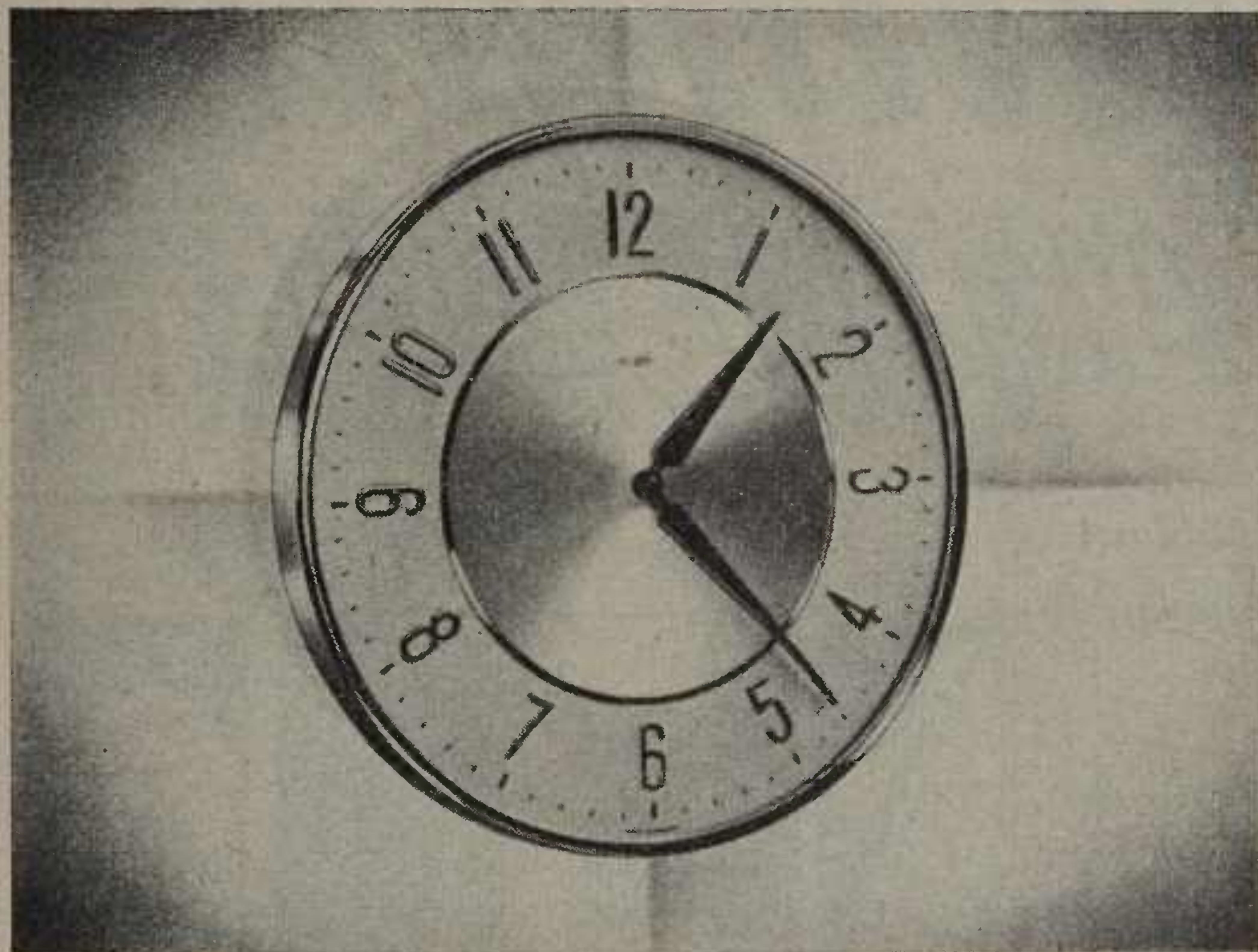
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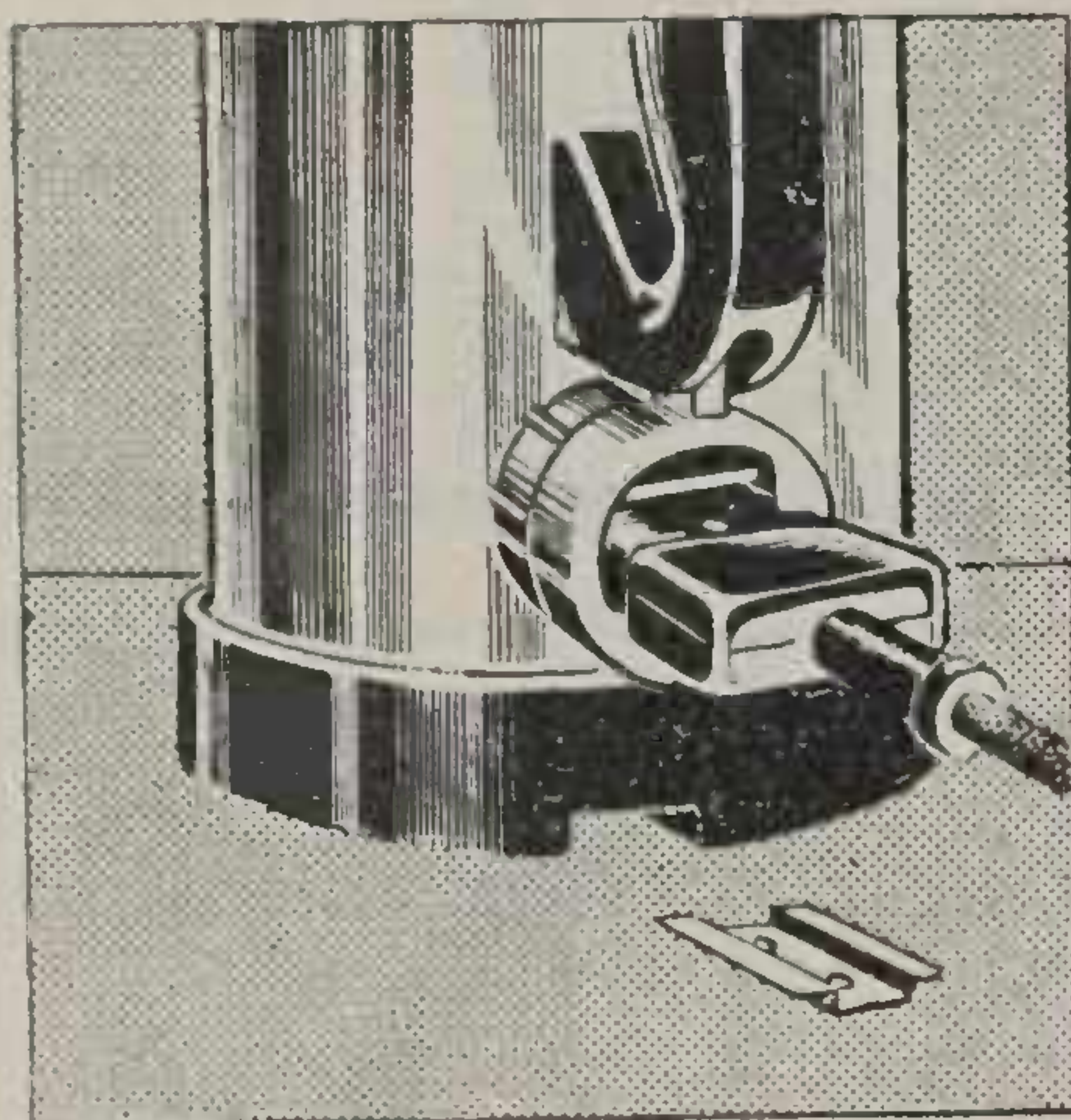
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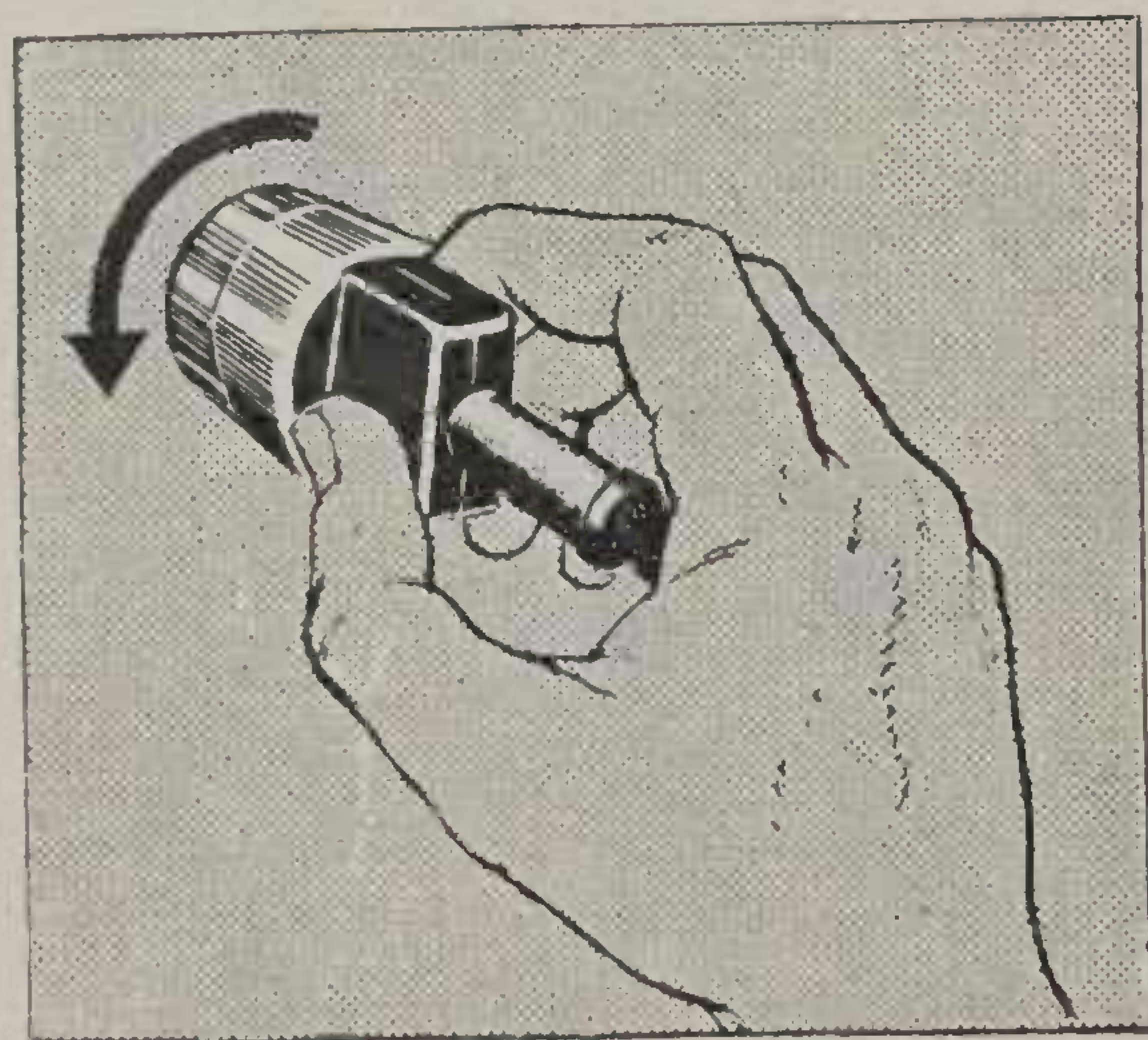
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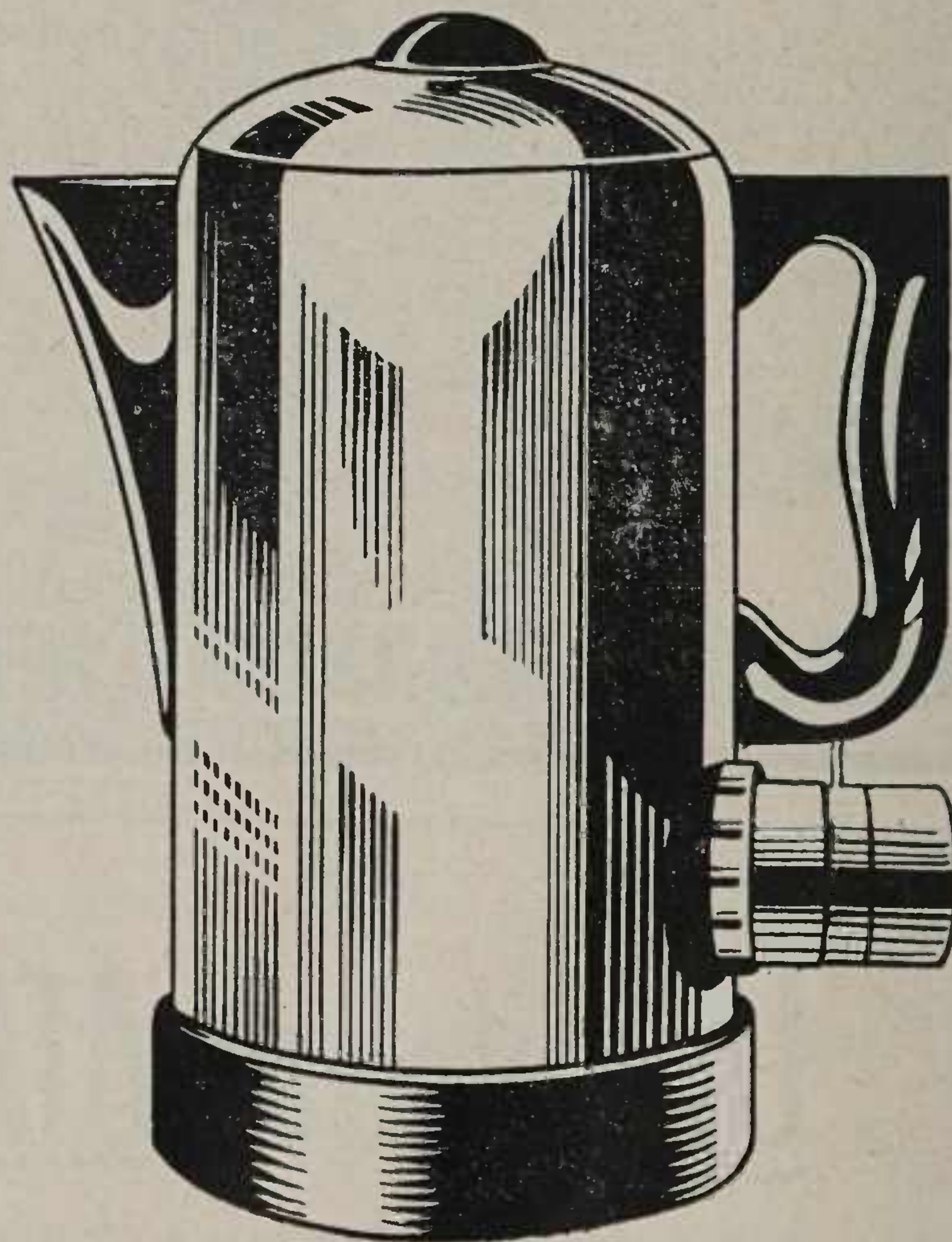
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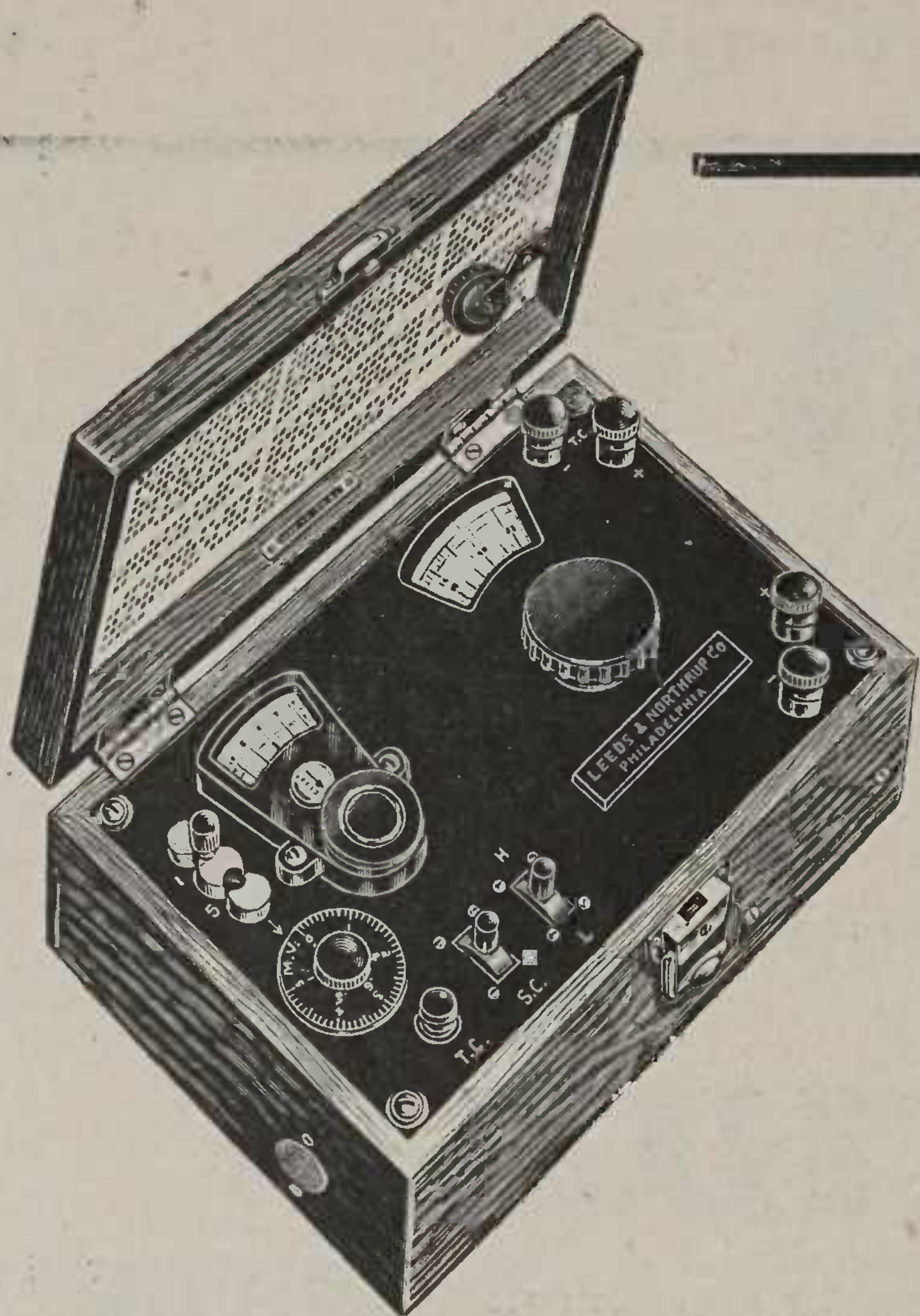
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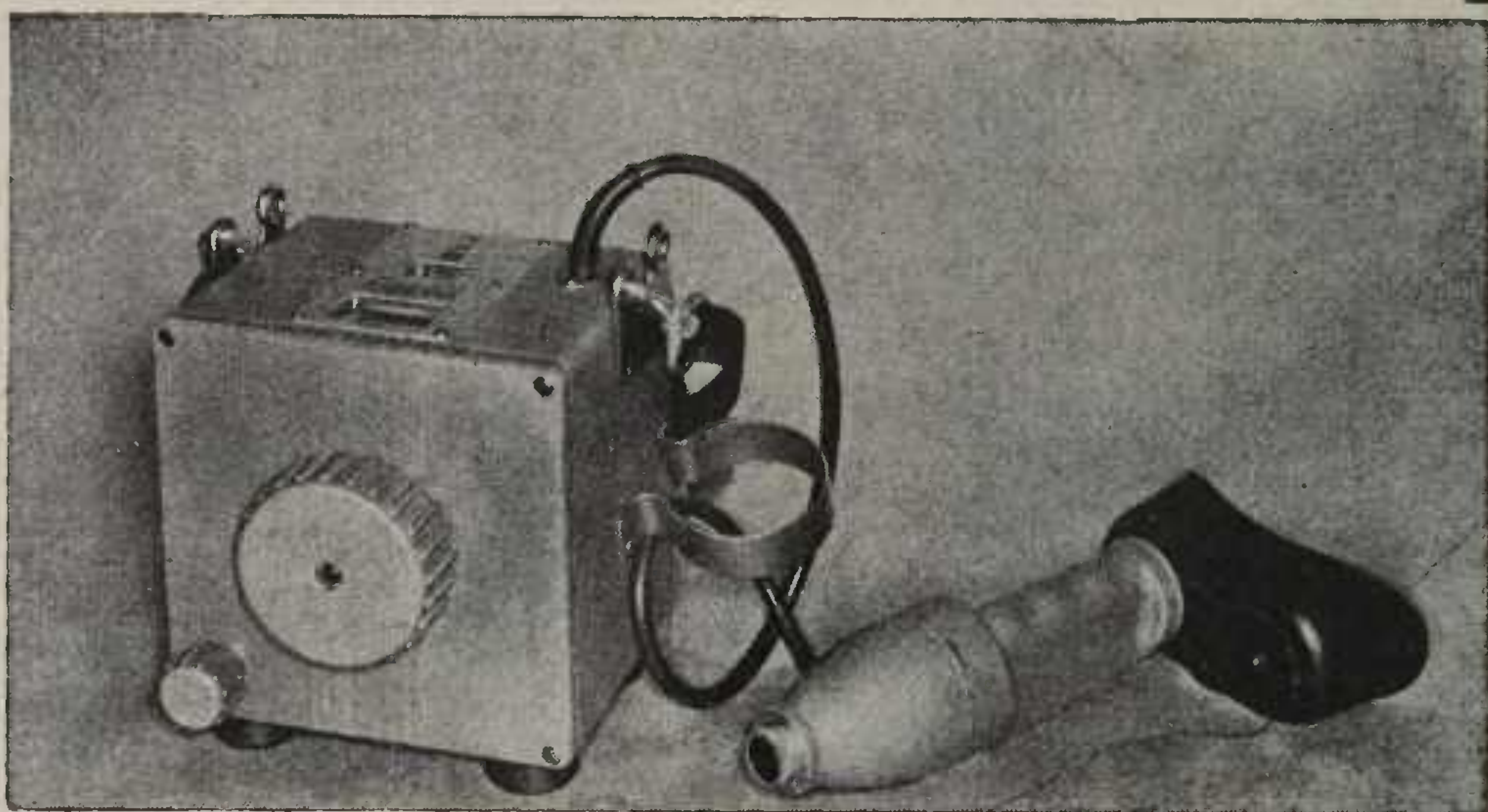
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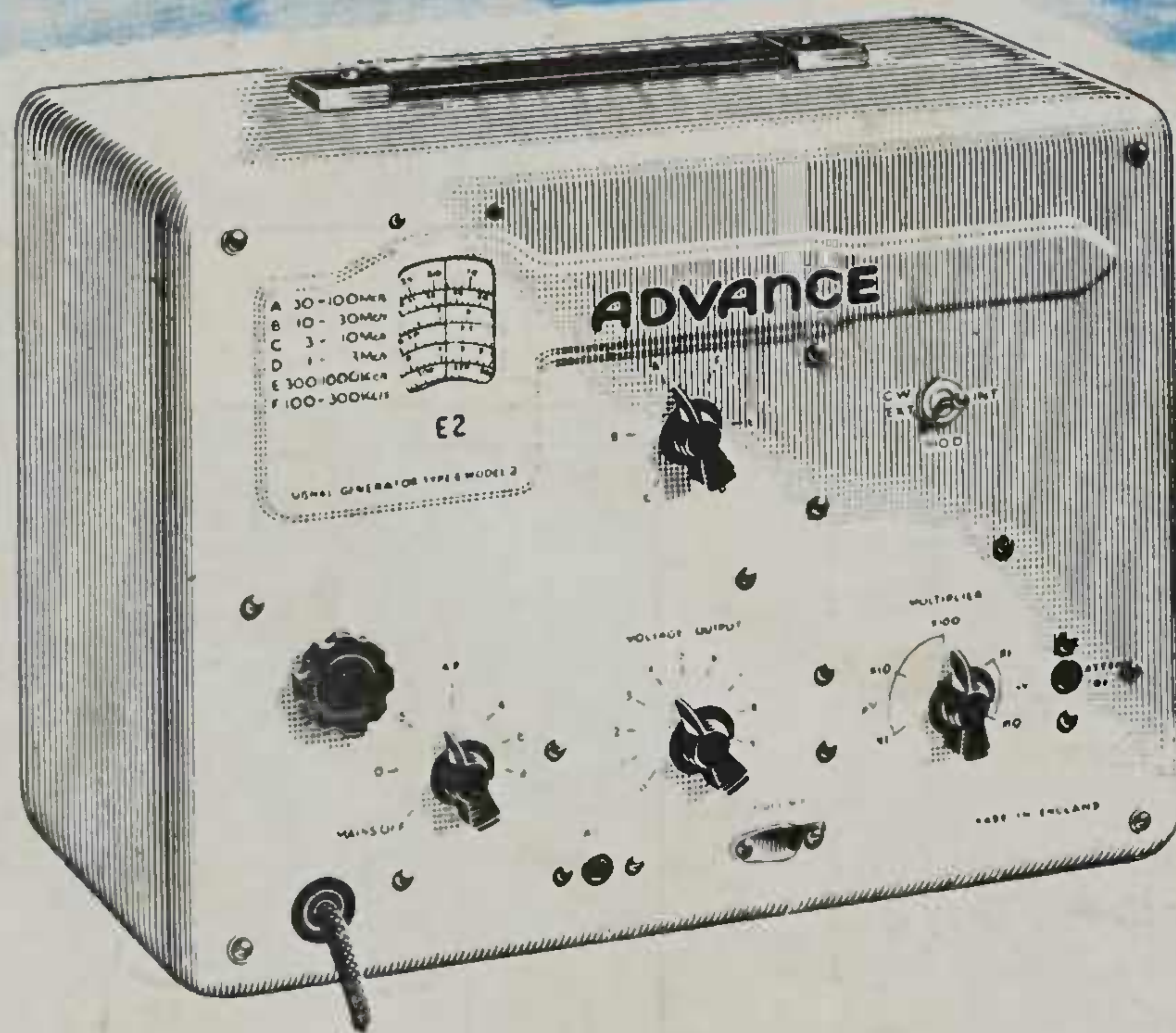
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