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TELEVISION - COMMUNICATIONS - SERVICE - SOUND



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VOL. 12, No. 9

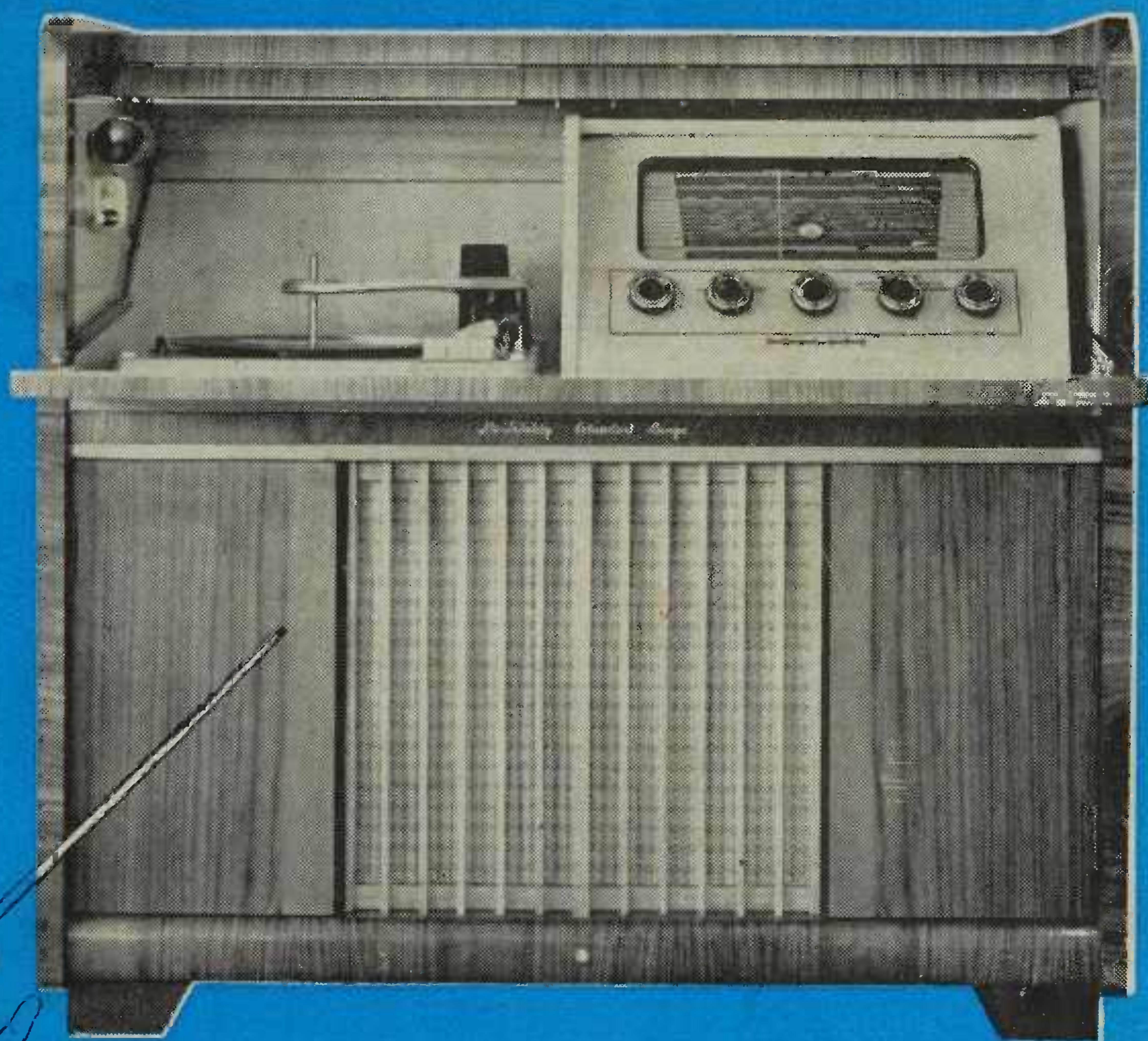
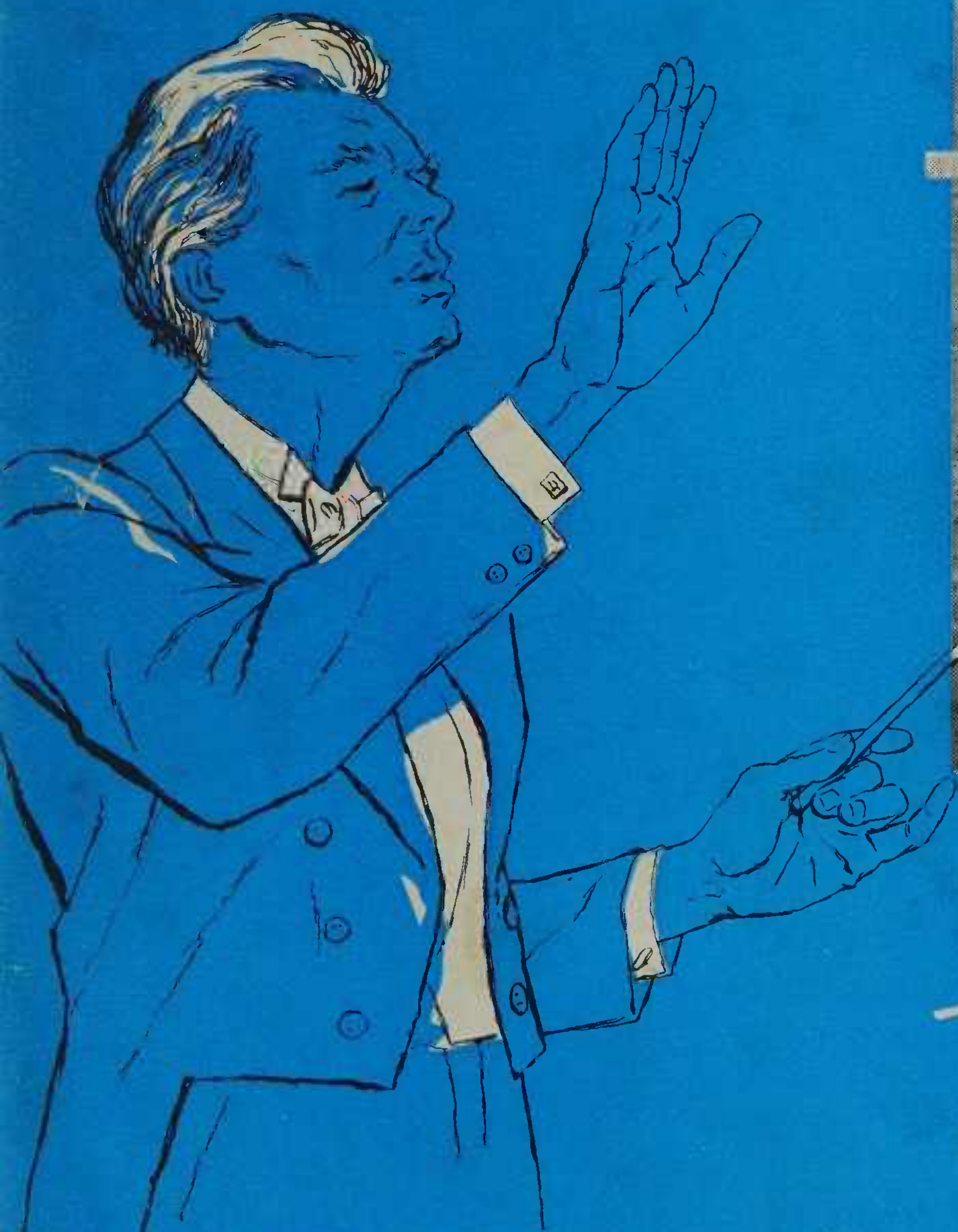
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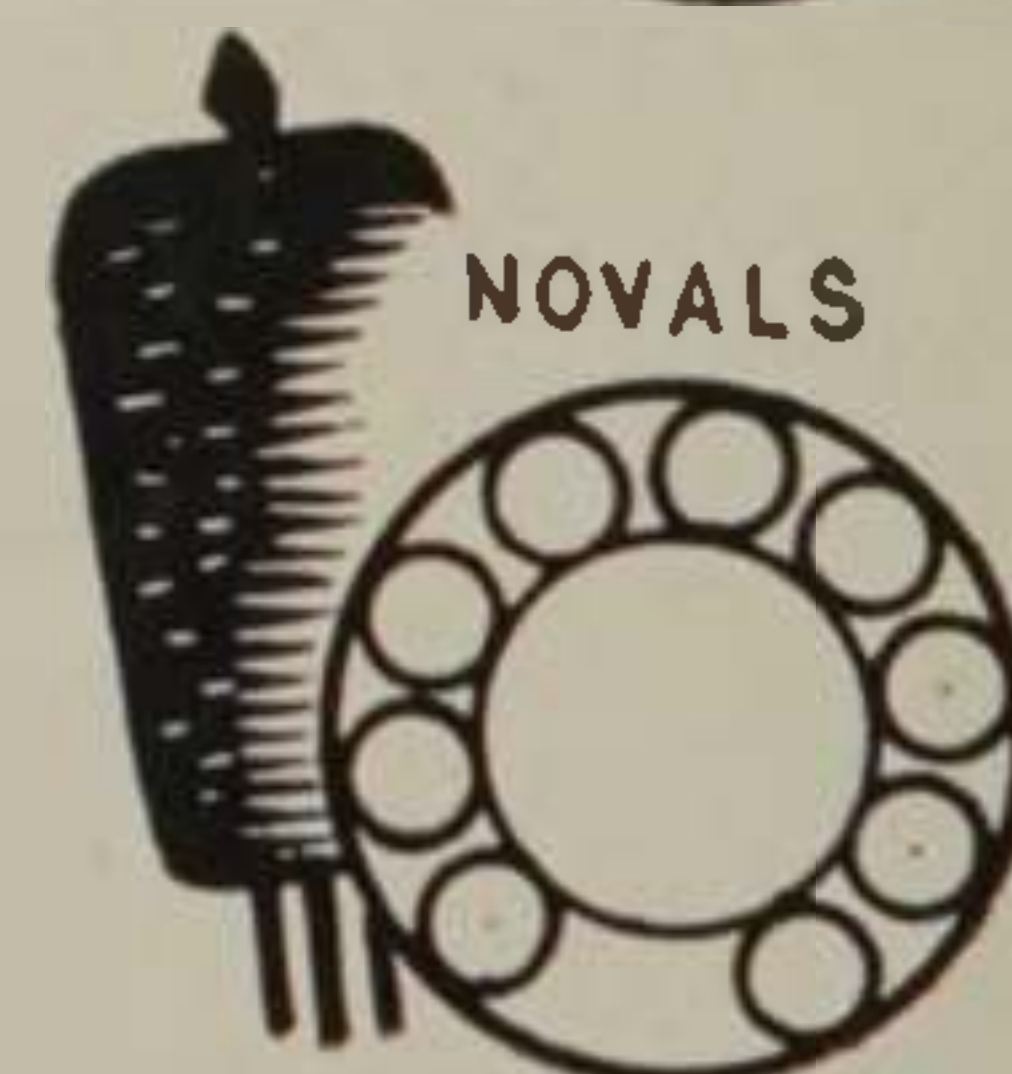
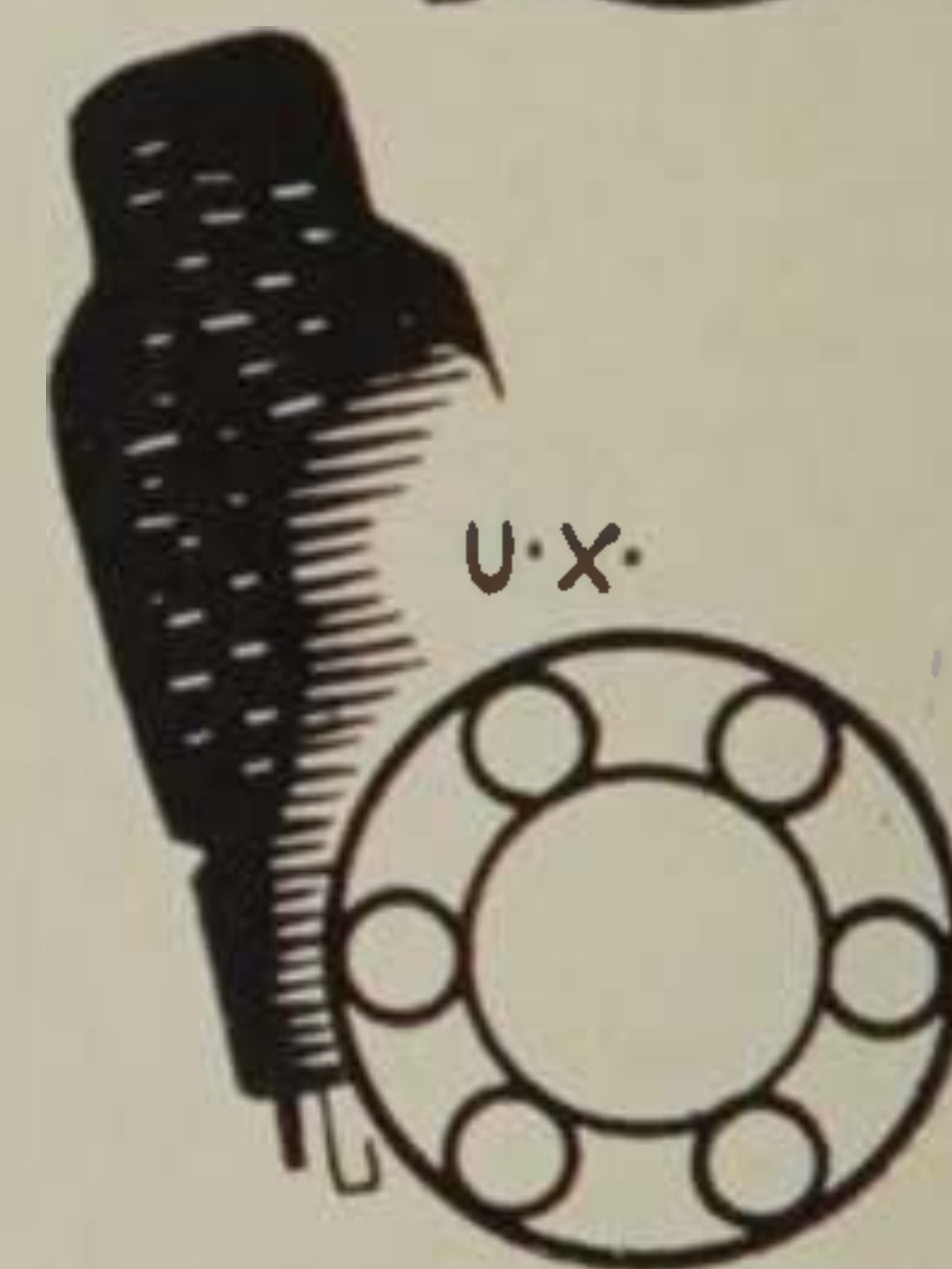
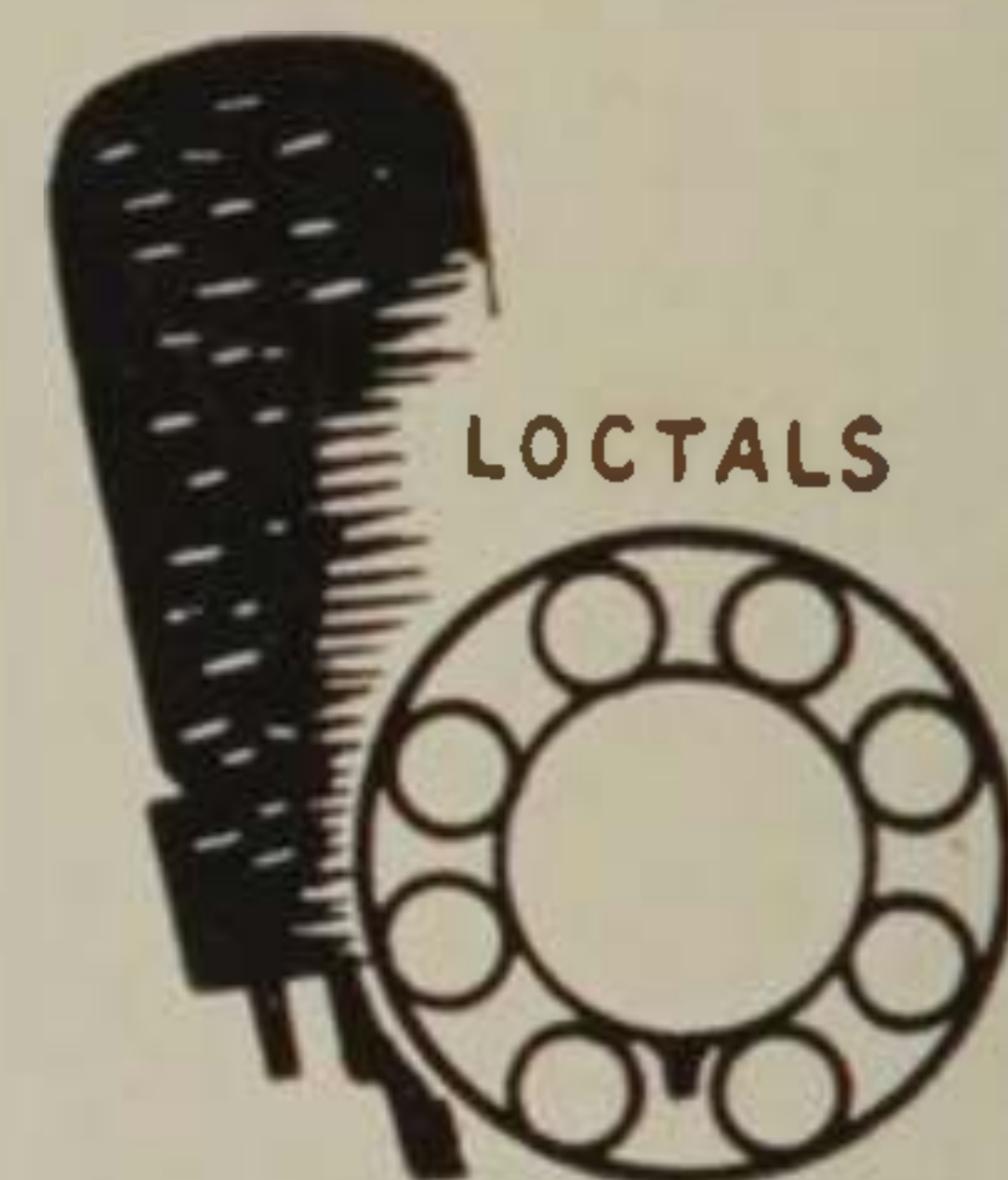
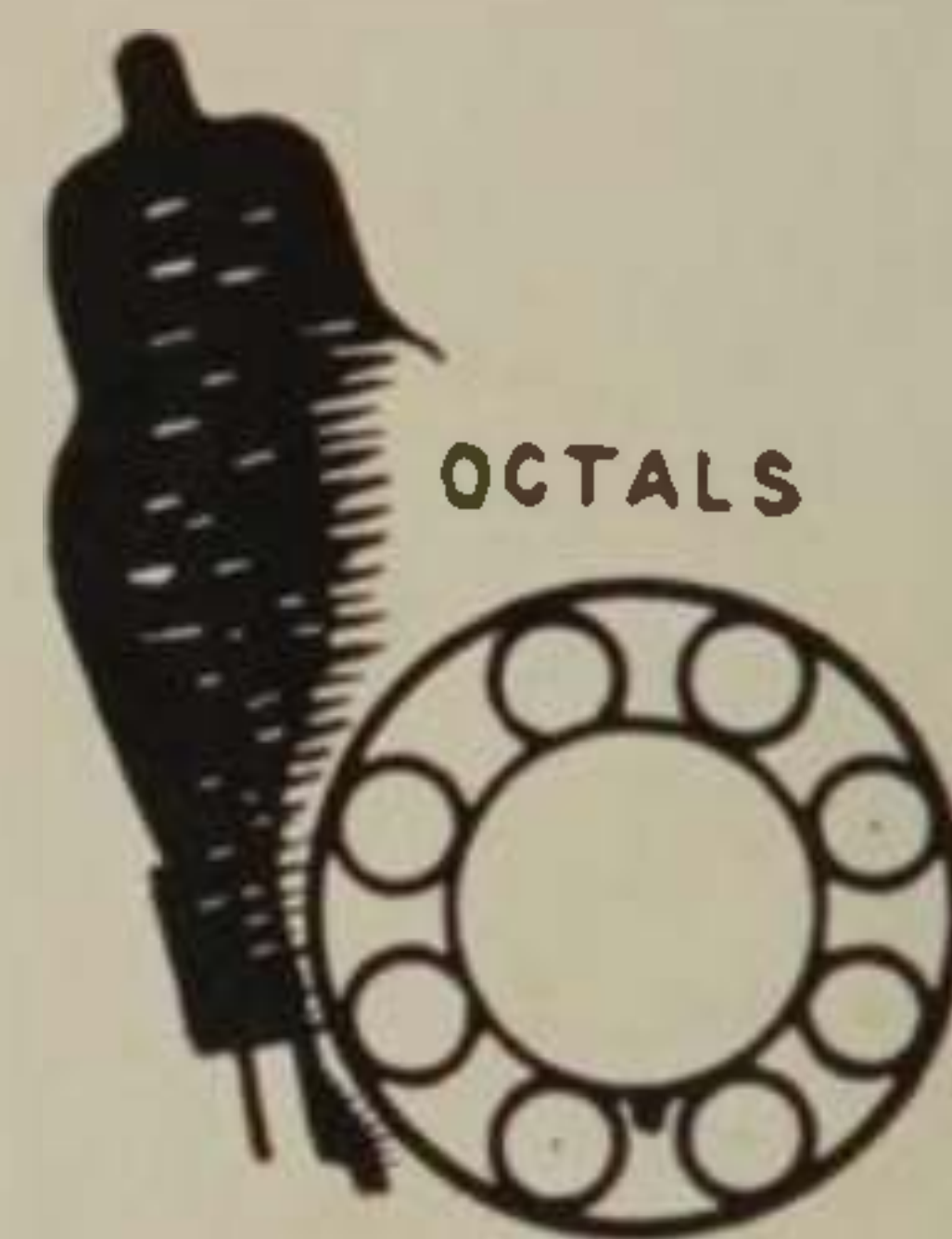
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NOVEMBER, 1957

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*Editorial***SPUTNIKS, TELEVISION, and ELECTRONICS**

It is little wonder that visitors to our shores accuse us of insularity and complacency. A recent article in the *Mercantile Gazette*, by that weekly's editor, strongly denounces the idea that New Zealand should institute a television service. It would be, he says, an expensive luxury which our economy could hardly support. His argument, or rather his bald assertion, is based on his own opinion that a recent estimate of the cost of establishing a television service errs grossly on the low side. At least, we gather it is his own opinion, since he does not support it with figures or with any authority whatever. The editor of the *Mercantile Gazette*, in short, sets himself up as an authority in a highly specialized field in which he can claim no more expert knowledge than any other layman, and proceeds on this basis to tell none other than Mr Ralph Slade that he does not know what he is talking about!

This would be laughable if it were not for the fact that the paper to which we refer is read by a very large section of our business community, and that its pronouncements in mercantile and financial matters probably carry some considerable weight.

The question, even so, is hardly one of whether or not we can find the money to support a television service, and this is the reason for our opening remark. There are much wider issues at stake than that. It is a matter of fact, not conjecture, that the free world is desperately short of trained engineers, technologists, and technicians. The Soviet Union is known to have much greater resources in technical manpower, both trained and in training, than have Britain and the rest of the free world, and it is not by accident, nor by ignoring technological development in other parts of the world, that the U.S.S.R. has been able to startle the world by itself launching the first two artificial satellites and by being the first nation, in all probability, to possess the inter-continental ballistic missile.

What has this to do with television in New Zealand? More, we venture to suggest, than might at first meet the eye. In the modern race for technological supremacy (which is what today's armaments race really means), electronics is one of the essential fields of attainment, and not, as it once was, merely an interesting new ancillary to existing techniques. Without electronics, it would not have been possible for the Allies to defeat Hitler, and without it there would be no earth satellite, and no I.C.B.M. We do not state these things as feathers in the cap of the electronics engineer; they are simply facts which must be recognized. And since they are facts, the possession by the free world of sufficient technologists and technicians trained in electronics is a matter of more than a little importance.

We cannot escape the fact, too, that this is a very small country, and that what we do here has a relatively small effect on global affairs, but that is no excuse for our dropping needlessly behind in the application of electronics to every-day life. The institution of television broadcasting would mean the creation of a demand for men much more highly skilled in electronics than are those who grace the radio industry today. It is only a short step from the techniques of television to those of radar, telemetry, and remote control, which form an essential part of today's defence, and an ever-growing part at that. Because of this, we would be doing ourselves, the Commonwealth, and the free world a service if we were to create the domestic demand in peace-time for men who would be immeasurably more use in time of war than would our present-day radio men, who have nothing more advanced than sound broadcasting on which to base their knowledge. It is not unlikely that many of the countries which now have television services have been actuated partly by such considerations as these when deciding to set them up.

It has been said that should a major war occur, our role here would primarily be that of growers of food. This may be true, but there are many more people in New Zealand than are required to grow food in such an eventuality. It may well be that in another world war our most valuable contribution, apart from growing food, would take the form of providing skilled technical men in such fields as electronics. But if those of us whose present jobs are already in or close to this field are prevented from expanding our technical horizons by short-sighted policies such as that of the editor of the *Mercantile Gazette*, how is this to come about?

Even if it is conceded that the monetary cost of television would not be low, who is to say that we cannot afford it? Certainly not the editor of the *Mercantile Gazette*, unless he can produce some more convincing arguments, backed by more authority than he has so far been able to raise.

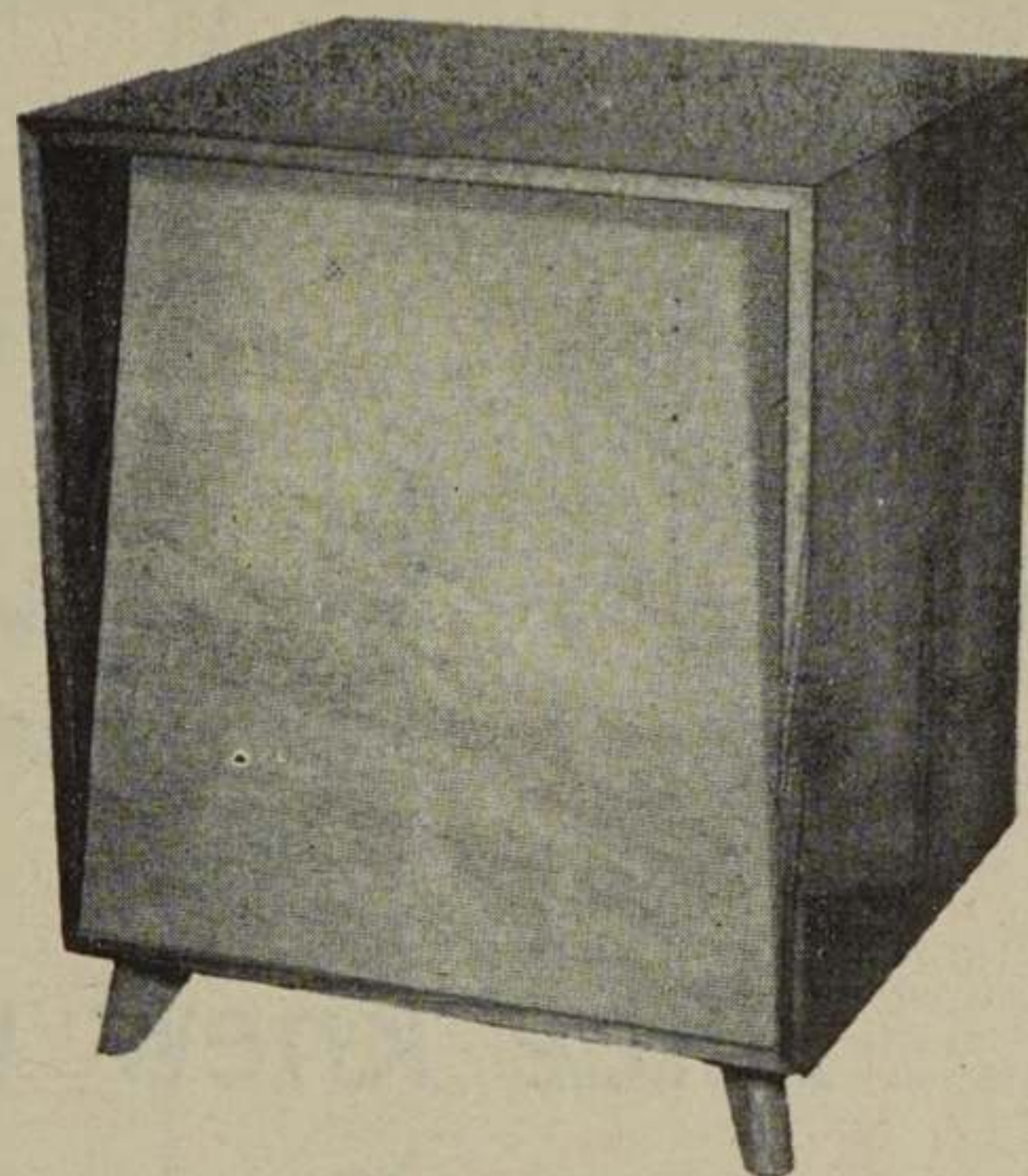
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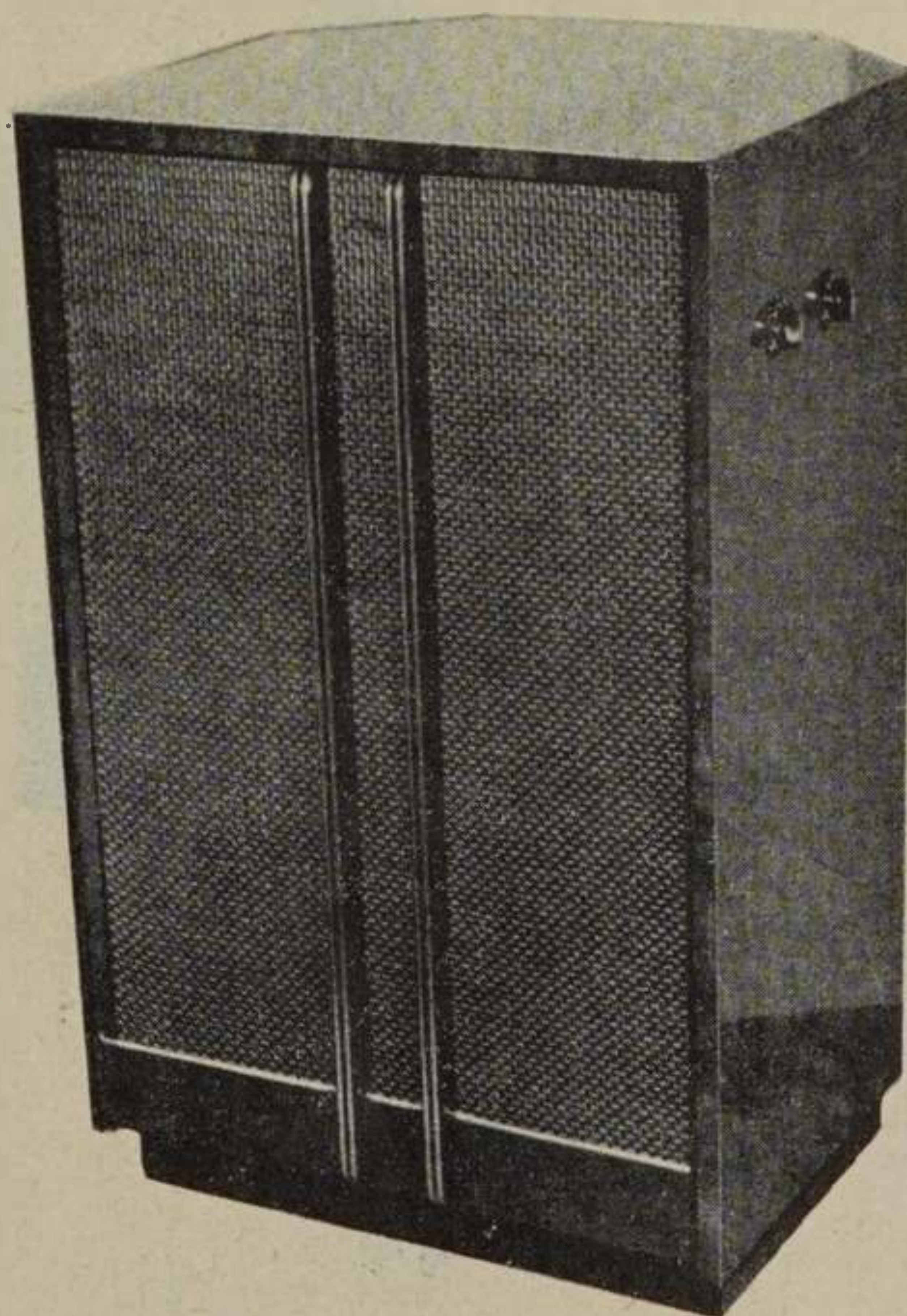
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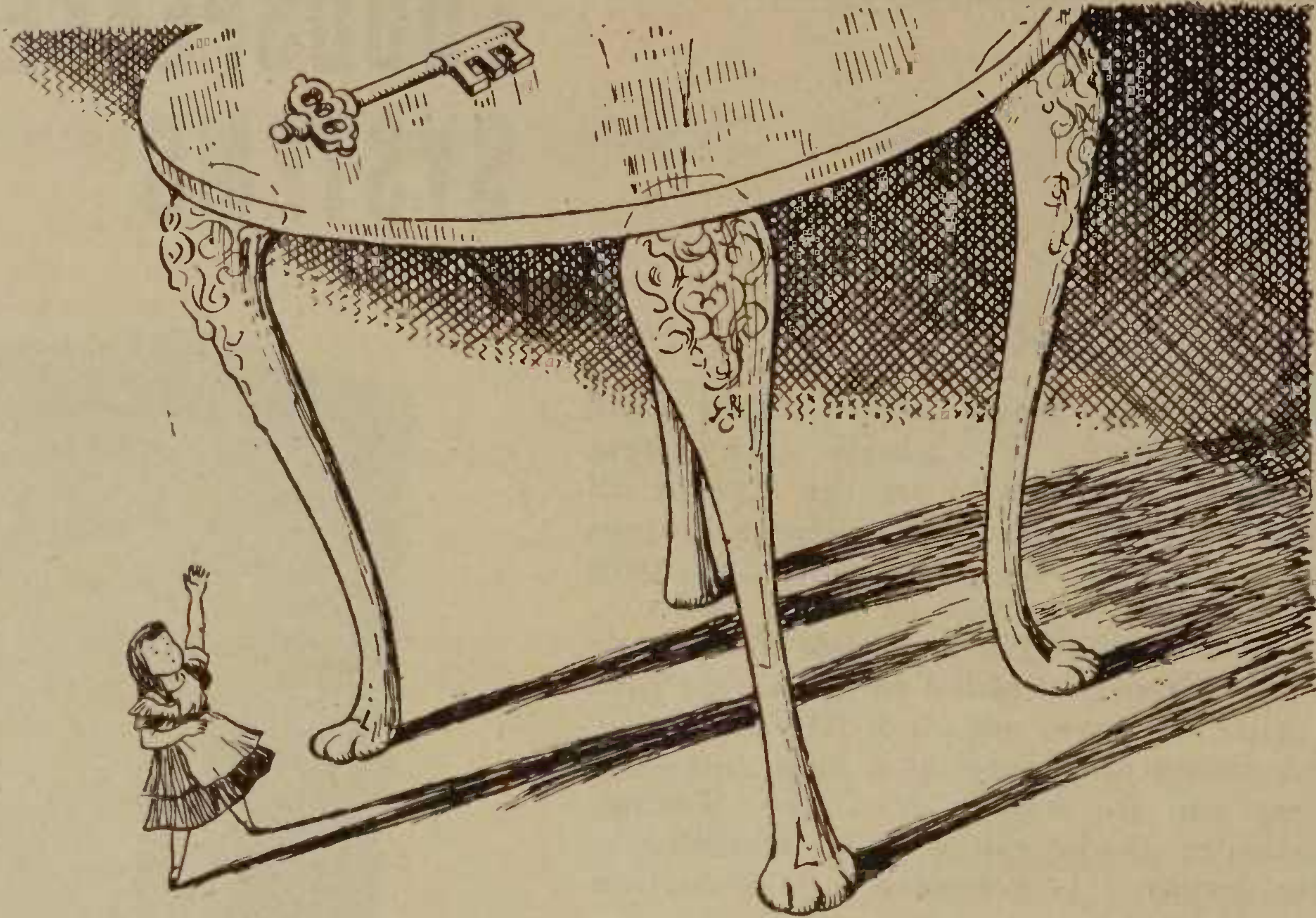
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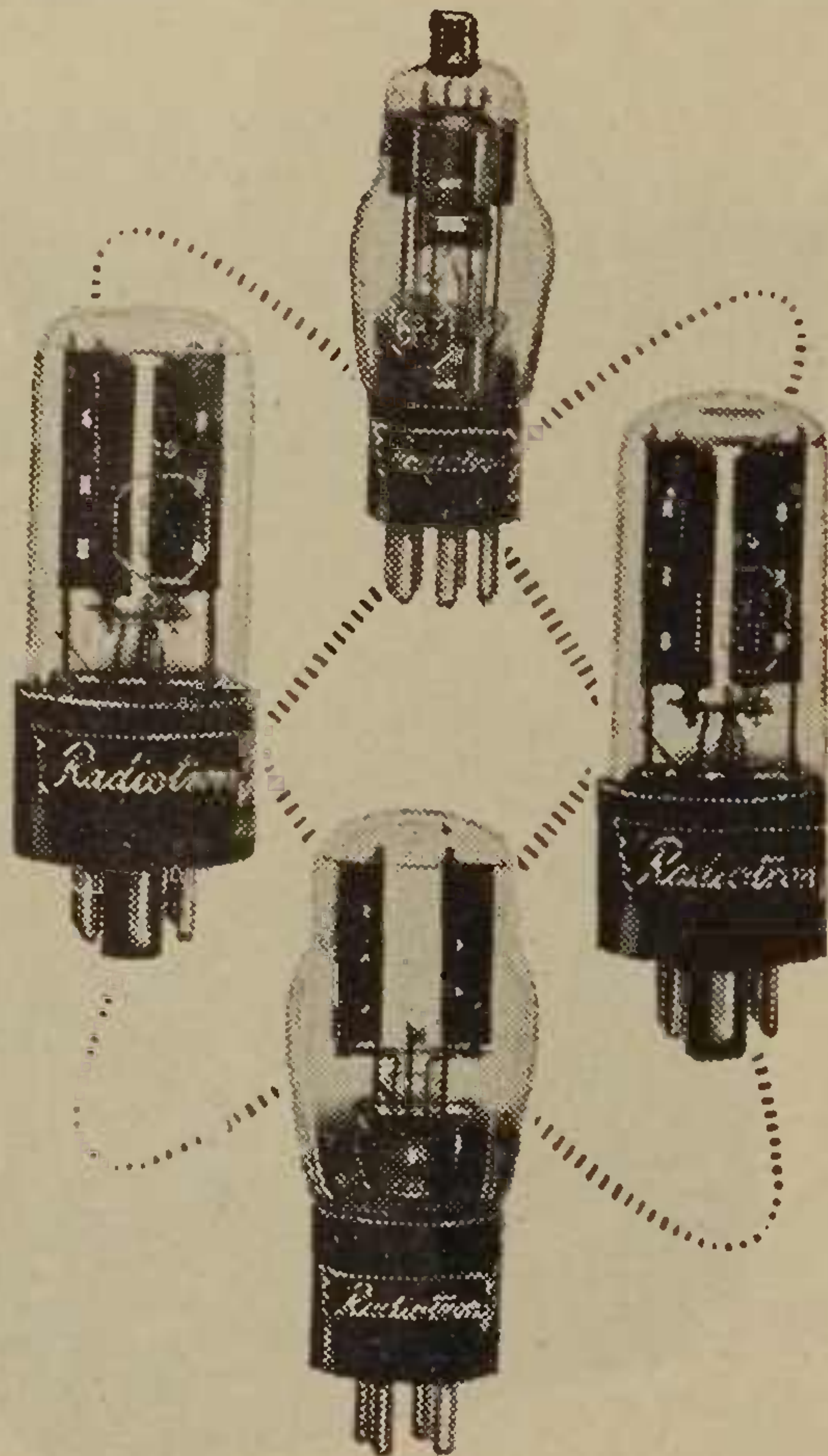
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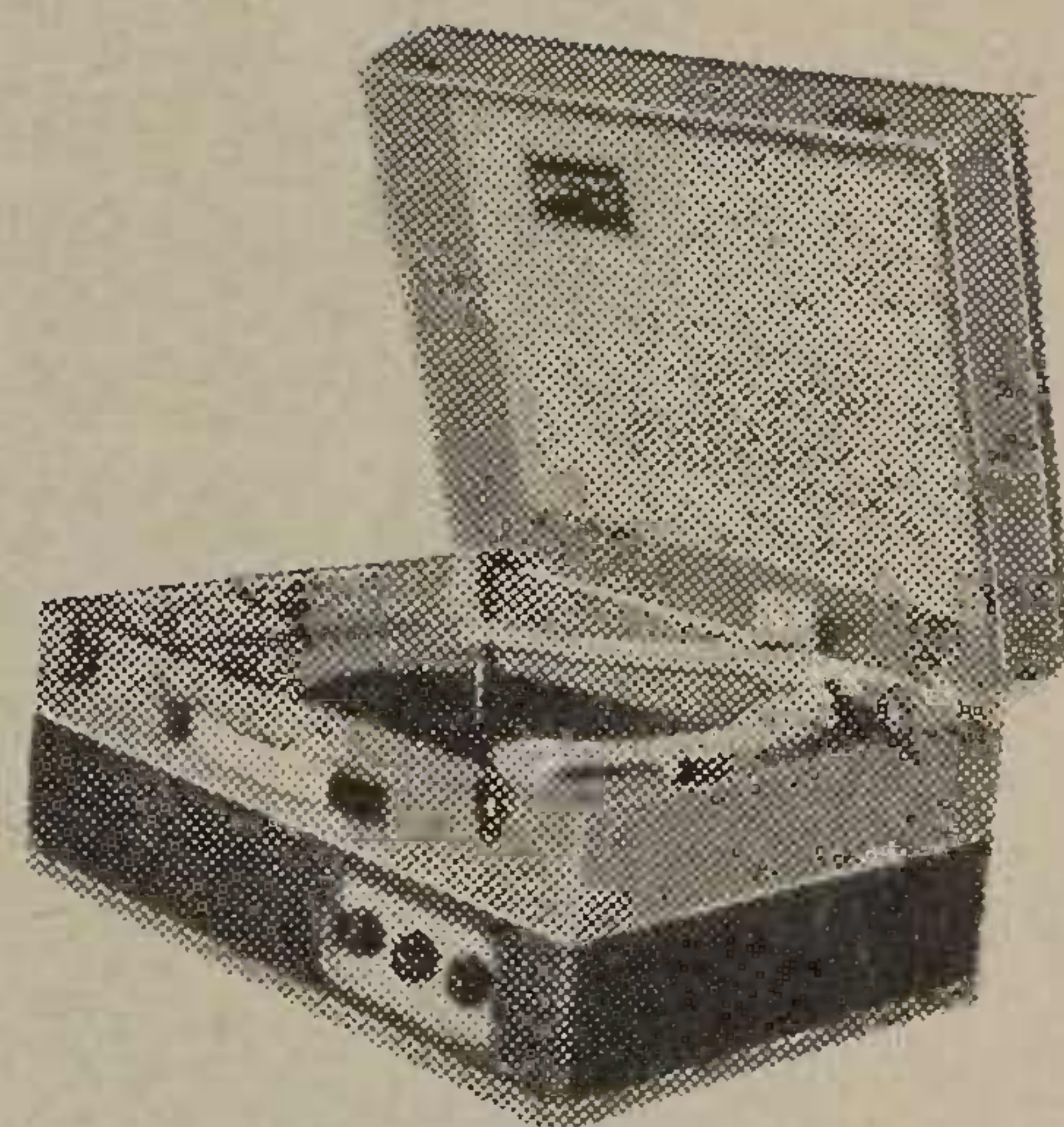
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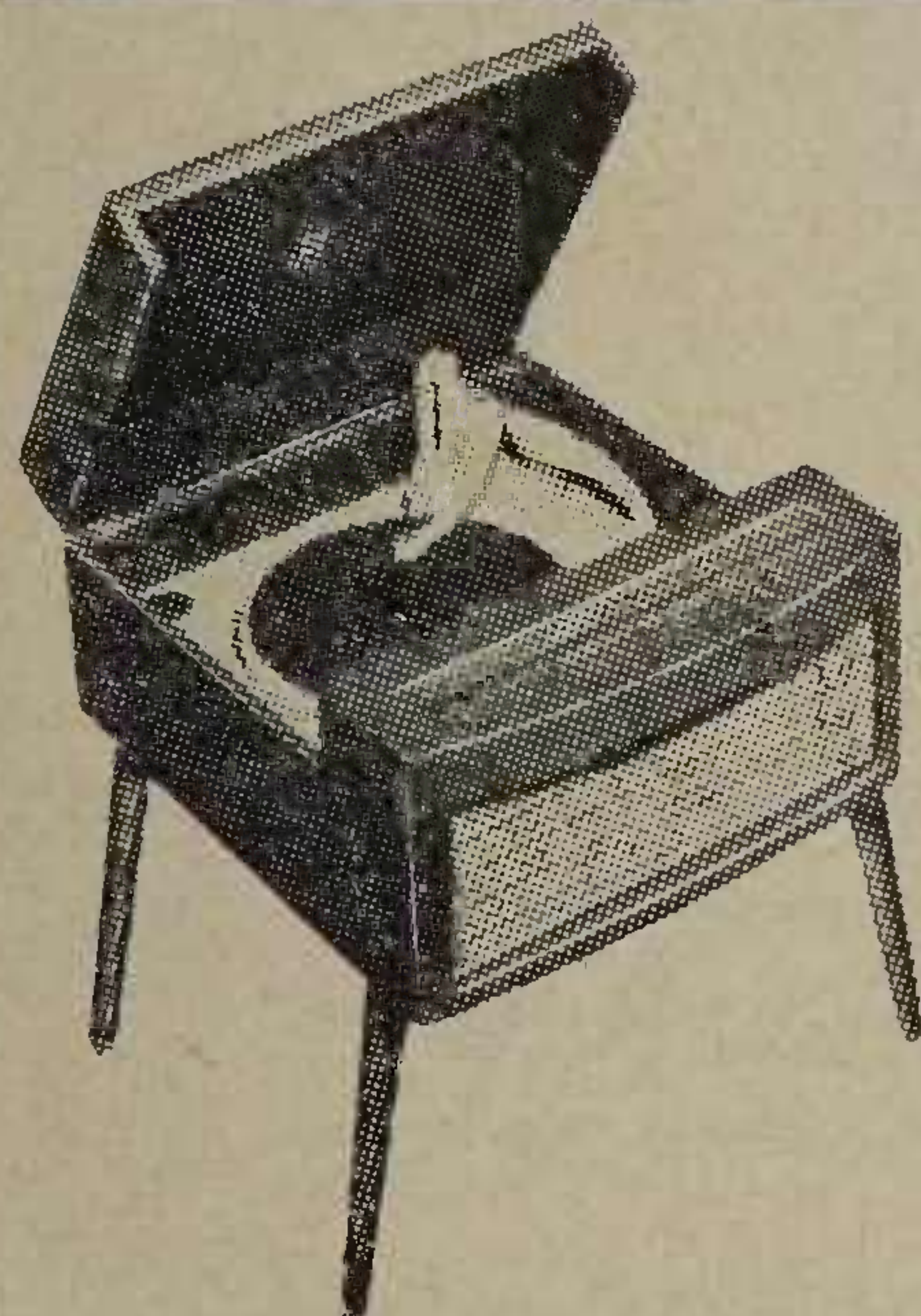
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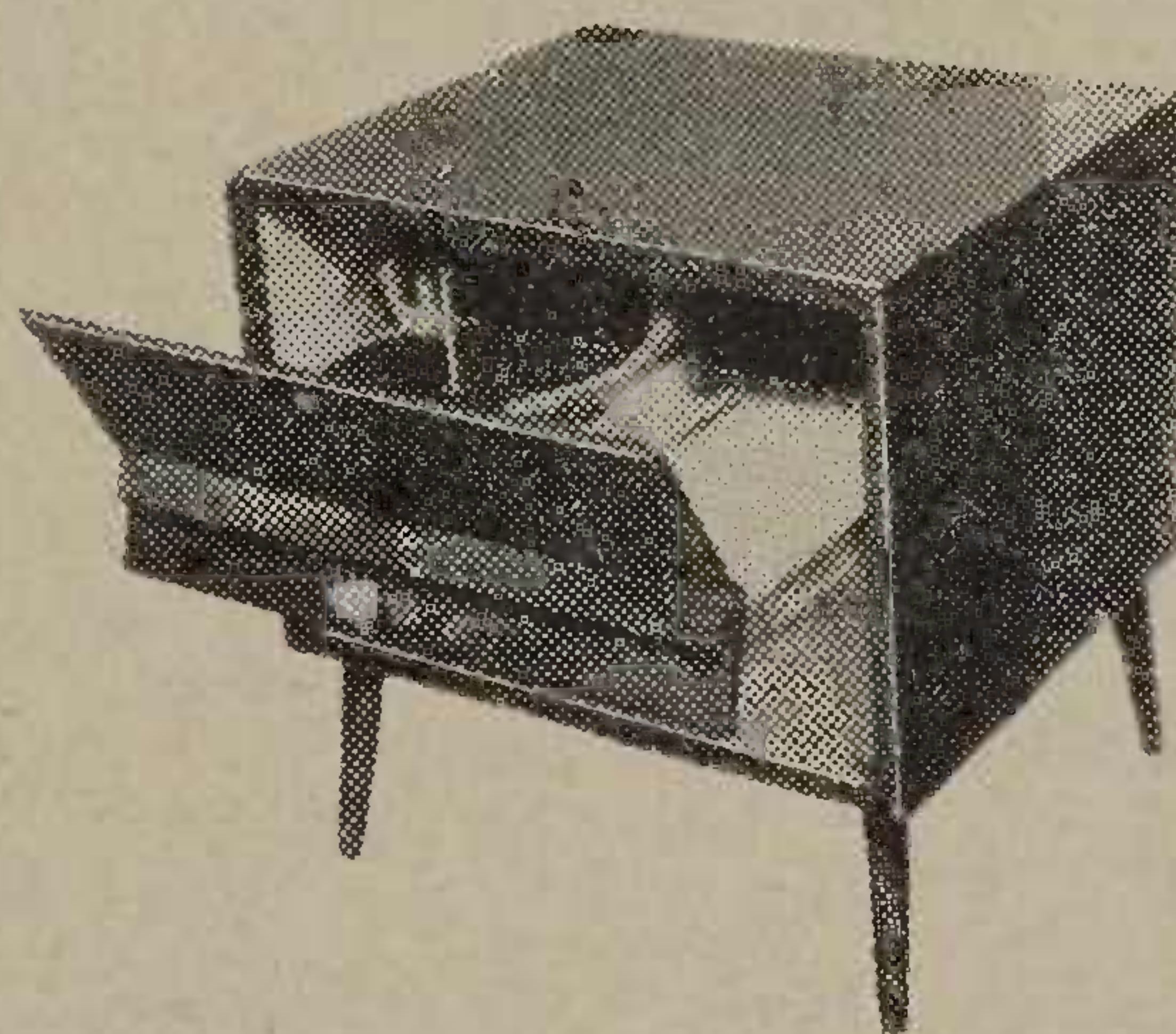
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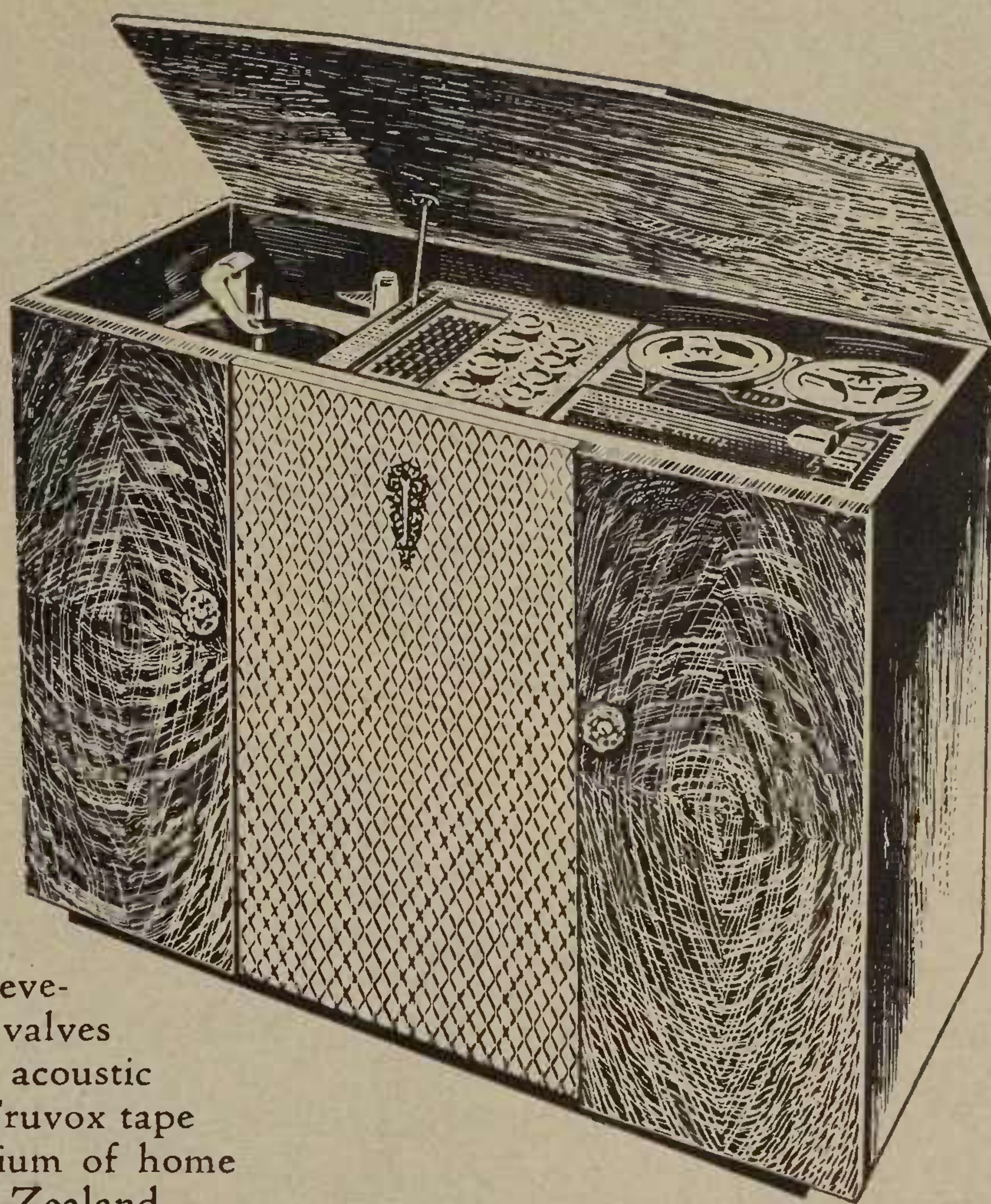
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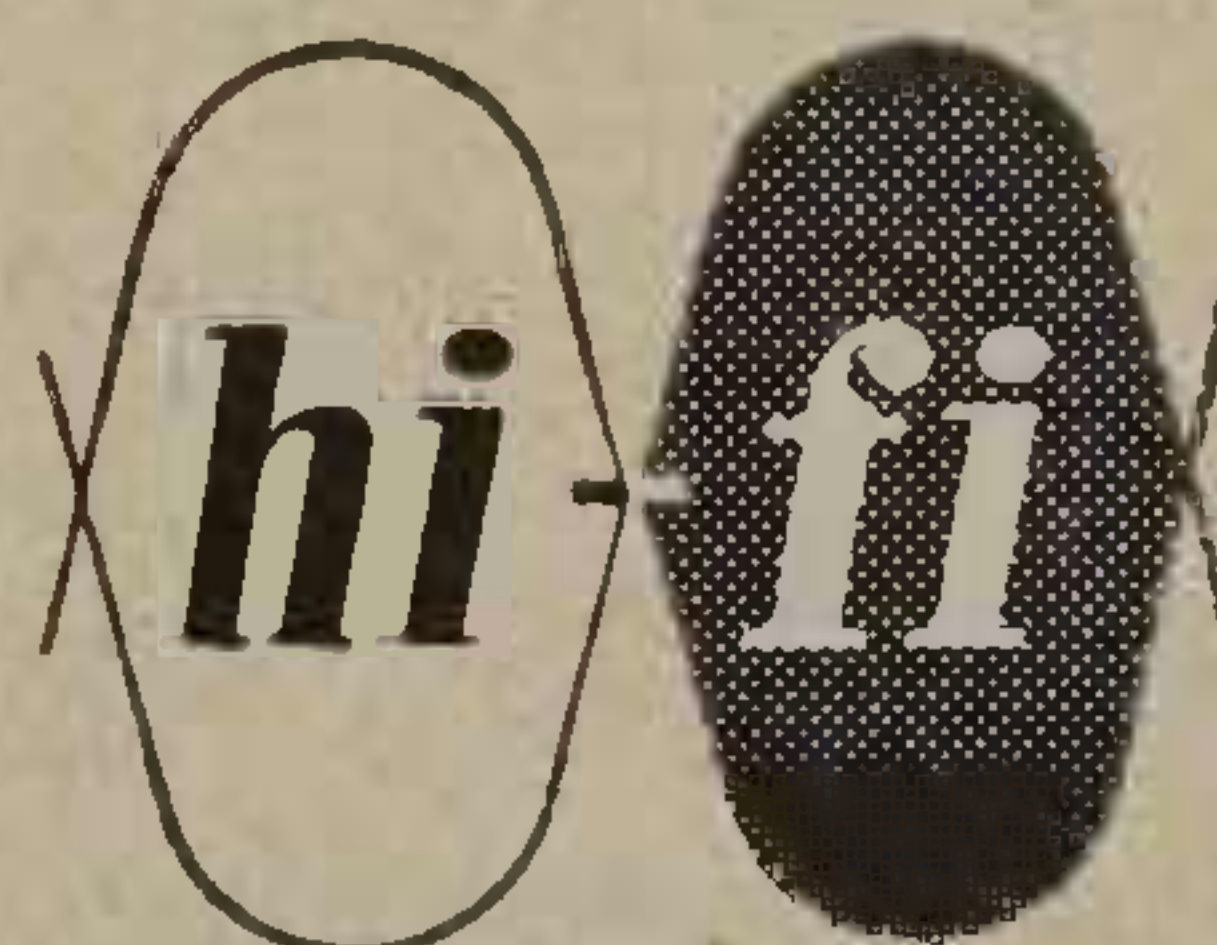
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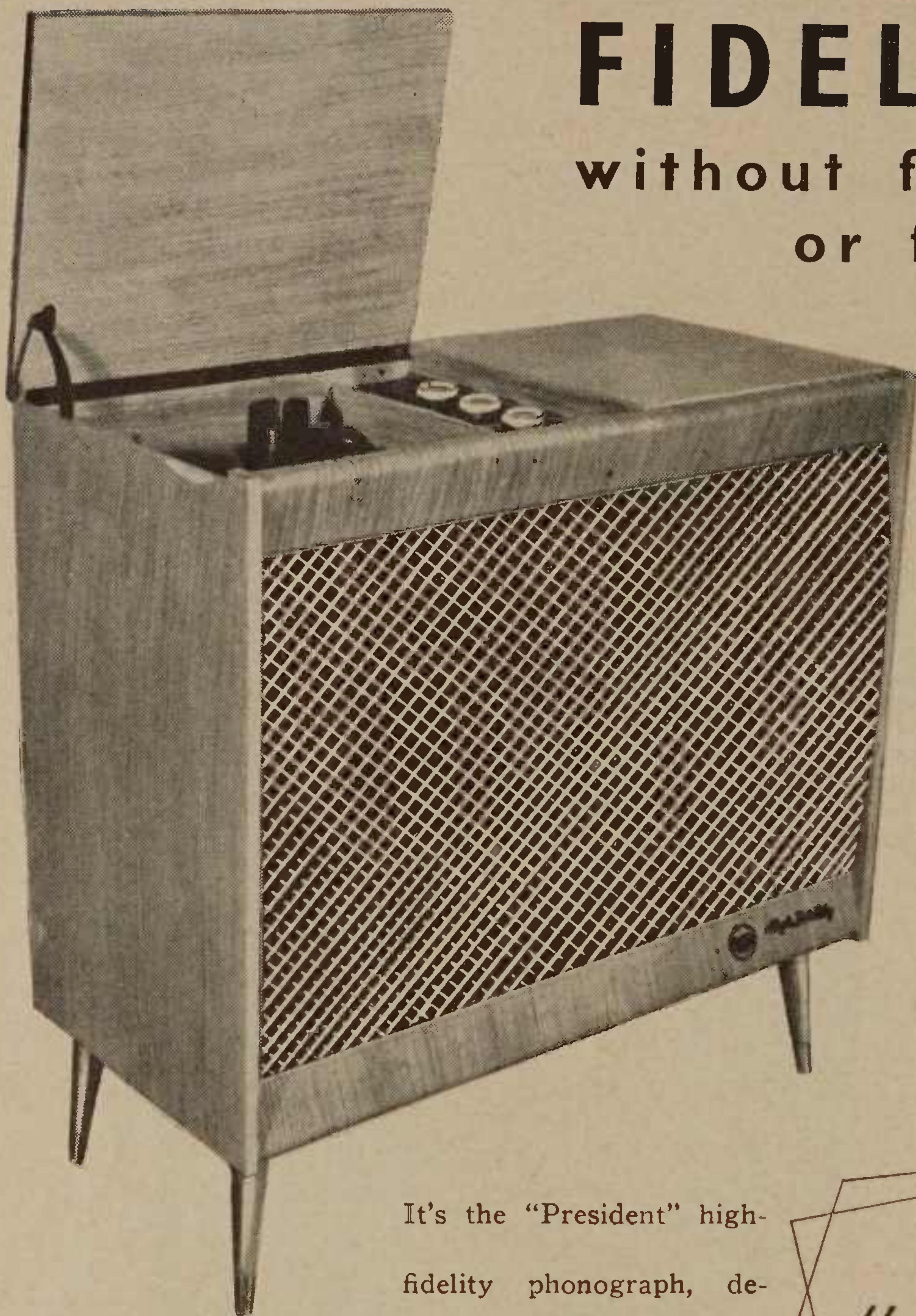
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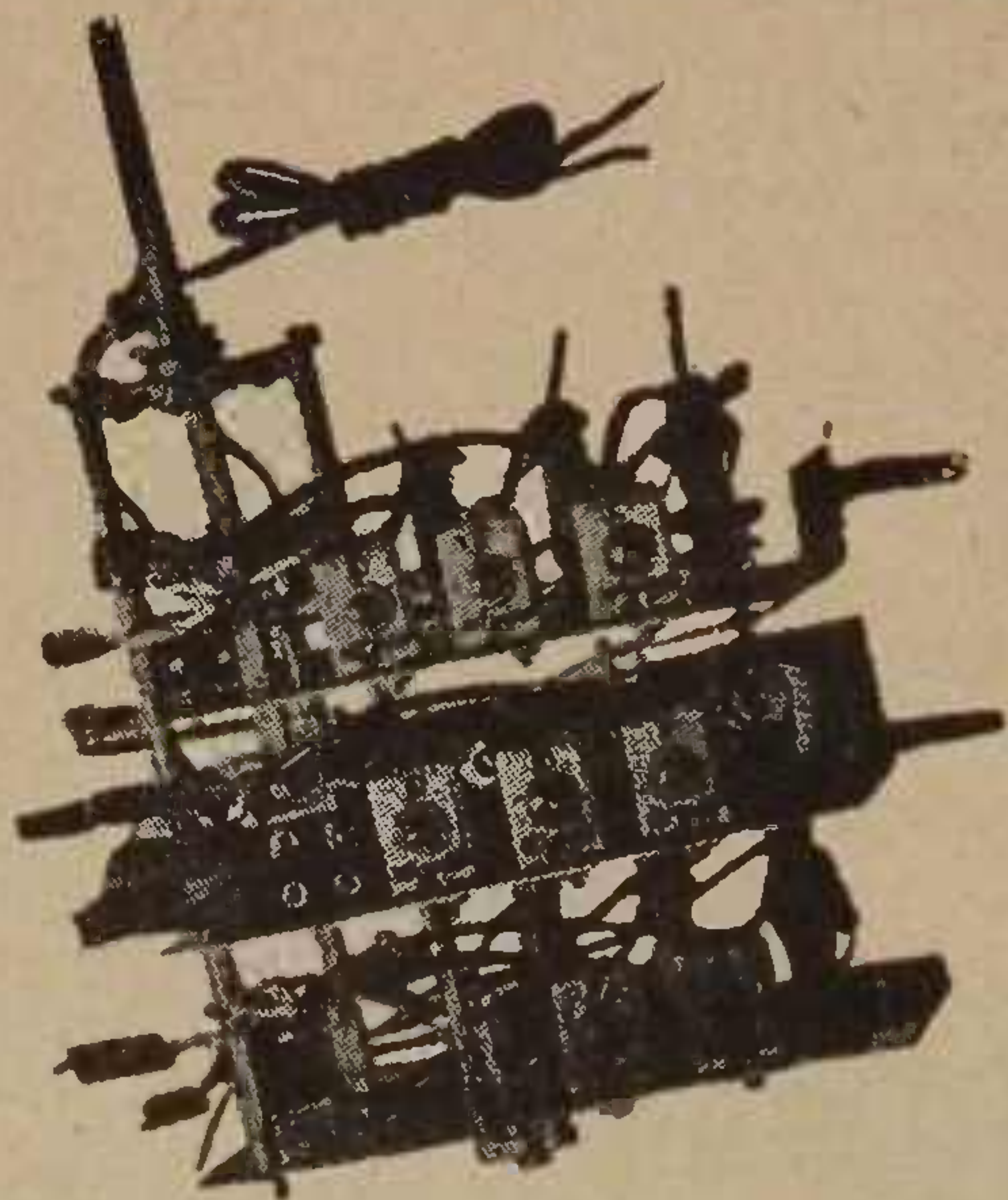


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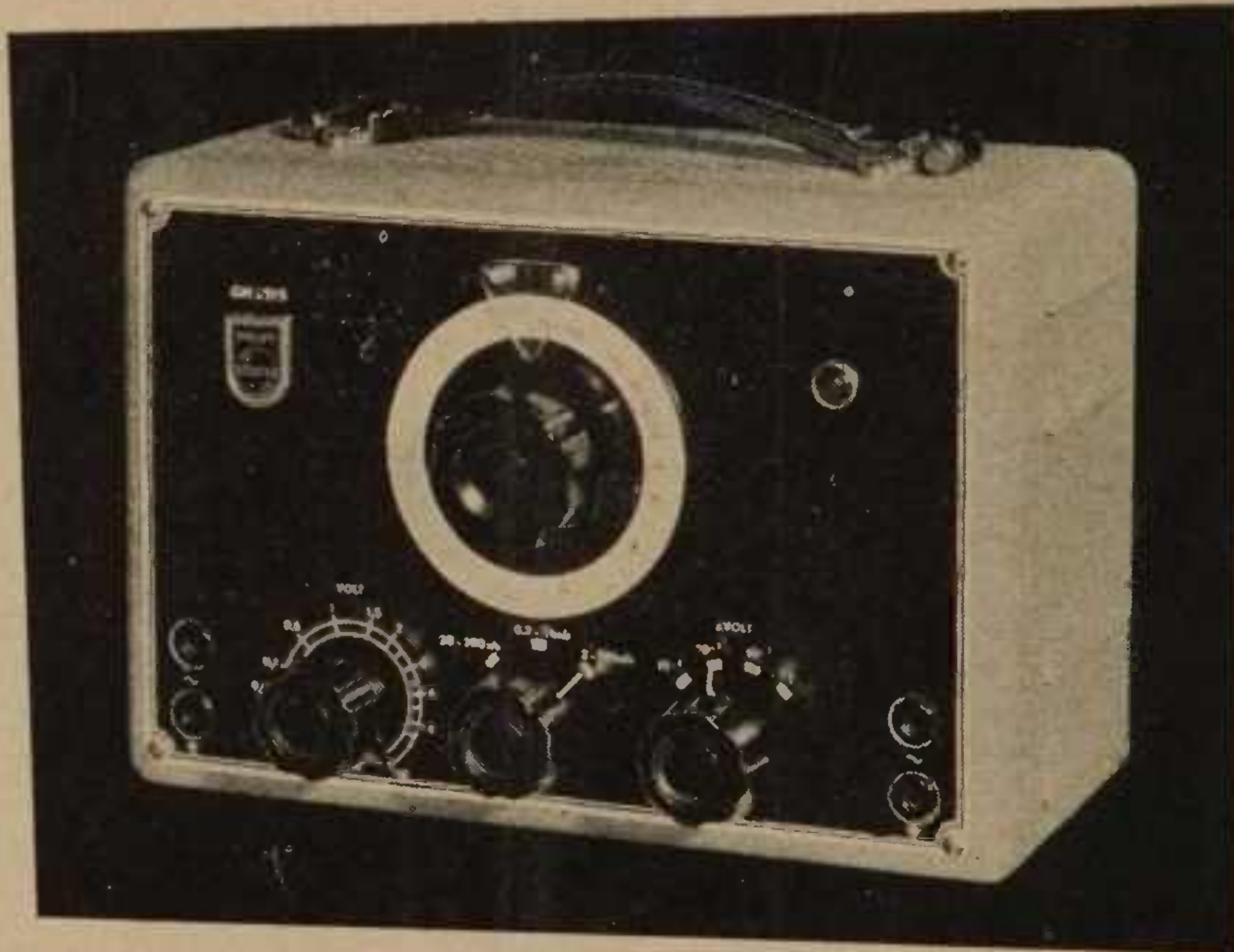
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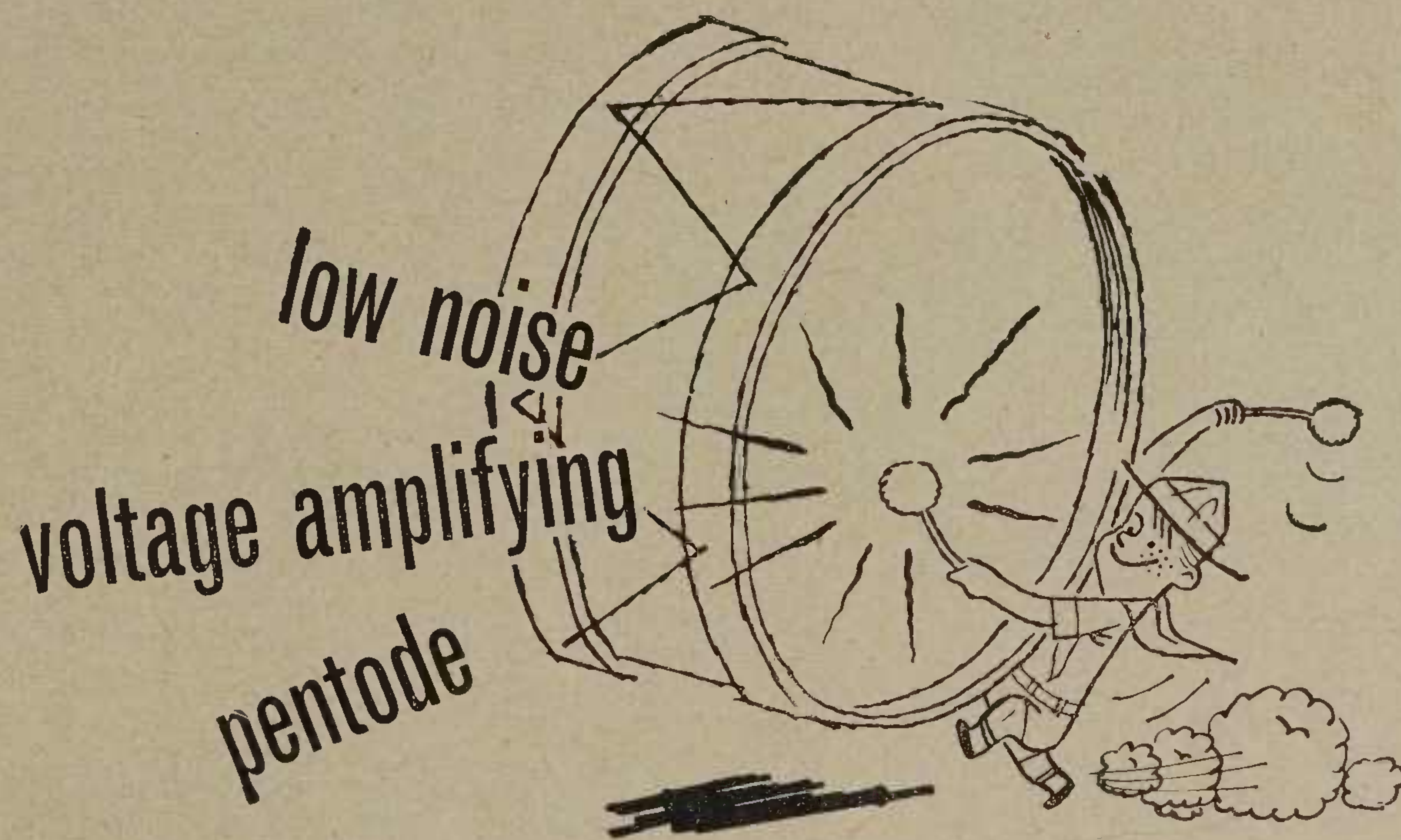
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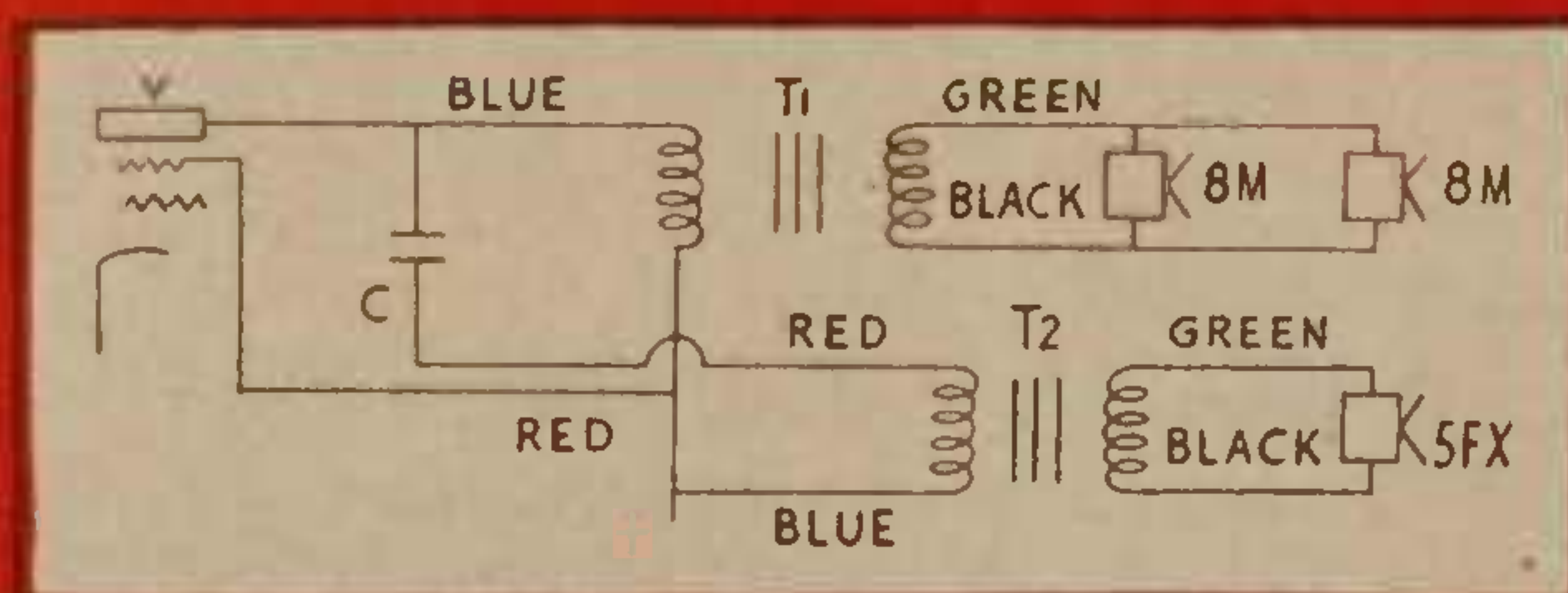
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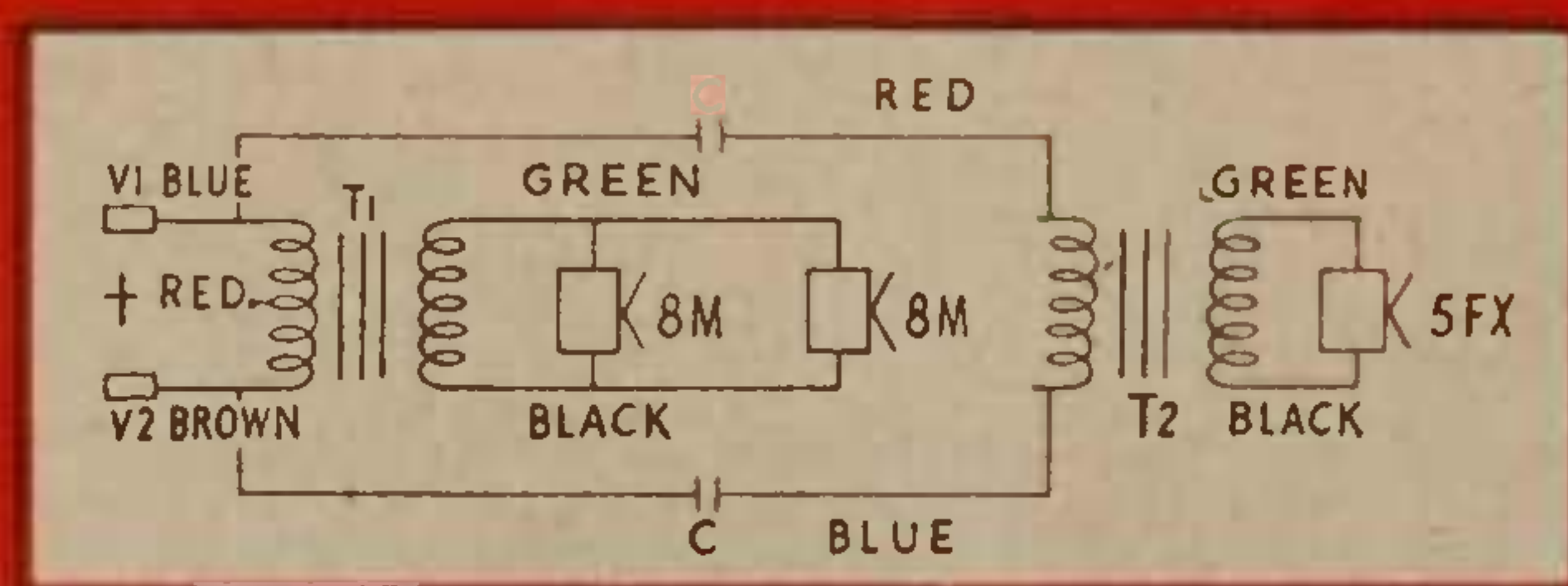
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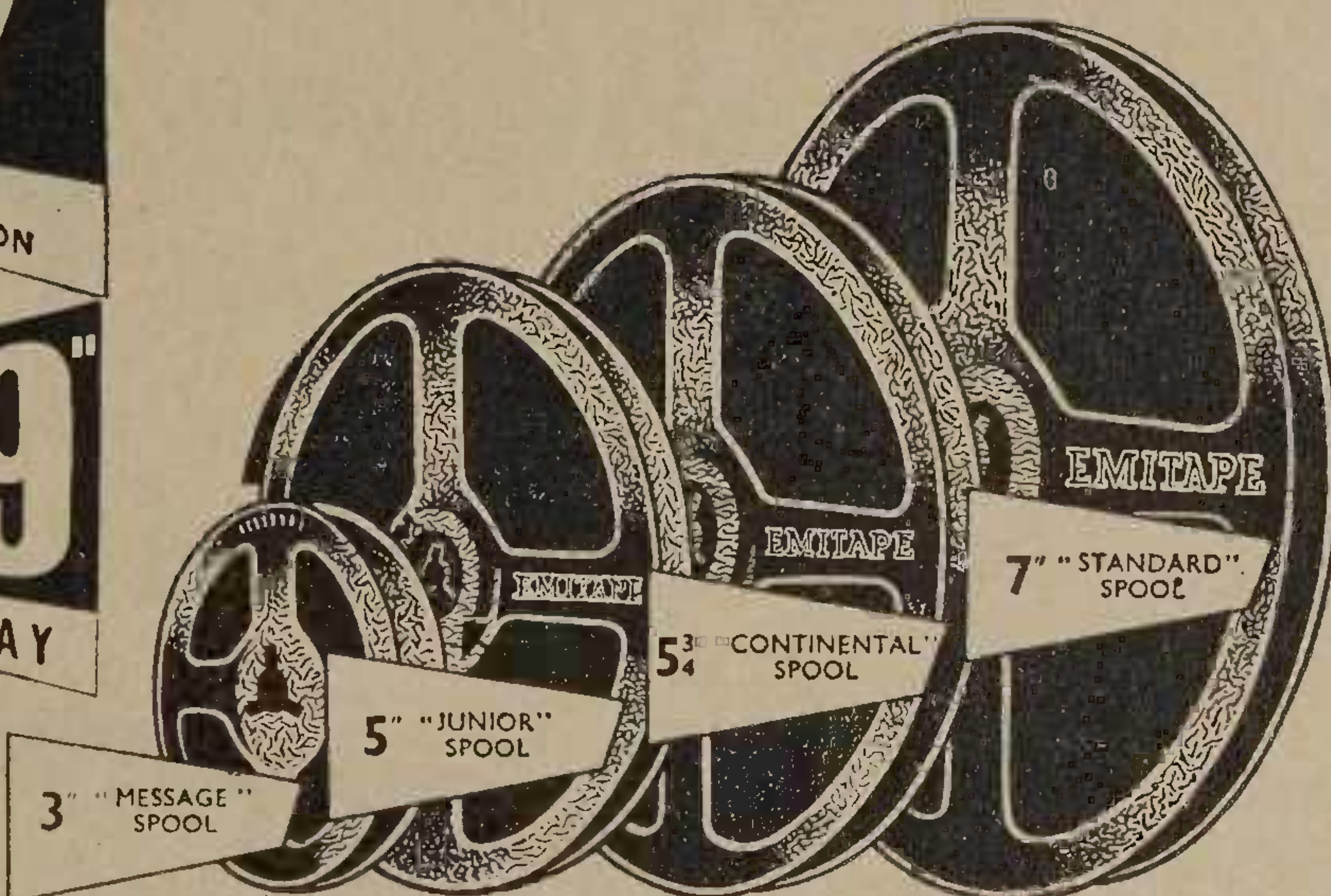
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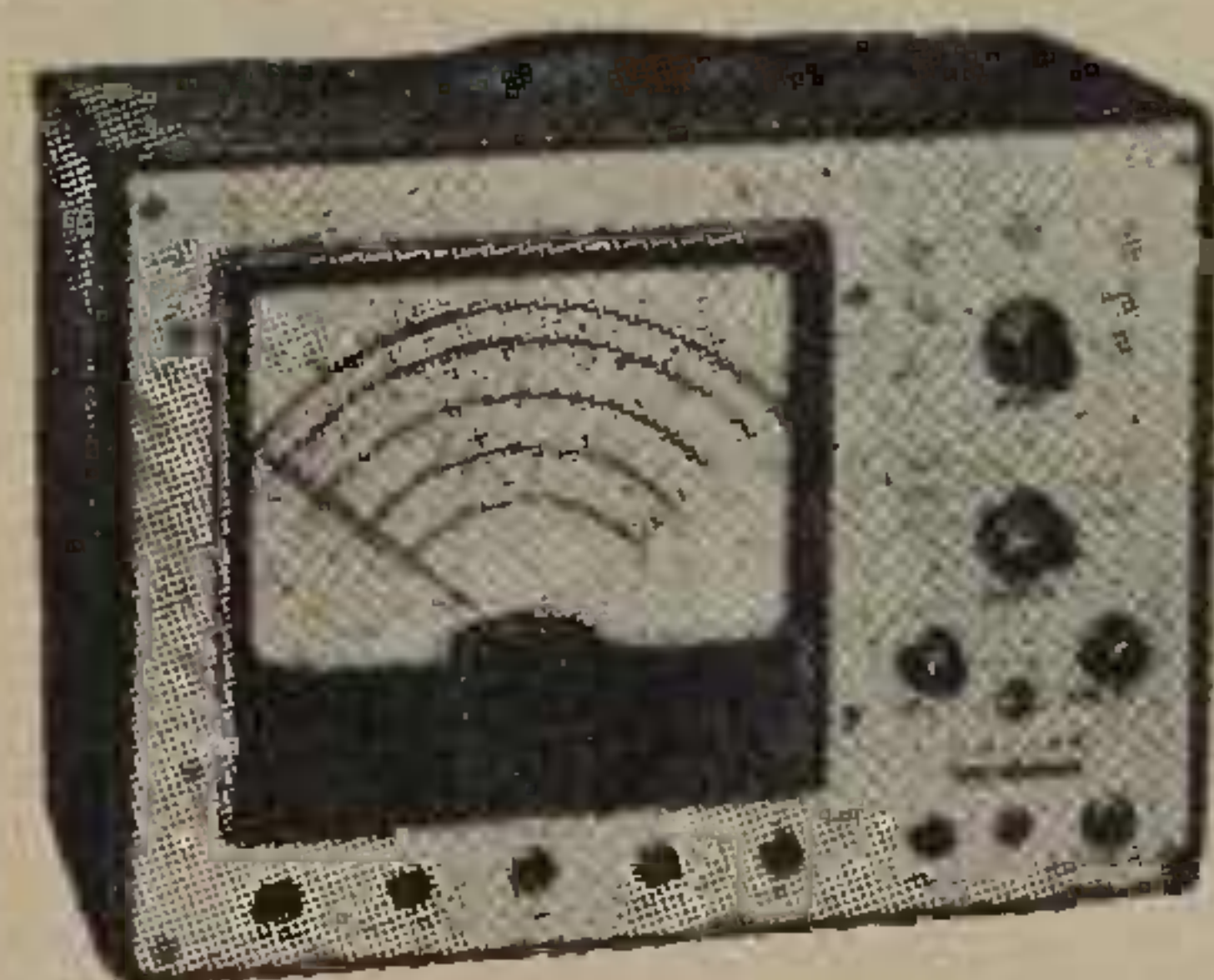
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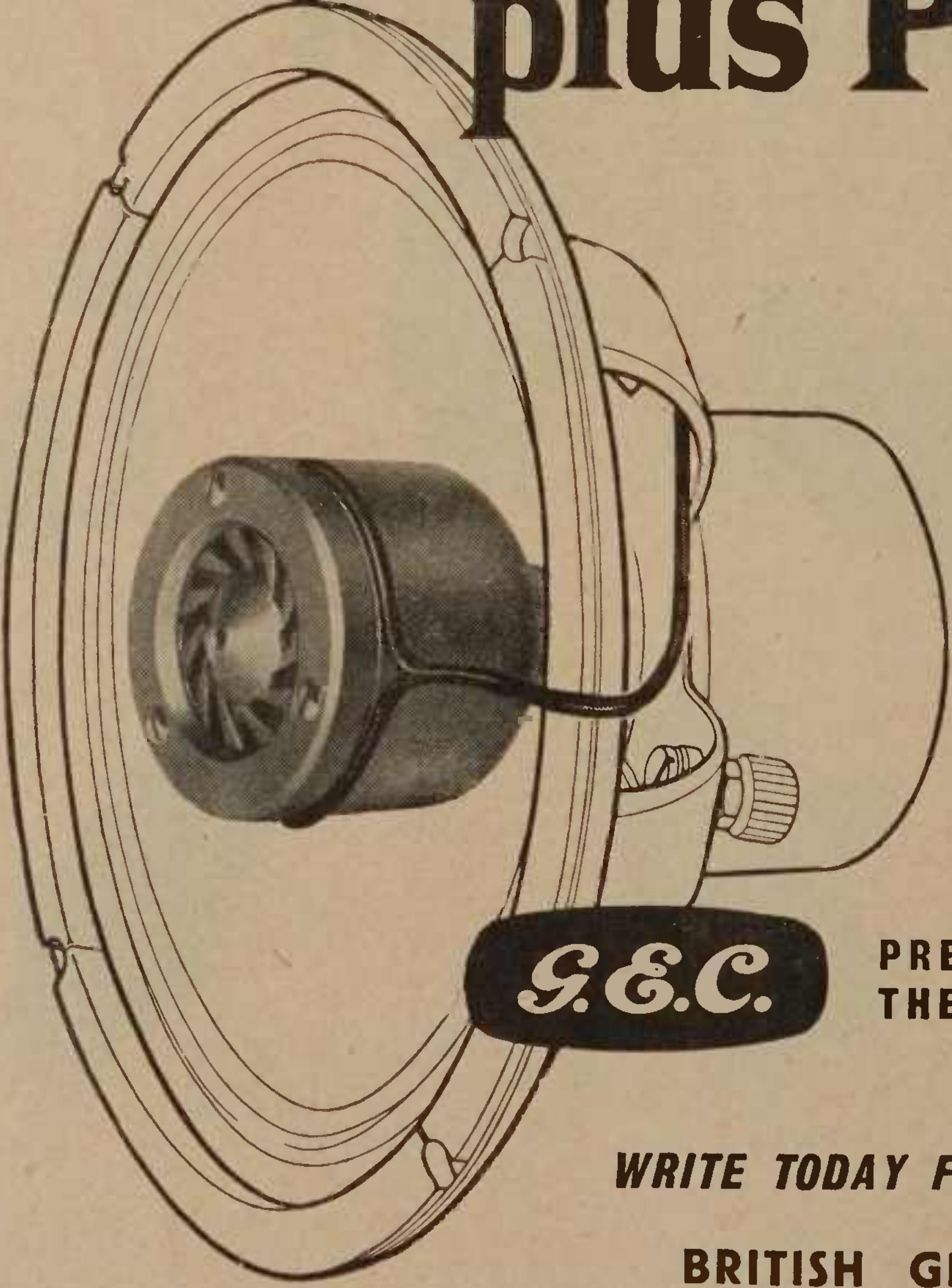
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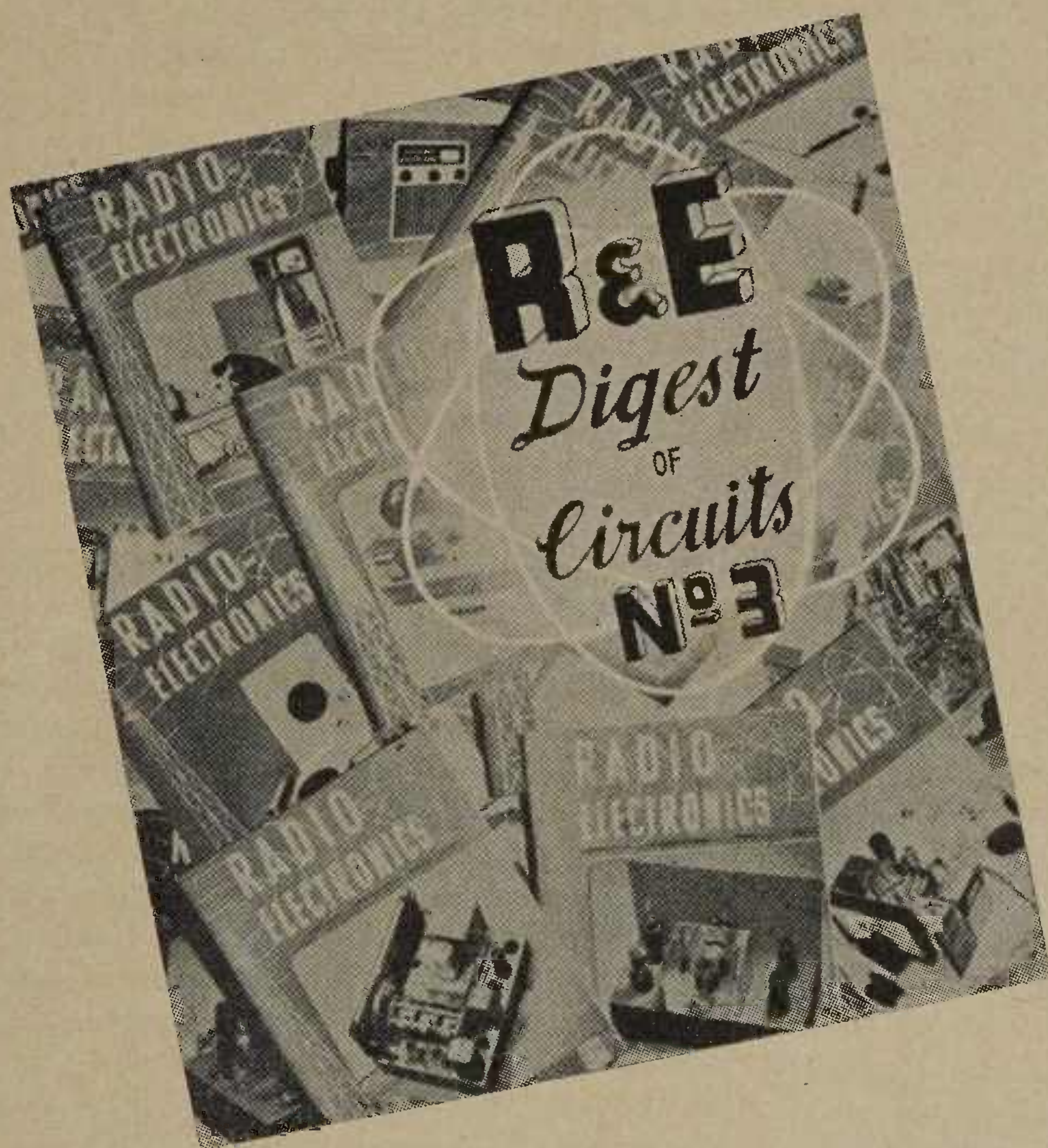
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WHAT MAKES A COMMUNICATIONS RECEIVER?—Part 1

In these days of plenty, it seems that most of those who used to revel in the complexities of building their own receivers for amateur transmitting or short-wave DX listening, have taken to buying them instead. Indeed, among amateur builders, the communications receiver seems to have become a lost art. This article has been designed to show the ways in which communications receivers differ from conventional ones, and to describe the methods that are used for obtaining the special performance characteristics that distinguish it from its less pretentious fellows.

Introduction

Listening to the amateur bands these days, one cannot help but be struck by the very high proportion of amateur transmitters who use commercially-built receivers. There was a time—not so very far distant—when very few commercial receivers were in use in the thousands of “ham” shacks throughout this country. Indeed, the dyed-in-the-wool “ham” at one time would have scorned to make his contacts on any receiver that had not been put together with his own hands, even if he might have cast envious eyes on the best commercial receivers that were occasionally to be found in other than government departmental receiving stations. A good many of those who built their own receivers also designed them themselves, and it is safe to say that there are few thrills in radio more satisfying or more lasting than that of operating a really good receiver that has come to life in one’s own back room, after much toil, sweat, and even blood and tears!

Times have certainly changed, and at the risk of being dubbed old fogies, we venture to suggest that the trend away from home-built equipment is not for the best. Of course, nobody will deny that a man is entitled to follow his hobby in any way he chooses, and that if his taste and pocket runs to commercial communications receivers, and often ready-made transmitters too, he is perfectly entitled to use them. All the same, it is a pity when a large number of amateurs seem to think the same way. For one thing, even today, it does not follow by any means that the home-brewed receiver is in any way inferior to its commercial counterpart. Very often, indeed, it is superior, from the point of view of the user, even if it is not the kind of receiver that would appeal to a manufacturer as a suitable type to commercialize.

The fact is, that in bringing out a commercial receiver, the maker can do no more than include those features which he considers will appeal to the greatest number of potential buyers. If he bases his design accordingly, and sees also that good engineering is put into it, he is bound to have a very saleable article. It will also be an expensive one, for the list of design features that must be included is a long one, and their execution to a satisfactory degree of excellence is a costly business. There will be very many users who have the necessary cash to buy his receiver, and

if it looks impressive, and performs reasonably well, the manufacturer will be assured of a market.

Is it all Necessary?

The question is, how much of the cost of a commercial receiver is justified from the amateur operator’s point of view? Often and often, we are afraid, the answer is “Not much.”

Very frequently, the amateur’s needs are simple—much more so than the commercial receiver he has bought—with the result that two-thirds of the beautiful design features incorporated by the manufacturer are never used, and are simply capital eating its head off, like unsold stock on the shelves of a shop. Of course, if the purpose of having such a receiver is partly to impress the neighbours, or (more likely) to impress the “hams” he works every night, then the expense may be justified. Even when the purchaser has provided himself with a commercial receiver and its many features on the score that they may come in handy some time, he very often finds that they are never in reality, wanted at all.

It is no use asking the manufacturer to provide simplified and less expensive receivers. In the first place, each man’s requirements are different from those of the next, so that to fulfill the demand, a whole flock of different receivers would have to be made to replace the general-purpose one, and this would not be economic for the manufacturer. Secondly, it would not be long before such extraneous considerations as “keeping up with the Joneses” would make very many buyers plump for the most expensive model, whether they need it or not!

Seriously, though, our considered opinion is that many of those who buy and use the commercial article would have much to gain from building their own. Within the limited requirements of the individual builder, it is often possible quite easily to exceed the performance of the general-purpose commercial set. Then again there is the worth-while achievement of tackling and successfully concluding such a job one’s self. Last but not least, there is the economic angle. If you meet your requirements with a relatively inexpensive home-built receiver, why pay three or four times as much to buy a commercial one?

We certainly do not expect those readers who already have good commercial sets of their own to sell

them and start building, on reading these paragraphs, but it is hoped that these words may give pause to at least some of those who were about to rush off and spend their hard-earned or about-to-be-earned cash on an expensive commercial receiver. If, having read thus far, you can bear with us, we hope that this series of articles will put matters in a new light—perhaps showing that what had been shirked as much too difficult is not really hard to accomplish—perhaps giving just those few bits of information that enable you to choose a type of receiver for yourself after reading them. And even if you are determined in spite of all we can say to go the commercial way, we hope that having read these articles will enable you to assess reasonably well the merits of the receiver you propose to spend that hundred pounds or so on.

What Does Make a Communications Receiver?

So far, about the only things that this article has definitely ascribed to the communications receiver are complexity and price, neither of which are mixed blessings. Perhaps it would be best, therefore, to list the main differences that distinguish a communications receiver from a conventional domestic one. The list is not intended to be exhaustive, but even so it will be long enough.

1. Frequency Range:

This, of course, depends on the purpose for which the receiver was designed. It can be anything from 100kc/sec. to 100mc/sec., to a mere 1.6 to 4mc/sec. It can even be for a single spot frequency anywhere inside the ranges mentioned. The general-purpose receiver most often covers the range from 3 to 30mc/sec., or a bit more, on the score that this range is relatively easy to provide, and at the same time probably covers more potential users' requirements than any other. It is this very matter of the range of frequencies covered that most often results in a lot of money being spent on something that is not always needed.

2. Tuning and Bandspread:

The communications receiver almost always provides special means for making the operator's job easier when it comes to tuning in signals on the fairly high frequencies concerned. These means entail specially-constructed dial mechanisms, and electrical bandspreading. This is a most important feature, since the "handle-ability" of the receiver to a very large extent depends on the designer's success or otherwise in this part of the receiver.

3. Selectivity:

Here is another feature in which the requirements are likely to vary widely depending on the application of the receiver and on the reception conditions obtaining from time to time as it is used. Almost all users at one time or another need extremely high selectivity, while for ease of signal-

reading on 'phone, and for the avoidance of difficult or "fussy" adjustments while reading CW signals, it is frequently desirable to work with much less than the maximum attainable selectivity. Thus it is that so many commercial communications sets have one form or another of variable selectivity, controllable by the operator, either in steps or in a continuous fashion.

4. Sensitivity:

This is a subject about which there is a good deal of misapprehension, even today. The aim of most communications receivers is to be as sensitive as possible. This is an excellent aim, which should not be confused with the amount of amplification available. One set can have twice as much gain as another, and yet be only a tenth as sensitive. Whether the sensitivity of a set is good, excellent, or just poor, depends to a large extent on the designer. It need not have any relation to the number of valves used, or to the number of control knobs on the front panel, or to any of the other features the set may possess. Without sensitivity, the whole set is useless for very weak signals, so that its sensitivity is perhaps the most important attribute of a receiver.

Other things which come under the same heading are the manner in which the set retains its sensitivity over the whole range of frequencies covered by it, and whether such things as A.V.C., and the design of the B.F.O. circuit have any deleterious effect on the sensitivity. It is up to the designer to see that they do not, of course, but it is in such details that the performance of a receiver can outshine that of another.

5. 'Phone and CW Facilities:

All communications receivers are designed so as to be useful either for 'phone or CW. This means giving the operator the choice of A.V.C. or manual sensitivity control, and the provision of a beat frequency oscillator (B.F.O.) with which to make CW signals audible. Whether or not a receiver is to be used for both types of reception makes a very profound difference to its design, especially in the I.F. section. For CW, selectivity so high as to make a 'phone signal unintelligible is often desirable, so that crystal filters are used in the I.F. amplifier to provide it. Special 'phone receivers, on the other hand, are sometimes provided with more complex crystal filters giving a band-pass characteristic. Here again, the use to which the receiver is to be put has a great bearing on the desirability or otherwise of including special features of this nature, which if not used, are merely expensive luxuries.

6. Single-Sideband:

Since the widespread adoption of single-sideband operation for amateur as well as professional communications, many people want receivers incorporating special means for receiving these signals. Some receivers have the necessary circuits built into their

structure, while still more have special arrangements for using with them special single-sideband adaptors.

The points so far mentioned are the main ones which distinguish the communications receiver from other short-wave sets, even if the latter may possess some of the features listed as belonging to the former. It should be pointed out that the making of a *good* communications set does not simply mean the provision of some or all of these features. The manner in which they are engineered is of equal importance, if not more so. For example, a slow-motion dial, giving a high degree of mechanical band-spread, is often included, in addition to some electrical form of band-spread, but if it is not well enough made, and exhibits such troubles as back-lash, or slackness in the gearing, it becomes worse than useless, for a good mechanism with a much smaller reduction would be very much easier to handle. Similarly, if, in order to catch more buyers, a set features an extended frequency range—say up to 50mc/sec. instead of the more usual 30mc/sec, its performance on the additional range must be as good as on the lower frequencies if the extra range is to be of any use at all.

As with everything else, you get only as much as you pay for when buying a communications receiver. This is why the very best of these are very, very expensive, and found almost exclusively in professional receiving stations. This is not to say that many of the less expensive models, designed for the pockets of amateurs, and for their special requirements, are not worth having. Nothing could be farther from the truth, but even so, it is a matter for some caution when you see a set with a very impressive specification at a price several rungs lower in the price ladder than other sets having comparable specifications.

Building Your Own Receiver

As pointed out earlier, the very fact that a commercial job has to attempt to include features that

anyone might conceivably want in a communications receiver makes them either very expensive, or else not as good in some respects as they could be. This same fact enables one to design and build his own communications receiver, and yet compete on more than equal terms with the professional designer. If you are building with only your own requirements in mind, many features that the professional designer would regard as a "must" can be omitted, simply because you, personally, have little or no need of them. Omitting them can easily simplify enormously the job of obtaining top performance in other respects, and can actually result in a better receiver for your own particular purposes than any you might be able to buy.

This is not a fairy tale. There is nothing mysterious about receiver design, or about obtaining satisfactory performance either; it is all a matter of taking all the relevant factors into account, and designing the set on paper before rushing in to wield the soldering iron. If enough heavy thought is put into the matter, possibly entailing scrapping several attempts before arriving at the final arrangements, and if, once the final design is "frozen", you resolutely refuse to make last-minute alterations that may have undesirable effects on other, apparently unrelated aspects of the set's performance, there is no reason at all why anyone should not vie successfully with the commercial article, and even out-perform it by quite a bit.

Succeeding articles in this series will discuss in some detail the practical aspects of the design process, and we hope will help those who have decided to "have a crack" at building a receiver for themselves to make some of the necessary, but sometimes very awkward decisions that must be made before actual building can commence.

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(Concluded on page 48.)

*Transistors***DISTORTION IN TRANSISTOR AUDIO AMPLIFIERS**

We have often been asked whether or not it is possible to build transistor amplifiers of the same high quality as is easily possible with valves. This short article explains why the answer to this question is, in general, "No."

Introduction

Now that transistors are becoming freely available in sizes that enable quite high-powered audio amplifiers to be constructed, it is natural to ask whether the advantages of transistors cannot be applied to high-quality audio amplifiers for reproducing music. There is no doubt, for example, that if our "hi-fi" amplifiers were fully transistorized, there would result a vast saving in the space taken up by such equipment, and as everyone knows, one of the commonly-complained-of disadvantages of high-quality audio systems is the amount of space they take up. The idea of having a complete amplifying system housed in a small box measuring about five by four by three inches is very attractive. There would be no difficulty in building a complete system of ten or even twenty watts output into so small a space that it could be housed in what is normally waste space in, say, a small cabinet holding a gramophone turntable and pick-up. It would then be much easier to convince the sceptics that a larger speaker cabinet is essential.

Of course, when the highest possible quality is not required, it is already a commercial proposition to use transistors for output powers up to 20 watts. This makes possible extremely compact public address amplifiers, for example, in which a given total power output, up to even as much as 100 watts, could easily be obtained from equipment taking up no more space than a conventional 20-watt amplifier. The question of interest at the moment is whether transistor amplifiers are capable of the degree of fidelity commonly obtained these days from quite inexpensive valve-operated equipment, and if so, would they be an economic proposition.

Briefly, the answer is that at the present stage of development, transistor amplifiers are more difficult to build, to very high standards of performance, than are valve amplifiers; this means that to do so, while by no means impossible, would be very costly. The purpose of this article is to point out why these things are so, and to show some of the methods that can be used if expense can be disregarded, and performance is taken as the sole criterion of excellence.

Transistors Produce Distortion

The fundamental reason why high-quality amplifiers are more difficult to design with transistors than with valves, is that transistors produce more distortion than valves. This may seem somewhat of a sweeping statement, but it is unfortunately true. Indeed, one American writer made this very point

by saying that "Transistors are a very expensive way of producing distortion." This statement certainly comes under the heading of slightly

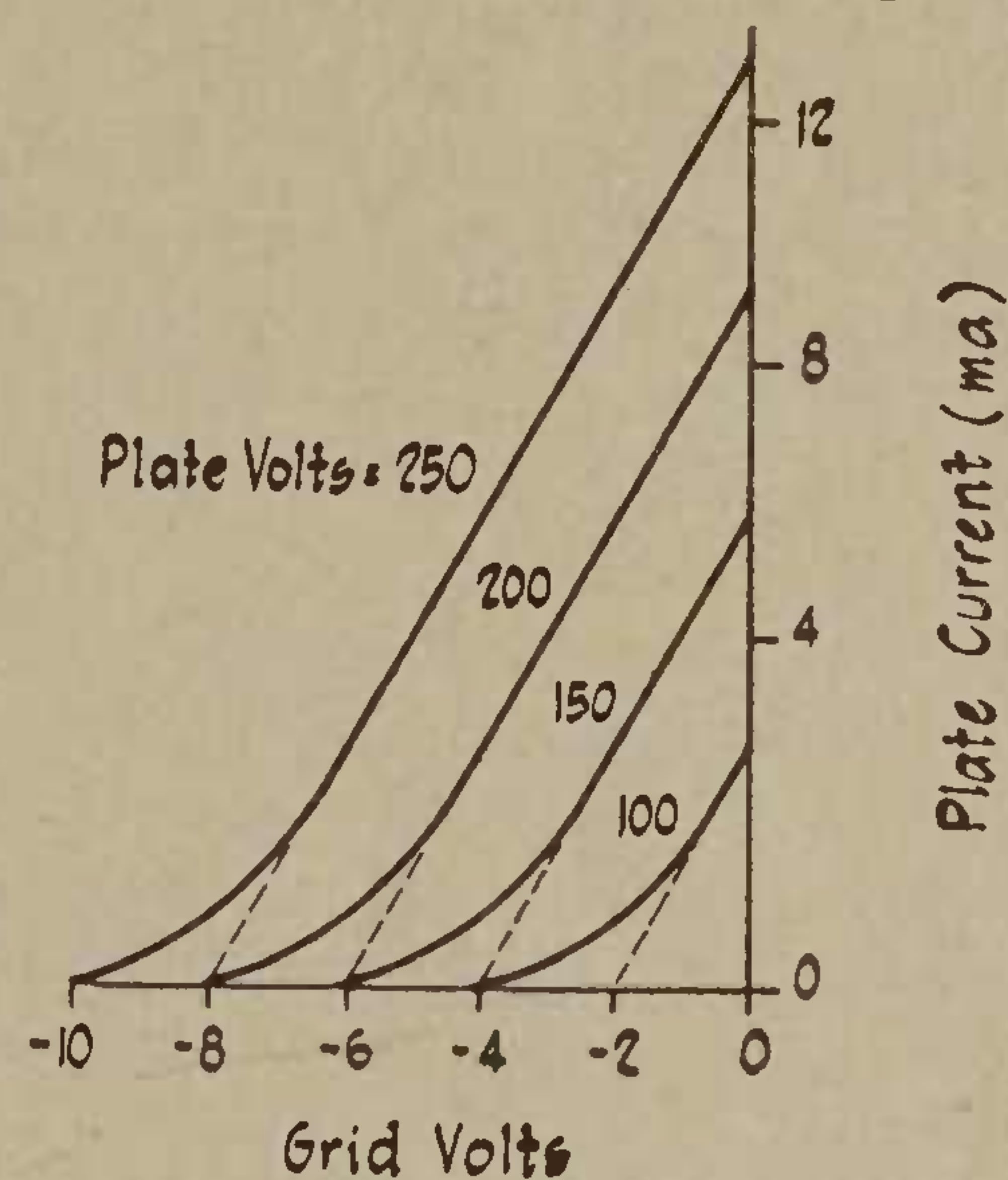


Fig. 1(a)

picturesque exaggeration, but there is more than a grain of truth in it.

The fact is that with transistors, there are two major sources of distortion, while with valves, there is only one. Let us look at a valve, for a start. When used, as most valves are, as a Class A amplifier, the only source of distortion is the fact that the

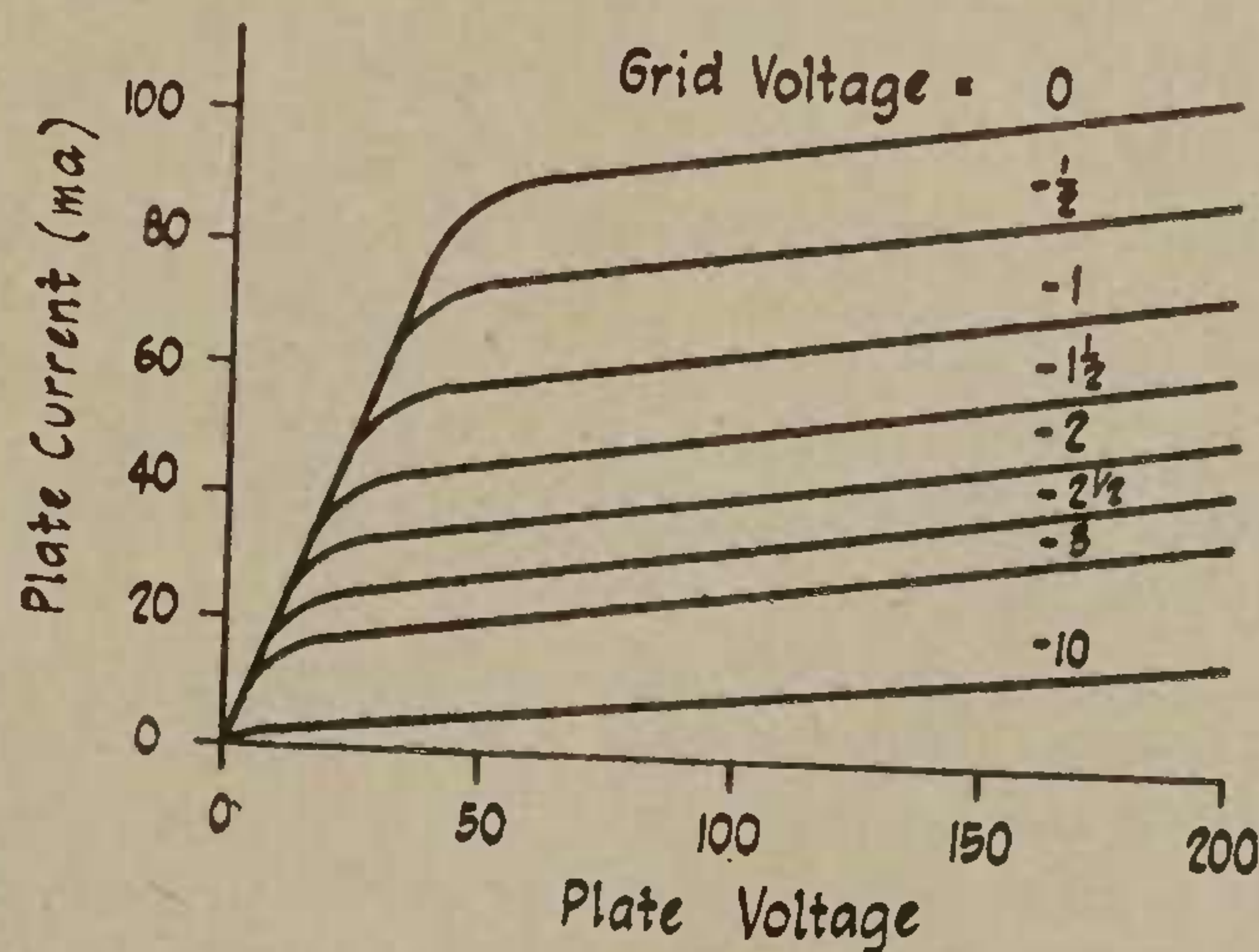


Fig. 1(b)

Fig. 1.—(a) Mutual characteristic of a typical triode showing (full line) actual characteristic and (dotted) the characteristic the valve would have to possess if distortion were to be zero. (b) Set of plate characteristics for a typical pentode valve.

characteristic curves are in fact curved lines, and not straight and parallel ones. This fact shows up in whichever form the valve characteristics are drawn, and it is illustrated in two ways in Fig. 1. At (a) we have what is usually called the mutual characteristic,

That is to say, it illustrates graphically the mutual conductance of the tube, which is measured in milliamperes per volt. This characteristic is a set of curves, each applying to a different plate voltage, and each showing how, for that plate voltage, the plate current varies in response to changes in the grid voltage. If the valve were a perfectly linear device, these curves would all be straight lines, and they would all be parallel, and equally spaced for equal changes in plate voltage. Indeed, this is what is meant by text books and writers of technical articles when they write about a thing being *linear*. They mean that the graph showing how the output (in this case, the plate current) varies in response to the input (grid voltage) is a straight line. As a glance at any valve data book will show, valves are very far from linear; in other words, the output is not proportional to the input at all times, and at all values of input or output.

How is it, then, that valves can and do amplify in an almost distortionless manner? It is simply because *certain portions* of the valve's characteristic curves are very nearly straight, parallel, and equidistant, so that if we take steps to ensure that the valve operates only in this region, we can guarantee that the distortion will be very small. In Fig. 1 (a), we have drawn dotted lines which are straight, parallel, and equally spaced, superimposed on the solid curves representing the actual valve. It can be seen that over a considerable range of values, the two sets of lines actually coincide. If we examine the curves further, we find that provided the plate voltage is kept high, and that the plate current is not allowed to become too small, the valve whose curves are illustrated is almost perfectly linear. We can see, further, that these conditions also mean that operation of the valve must be restricted to low values of negative grid voltage.

To sum up, provided that the valve is operated in the straight portions of its characteristic curves, the distortion will be very low, **IF THE SIGNAL IS NOT DISTORTED BY THE VERY FACT OF APPLYING IT TO THE VALVE'S CONTROL GRID.**

The latter part of this statement may at first sight seem a trifle unnecessary, because everyone knows that as long as a valve does not draw grid current (and it won't as long as the conditions laid down above are adhered to) it cannot distort the voltage actually applied to the grid. In fact, with valves, this is so universally true that we tend to forget all about it, and assume that it is automatically so.

But what would be the situation if the control grid of the valve behaved differently? Suppose, for example, that the grid of the valve always drew current, and that there was nothing we could do to prevent it? Would this mean that the grid current would distort the input signal before it began to be amplified in the valve itself? Not necessarily. It could simply

mean that power was consumed by the control grid, and that as long as that power was available from the source of the signal, the latter would still be undistorted. The imaginary situation just described could be obtained with an actual valve simply by connecting a fixed resistor from grid to cathode of the valve. This would represent a grid circuit that draws appreciable power, but there would be no reason why the signal should be distorted. Nor would it be, as long as the source of signal could deliver the required input power.

The Transistor Input Circuit

In books on transistors, it is always pointed out that the input circuit of a transistor draws current from the signal source, and so has a low impedance compared with the input circuit of a valve, which does not. This is quite true, but the bare statement does tend to give a false impression to those who are used to dealing with valves. For instance, it is common knowledge that if a valve is driven into grid current, the output will be distorted. It is easy to imagine, therefore, that the grid current is the actual cause of this distortion, but it is not. The cause of the distortion is that when the grid starts to draw current, the impedance of the input circuit, as seen by the valve or other device producing the signal, suddenly changes from a very high value to a very low value.

If the circuit feeding the valve is designed so that it *can* feed a low impedance without distorting the input waveform, there will not be any distortion. Otherwise, Class B amplifiers would never be practicable!

Distortion when grid current starts is caused because the circuit feeding in the signal is not designed to feed the very low impedance of a grid which is taking current, but to supply voltage to the very high—almost infinite—impedance of a grid which is not. Thus, that part of the input cycle which occurs while the grid is not conducting will be undistorted, while the part that causes the grid current will be highly distorted.

All this means is that input-signal distortion is caused not by reason of the fact that a valve has a low or a high impedance, but because the impedance it does have is not constant throughout the whole cycle of the input voltage.

Translating all this into terms of transistors is not at all difficult. It is true that the transistor's input impedance is low; sufficient has now been said to indicate that this in itself cannot cause distortion. For one thing it is always possible to design the input circuit so that this low input impedance can be supplied without causing distortion, provided that the input impedance does not change during the input cycle.

The unfortunate fact is that in transistors, this is not so. The input impedance is not constant at all parts of the input cycle, and this variation does cause distortion, of a kind which really has no counterpart in a valve which is not driven into grid current. One way

of looking at the transistor input circuit is as though it were a valve which is constantly being driven in and out of grid current, on each cycle of the input voltage. Such a view of the transistor is a little unfair, because its input distortion, as it is called, is not nearly as bad as in the case of the valve being driven in and out of grid current, but it does help to visualise what is going on in the input circuit of the transistor.

Let us look at it yet another way. Suppose we have a signal to apply to a transistor, as, for example, the output voltage of a low-impedance magnetic pick-up. Since the pick-up's impedance is low, it will be quite able, without distortion, to produce a small current in a low-valued resistor connected across its terminals. If the transistor input circuit could be truly represented by such a low-valued resistor, then there would be no input distortion at all. But a true representation of the input circuit of the transistor would be that of a low-valued resistor, whose value at any moment depended on the voltage applied to it. With this sort of resistor connected across the pick-up, the current

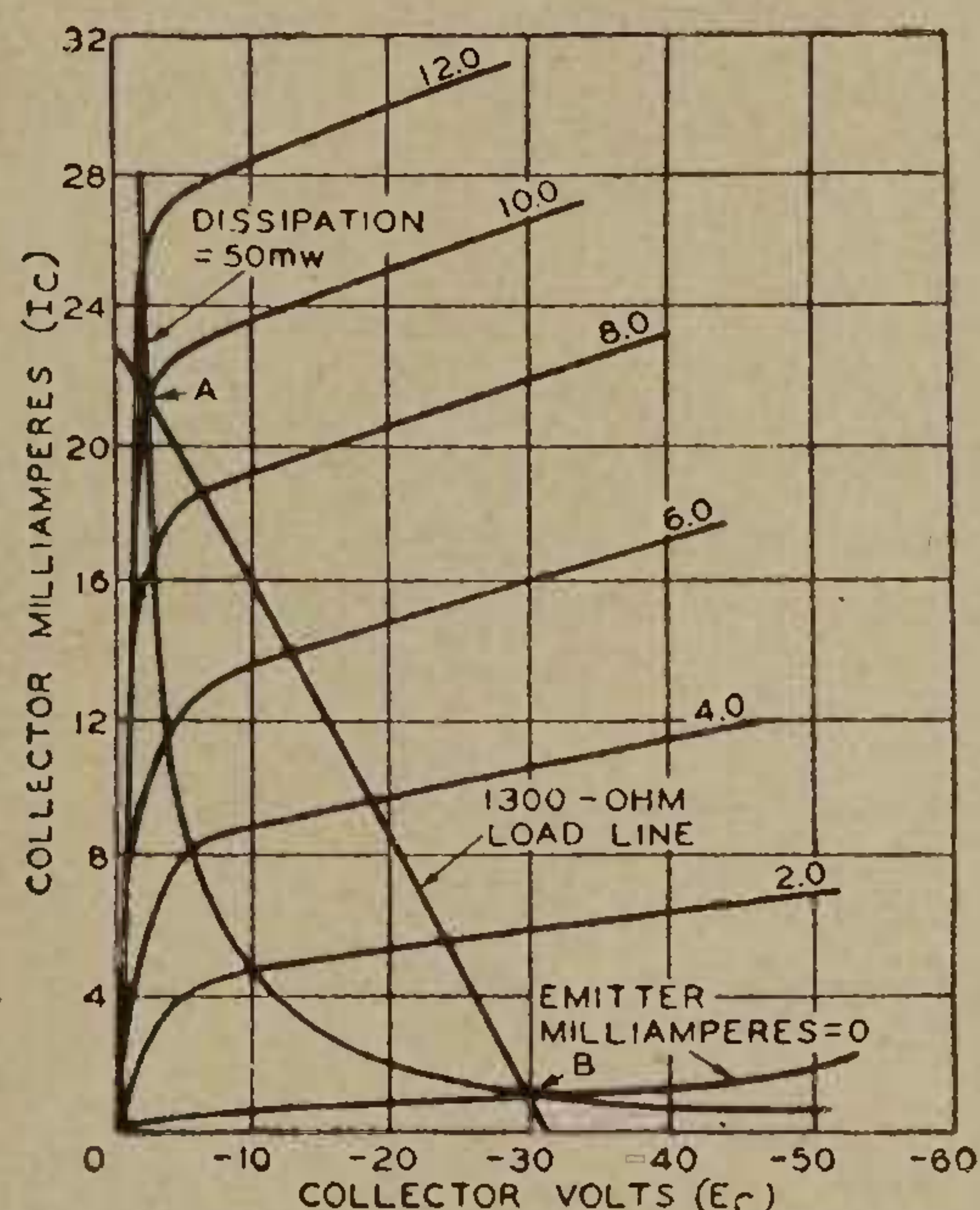


Fig. 2.—Collector characteristics of typical transistor illustrating the similarity to those of the pentode in Fig. 1 (b).

delivered by the latter would not be a true representation of the voltage at its terminals, and this is nothing more than distortion.

Characteristic Distortion as Well

It will be noticed that in the above paragraphs, nothing at all has been said about the characteristic curves of the transistor. The distortion we have been describing occurs in the input circuit, and has nothing whatever to do with the kind of distortion, described earlier while talking about valves, that arises because the output of the transistor is not linearly related to the input. With transistors, it is convenient to regard the input as a current rather than as a voltage, so that the most often-used set of curves for a transistor usually shows how the output current varies in response to changes of input *current* rather than to changes of input *voltage*. If this set of curves were composed of a series of straight,

parallel, and equidistant lines, there would be no characteristic distortion. Like valves, however, transistors are linear only over part of their characteristic, and it is just as possible with them to keep down the characteristic distortion by ensuring that the operating currents are confined to the region where the curves are linear. In this respect, dealing with transistors is very similar to dealing with valves. In Fig. 2 we have shown a typical set of curves for a transistor in the grounded emitter connection. Here, we have collector current drawn as a function of collector voltage, each for a different value of input current to the base. It can be seen that the curves look quite familiar, and very similar indeed to the plate characteristic curves of a pentode valve. The crowding

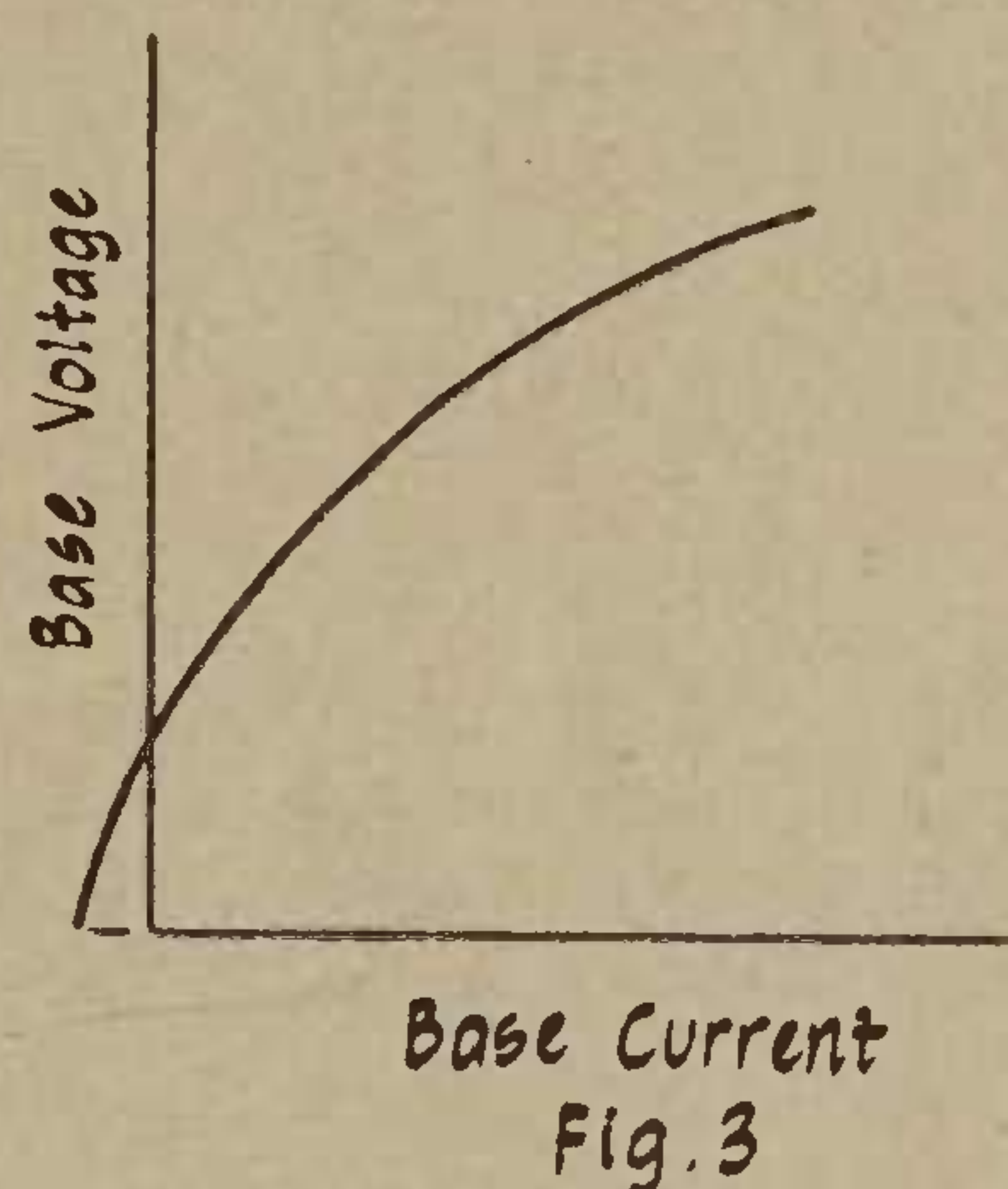


Fig. 3.—Typical curve showing input current versus input voltage for a transistor. Note that it is curved all the way. A similar curve drawn for a Class A valve would be a straight line, showing that no valve distortion exists which corresponds to the transistor input distortion.

together of the curves at high input and output currents shows that if the transistor is operated in these regions distortion will occur, and similarly, that distortion will take place if the transistor is operated at very low values of collector voltage. This latter effect is exactly similar to operating a pentode valve at very low values of plate current, as shown by the fact that the two sets of curves have exactly the same sort of shape.

Why Transistor Distortion is Greater

In some ways, the curves of transistors are much better than those of valves, and if we were to judge on these curves alone, we would reach the conclusion that distortion in transistor circuits should be less than that in valves. We would be quite wrong, however, because we would be forgetting completely about input distortion—the kind that is avoided altogether in valve circuit, simply by seeing that they are not driven into grid current. This input distortion of transistors is the real nigger in the woodpile. There are ways of combating it, but they all have disadvantages. The simplest of these ways is to connect a resistor in series with the input circuit of the transistor. If this resistor is made much larger than the input impedance of the transistor circuit itself, it is able to swamp the undesirable effect of the varying transistor input impedance. By

making the series resistor large enough, we can reduce input distortion to any desired degree, but by so doing, we give away a great deal of the circuit's amplification. This can mean that more stages are needed in order to achieve a given overall gain, and in turn is expensive in transistors. Then, too, there is the question of output voltage or current. If the series resistor method is used, it limits severely the maximum input that can be applied to the transistor stage concerned, and this in turn means that the output current (or voltage) is correspondingly limited. In the case of power stages, it limits the power output too severely.

Another dodge is to connect an unbypassed resistor in series with the emitter of the transistor. This gives negative feedback, and assists by raising the input impedance of the transistor circuit, and also by reducing the range of its variation, but it also reduces stage gain.

Power Stages

So far, we have been discussing only the early stages of transistor amplifiers—those which correspond to voltage amplifier stages in valve circuits. When it comes to power amplifiers, it is still not easy to make the distortion as low as we would like. Input distortion is even more severe in power amplifier stages than it is in low-level ones, and must be combated mostly by negative feedback, and by such means as using a small power amplifier to drive a larger one,

even when the output stage is in Class A. This is a thing that never has to be done with valve amplifiers, in which input distortion does not occur at all in Class A stages. Using two power amplifiers in cascade means using transformer coupling between driver stage and output stage, again even in the Class A case; this makes it more difficult than with valve amplifiers, to apply large quantities of negative feedback over the whole amplifier, since the addition transformer's phase shifts reduce the amount of feedback that can safely be applied before oscillation is a danger.

From these facts, it is not difficult to see that (a) the inherent distortion of transistor circuits is higher than that of valve circuits, and (b) reducing this distortion by means of negative feedback is more difficult with transistors. Thus, it looks as if it must be a much more difficult problem to design a transistor amplifier with, say, 0.1% distortion at full output, than it is to do so using valves. This, then is the real answer to the question posed right at the beginning of this article.

However, we would not like this to be interpreted as meaning that high-quality transistor amplifiers are not possible.

Such is not the case at all. They can be designed and built, even now, provided one does not mind the expense, but this is such that the advantages of transistors for the suggested purpose are largely neutralized. It will be some time yet before transistors supersede valves for this particular application.

LETTER TO THE EDITOR

Sir,—I have been a subscriber to your magazine ever since its inception and have always read your Editorials and have at least appreciated most of them.

Your article on the sale of gramophone records in the August issue, however, made me wonder whether there had been a change in the position of Editor, as I did not think that a technical man would write such an unprincipled article. You know as well as I do that the radio and electrical retail business is being taken up by all sorts of firms such as stock and station agents, wool brokers, chemists, hairdressers, grocers, hardware merchants, motor dealers, and worst of all, chain stores. Most of this class of retailers do not employ any qualified staff nor can they give the customer the right advice regarding their purchases. All that they are interested in is a quick sale and to forget it.

It is all very well to say that the servicemen get the repair work afterwards, but you know that this is the thin end of the wedge as someone else has had the cream, the profit on the sale.

Surely the retailing of radio and electrical goods belongs to those who are qualified to offer technical

advice and skilled after-sales service, not every Tom, Dick, and Harry, as is fast becoming the way these days?

After all, Mr Editor, ours is a skilled and registered trade and quite frankly I am surprised that you as a technical man should have written such an article, as you have trodden on very dangerous ground.—I am, etc.,

IAN L. TAYLOR.

EDITOR'S NOTE

We can hardly agree that to express this journal's opinion (however misguided it may be) on a matter of interest to the radio trade, can be called "unprincipled". The Editorial of which our correspondent complains does no more than point out what he himself does, namely that if the radio dealer is a skilled and registered tradesman in his own line, he should be able to compete on more than equal terms with non-specialist firms, provided only that he is prepared to work for his sales and give good after-sales service which the rival concerns do not.

A TWO-STAGE TRANSISTOR D.C. AMPLIFIER

The simple circuit described below can be used for a variety of purposes.

It has a D.C. amplification of approximately 1000 times.

Introduction

Previously in these pages we have introduced circuits which make use of transistors as D.C. amplifiers. One of these enables a 0-1 ma. meter movement to function as though it were one of 0-25 micro-amperes. This it does with good zero stability and excellent linearity. With a single-stage amplifier of this kind having a D.C. gain of 40 or more, it is natural to speculate what could not be done with a two-stage D.C. amplifier, having a gain of some 1600 times. Unfortunately, constructing such an amplifier is not as simple as to wish to, as anyone will know who has had experience of building multi-stage D.C. amplifiers using valves. Fortunately, however, when transistors are used, one of the major difficulties disappears—or almost so—and this article is written to illustrate the point, and with it, one of the major differences between valves and transistors. Into the bargain, a circuit emerges which though by no means perfect for some applications, can be very useful indeed.

Cascade D.C. Amplifiers Using Valves

To illustrate what we mean, let us first of all examine the problem of connecting in cascade two valves, with direct coupling between them, so that the response extends down to D.C., or more properly, to zero frequency. In Fig. 1 we have a two-stage amplifier, drawn in skeleton form. V_1 has a load resistor in its plate circuit, and it is a normal resistance-coupled stage, which, using a triode, has a gain of $\mu R_1 / R_1 + R_p$, where μ and R_p are the amplification factor and plate resistance of the valve, and R_1 is the load resistor. If V_1 is a pentode, and if R_1 is much smaller than the valve's plate resistance, then the stage gain is $G_m R_1$. In either case the stage gain can be quite high, and also in either case, the current in V_1 will be quite small. This may not be self-evident, but it should become so when it is pointed out that in both the above formulae, the stage gain increases as R_1 is made higher in value. Whether the valve is a triode or a pentode, R_1 is likely to be 100k. or more, and the current through is not likely to be more than 1 ma. at most, and often much less than this. The high value of the load resistor, and the small current through it, add up to fact that the plate of V_1 must live at quite a high potential above ground. Indeed, the plate voltage of V_1 will be closer to that of the H.T. line than to earth.

In a single-stage amplifier, this is of little consequence, but when it is proposed to couple the plate of V_1 directly to the grid of the next stage, as we must do if the whole amplifier is to respond down to zero frequency, it is very inconvenient. Sup-

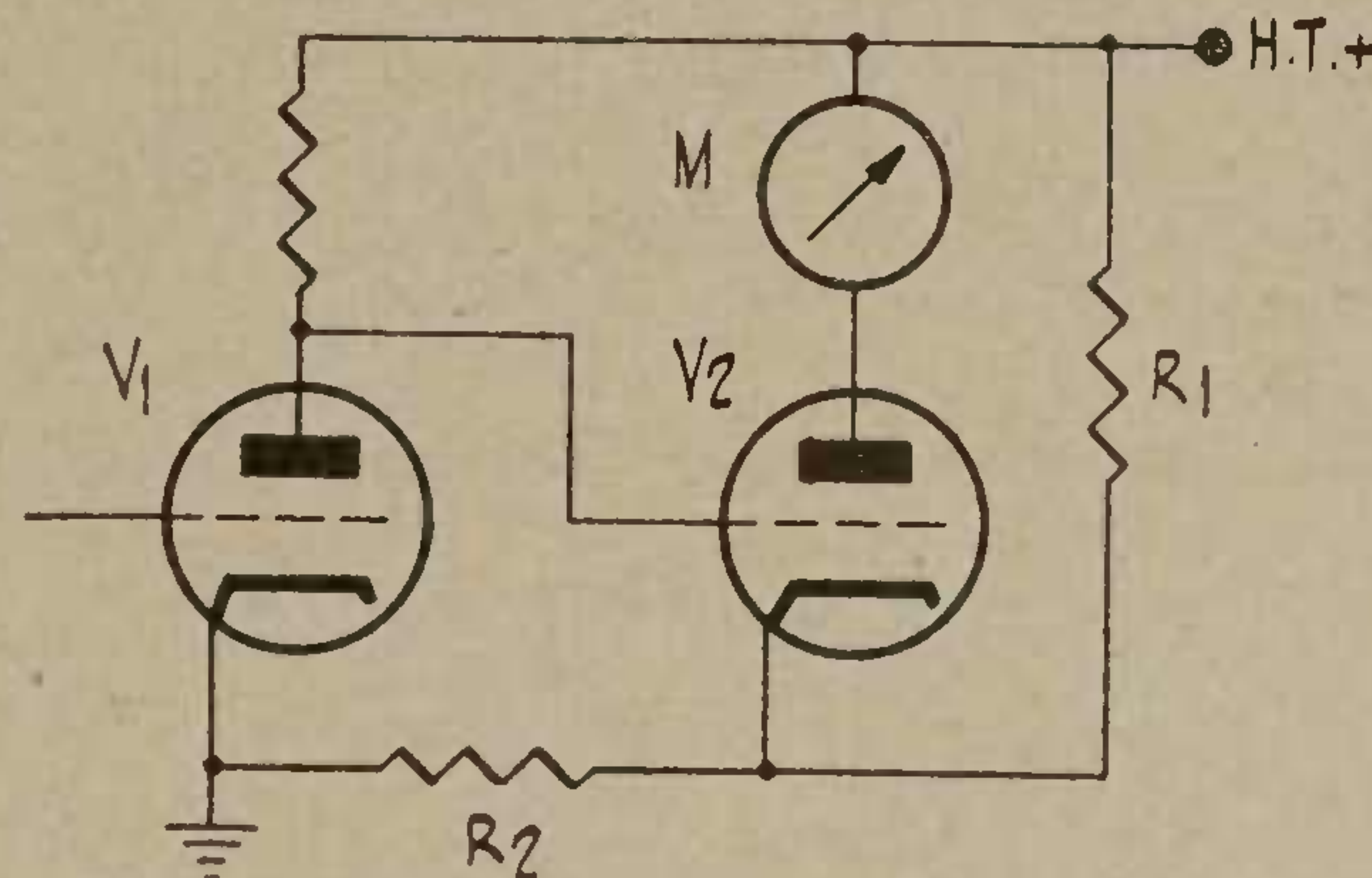


Fig. 1

pose, for example, that the H.T. line is 250 volts—a common figure, and a convenient one. If the load resistor of V_1 is 100k. and its plate current, 0.5 ma., then the voltage dropped across the resistor is 50 volts, and the plate of V_1 is at $(250 - 50) = 200$ volts. Now let us see what this means with respect to the second stage. This tube, V_2 must have its control grid at +200 volts. If it is to be properly biased, the cathode of V_2 must be slightly less positive than this, and in our circuit we have shown a potential divider, arranged so that the bias on V_2 is correct. In the plate circuit of V_2 we have put a meter, which it could well be the object of the amplifier to deflect. The output device could equally well be a second load resistor, or a relay coil. But whichever form the output device takes, we are left with only 50 volts as the plate supply for V_2 . This is very little, and operating a tube with a plate supply as low as this has several disadvantages. In the first place, it is impossible to obtain a very great output current, particularly if it be a condition that the output current must be a linear function of the input voltage. Secondly, the actual output power available from the valve is very much restricted. This would be important if the object was to operate a relay, or perhaps a pen recorder movement.

One obvious way out of the difficulty is to have available a power supply of 500 volts, tapped at 250 volts for the first stage. In this way, both valves can work with supply voltages of 250 or more, and the above-mentioned disadvantages disappear—at least in theory.

Other Difficulties

The difficulty we have just been describing is not, however, the greatest that confronts the would-be user of cascaded tubes in D.C. amplifiers. With its very high gain, stability is very difficult to attain in a circuit like that of Fig. 1. The amplifier is unable to distinguish signals from other effects which are equally capable of producing output, such as

changes in the characteristics of the amplifier valves, and changes in the power supply voltages. Indeed, to be at all successful, such amplifiers absolutely require heavily-regulated supplies for both H.T. and heaters, and neither of these is easy to do, or economical either. One commonly used expedient is to use voltage regulator tubes wherever the circuit calls for a potential divider. This is necessary, because even if the main H.T. line is regulated, regulation is lost when a potential divider is used to obtain a lower voltage, unless no current is drawn from the tapping point.

Transistors in a Similar Circuit

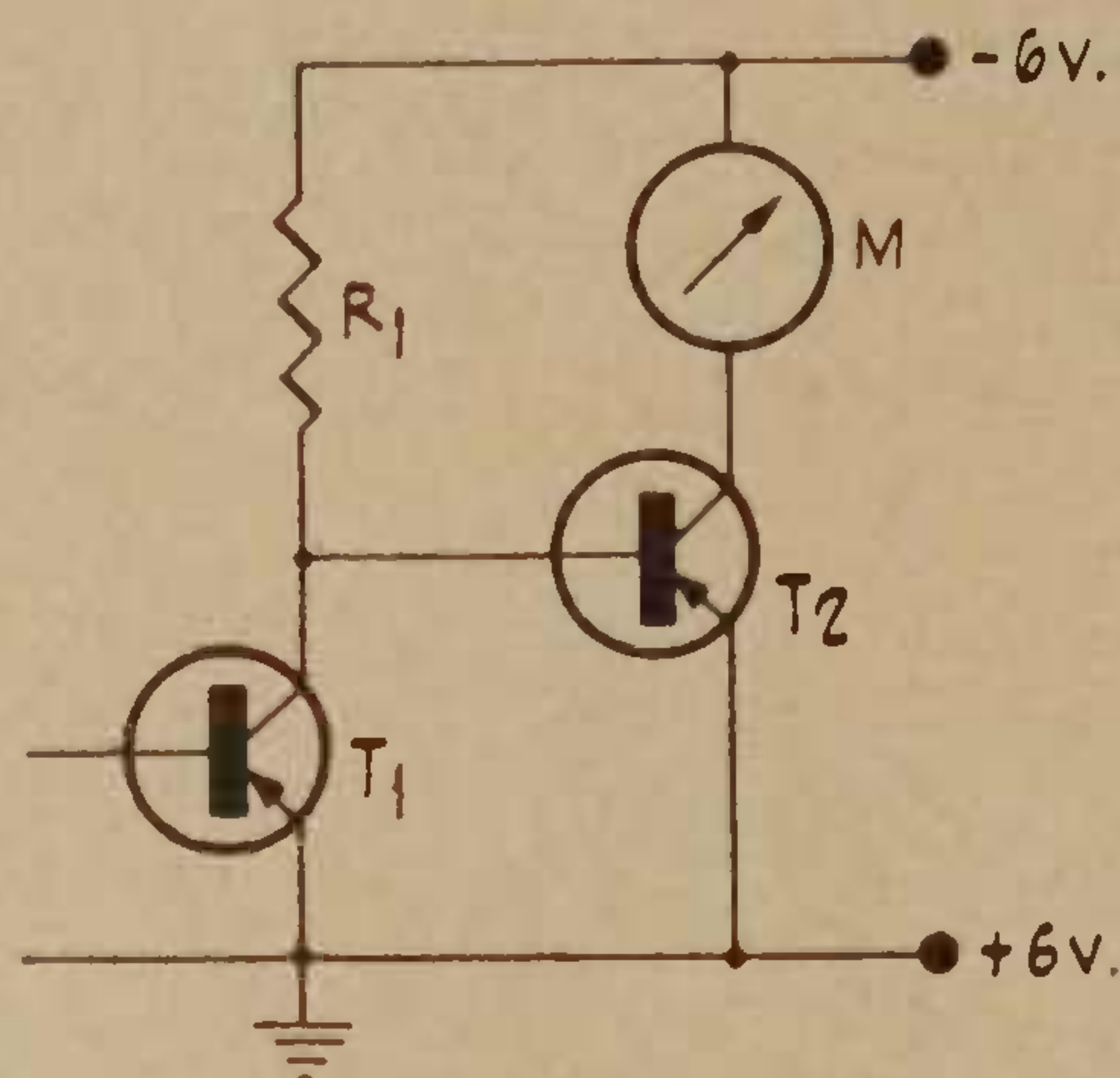


Fig. 2

If transistors are used in a circuit which is basically similar to that of Fig. 1, we obtain a circuit like that of Fig. 2. However, although the arrangement looks very similar, the similarity is only superficial. In the first place, the input impedance of the valve circuit is very high, while that of the transistor circuit is low. Secondly, the supply voltage is low, since transistors are essentially low-voltage devices, that will work with supplies of only a few tenths of a volt, if necessary.

The main difference, however, is that there is no need, even in practice, to provide a higher supply voltage for the second transistor than for the first. This is really a consequence of the second point, and the reason for it is the same. The fact is that transistors are much more efficient than valves, when used as a switch.

When a valve is used, as its name suggests, primarily as a means of turning current flowing in the plate circuit on and off at will, in response to a control signal, it is really not a very efficient device at all. For example, when turned "on", its resistance to the flow of plate current is still quite high, so that even though there is a very pronounced difference between the "on" and "off" resistances of the valve's plate circuit, which enables the valve actually to be used as a switch, the valve does not look very much like a perfect switch, whose resistance when open is infinitely great, and whose resistance when closed is very close to zero. This is exemplified by the fact that even when a valve passes as much current as it is able, there is still a considerable voltage drop across it; for example, if the H.T. voltage is 250,

we will be lucky if, when the valve is conducting, there is less than 50 volts still dropped across the valve's plate circuit. The ratio between the supply voltage, and the voltage across the valve when it is conducting, is thus no more than 5 to 1.

With transistors, however, the situation is considerably better. When one of these is conducting, it is possible for the volts dropped across the collector to be as low as a few tenths of a volt. The actual voltage is characteristic of the transistor type, and remains roughly constant irrespective of supply voltage. Suppose, for example, that a given transistor drops 0.2 volts across its collector circuit when it is fully "on", and also that we are free to choose the supply voltage, up to a maximum of, say, 20 volts. If this voltage is actually used, the ratio of the supply voltage to that dropped across the transistor is $20/0.2 = 100/1$, representing an improvement over the valve of twenty times.

Thus, it becomes possible to use cascaded circuits similar to that of Fig. 2 without dropping so much voltage across the first stage that the second requires an increased supply voltage to allow it to work properly. In Fig. 1, suppose that T_1 is "on", and T_2 is "off". T_1 is passing just enough current to allow the collector to "bottom". This means that T_1 is passing as much current as the load resistor R_1 will allow it to, so that the collector will be only very slightly more negative than the emitter. The actual voltage between them will be the aforementioned few tenths of a volt. Since the base of T_2 is directly connected to the collector of T_1 , this electrode will also be at the same potential. Both transistors are used in the grounded-emitter arrangement. This means that with the base of T_2 almost at earth potential, this transistor will be cut off. Now since the base electrode of T_2 is so close to earth potential, a signal in T_1 is able to swing the base voltage of T_2 over almost the whole range from zero to the maximum negative supply voltage, the whole of which is available for the collector circuit of T_2 .

Such a simple circuit cannot be used in practice, however, because the input impedance of T_2 is so low that it would form a low-resistance shunt on the load resistor R_1 of the first stage. This would reduce the amplification of T_1 , and thus reduce the sensitivity of the whole circuit.

A Practical Arrangement

To turn Fig. 2 into a practical circuit, though, very little modification is needed. The final arrangement is shown in Fig. 3. T_1 is an OC71, and T_2 is an OC72. The collector circuit of T_1 contains a load resistor of 4.7k., and the common supply voltage can be $4\frac{1}{2}$ to 6 volts. The load device, which can be a meter, a relay, or any other low-impedance device operated by D.C., is in the collector circuit of T_2 . A resistor, also of 4.7k. is connected in series with the base of T_2 . This has the effect of never allowing the actual load for T_1 to be less than 2.35k., while in practice, the load

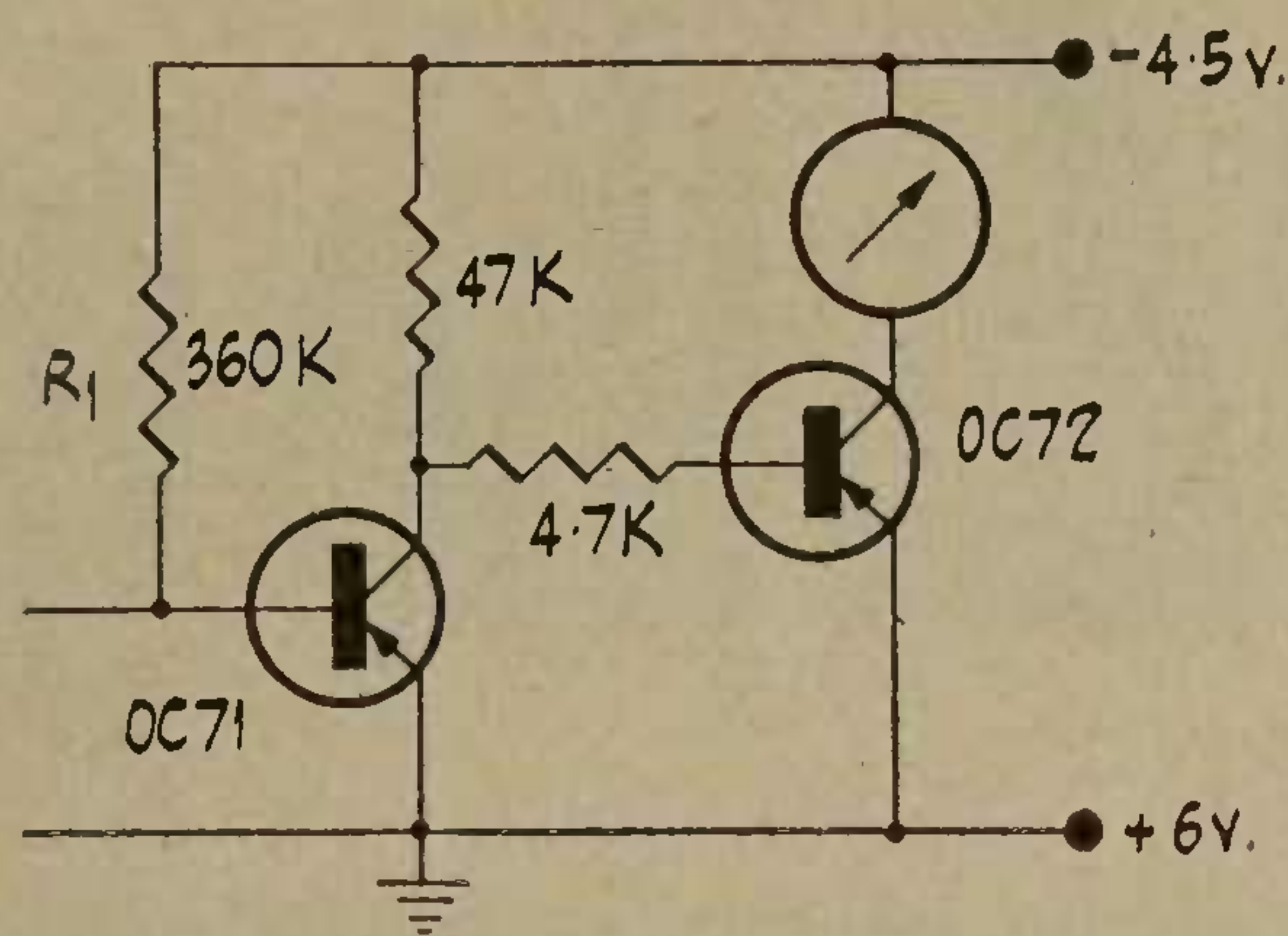


Fig. 3

will be somewhat higher, owing to the fact that the input impedance of T_2 is in series with the 4.7k. resistor connected between the collector of T_1 and the base of T_2 . The resistor connected from the H.T. line to the base of T_1 is there to bias T_1 in the forward direction, and its value can vary widely according to the requirements of the particular application. In order to make T_1 pass current, and thus to bias in to the "on" condition, the base must be made negative with respect to T_1 's emitter. Because of the current amplification occurring in T_1 , the resistor needed to bias it is quite high in value. If, for example, the current amplification of T_1 were 50 times, and if T_1 is to be biased to a collector current of 0.5 ma., the base current would be $0.5/50 = 10 \mu\text{amps}$. Since this base current must flow from the battery to the emitter, the resistance needed can be found by a simple application of Ohm's Law. With a battery of 6v., and a current into the base of T_1 of $10 \mu\text{amps}$., R would need to have a value of approximately 600k. This answer is not exact, because in working it out, we have conveniently forgotten about the few tenths of a volt that exist between emitter and collector when the transistor is "on". However, this is so small that only a very small error results, and since in any event, the final value of R will be found experimentally, it does not matter much.

The actual bias point for T_1 will largely be determined by the application to which the D.C. amplifier will be put. For example, if this concerns the operation of a relay or a meter type of movement, such as a pen recorder, it will usually be desirable to bias the circuit in the way already described. It is just as possible, however, to bias it so that the output transistor normally passes approximately half its maximum current. If this is done, the input current can move in either direction to produce a current either larger or smaller than that resulting from the fixed bias. Alternatively, it is possible to bias T_1 near cut-off, so that T_2 normally passes a high current, and the signal causes a reduction in this current.

Performance of the Circuit

It is not difficult, with the aid of one or two simplifying assumptions, to calculate the actual current gain of the circuit of Fig. 3, by working back from

the collector current of T_2 , using the known figures for the current gains of the transistors used. These figures can be obtained from the manufacturer's data sheets. If both transistors have a current amplification factor in the grounded-emitter circuit of 40 times, the overall current gain of the circuit would be $40 \times 40 = 1600$ times, if all the change in collector current of T_1 passed through the base circuit of T_2 . Owing to the presence of the series base resistor of T_2 , this does not happen, and the current gain is smaller. For those who may wish to work out a particular case for themselves, the working is as follows.

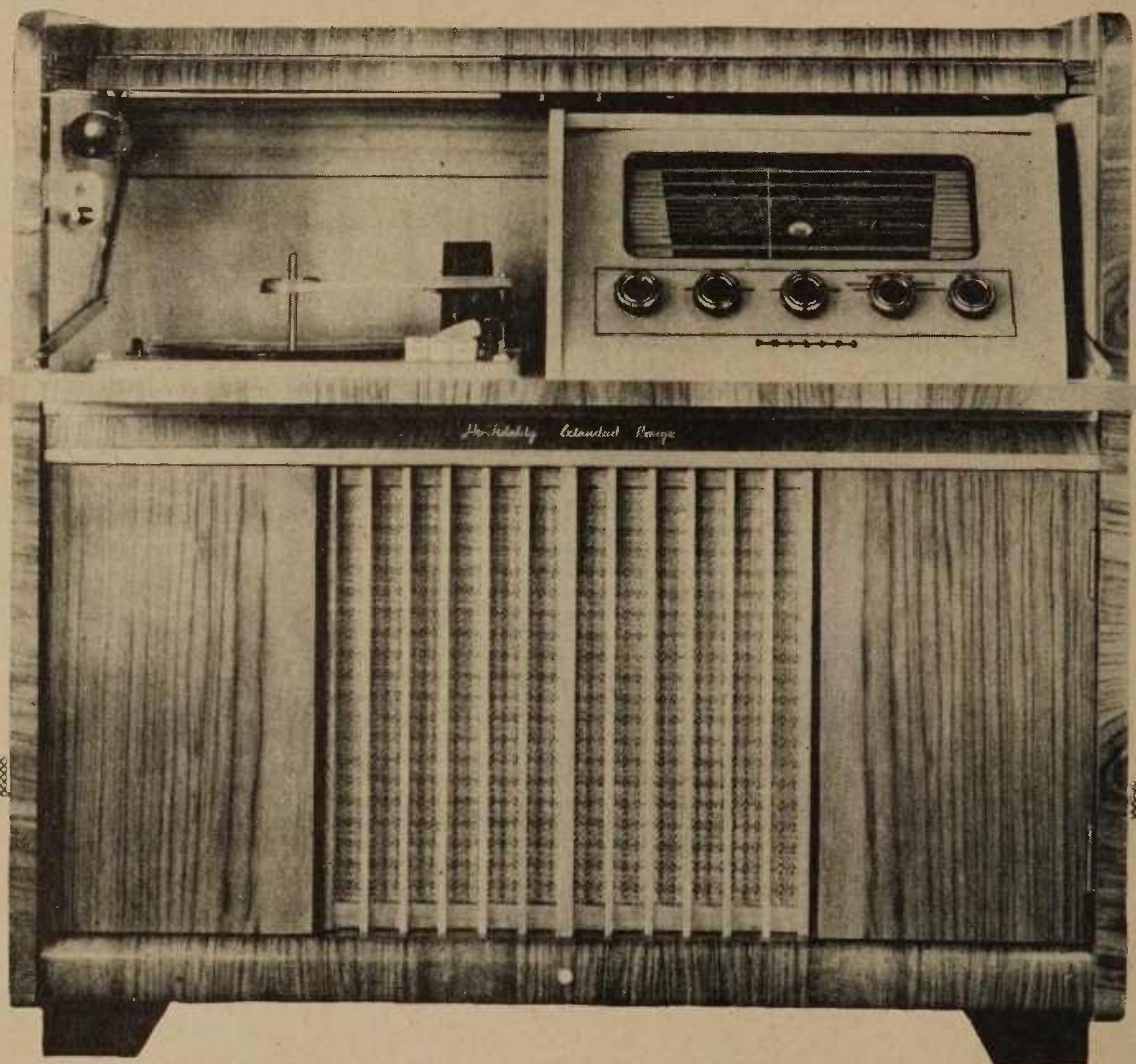
- (1) When T_1 is cut off, T_2 will be fully "on". We can assume that the collector current of T_1 is zero at cut-off, for purposes of calculation, although in fact there will be a slight current of approximately $100 \mu\text{amps}$. Thus, the base current of T_2 will be determined only by the battery voltage, and the value of the two resistors. If we further assume that the resistance of the base-emitter junction of T_2 has a very low resistance compared with 9.8k. (which is true) we can then work out by Ohm's Law the base current of T_2 . This comes out to approximately 0.45 ma.
- (2) If the current amplification factor of T_2 is 40, then the collector current of T_2 will be $40 \times 0.45 = 18 \text{ ma.}$, provided that the resistance in the collector circuit of T_2 is small enough to allow this much current to flow.
- (3) We can also assume without much error that the characteristics of the transistors are linear, which means that at lower collector and base currents, these currents will be in proportion. Put another way, we can assume that the current amplification of the transistors remains constant at all collector currents. Assume now that the collector current of T_2 is, say, 9 ma. The base current of T_2 will then be 0.225 ma. This current, flowing through the 4.7k. series resistor produces a voltage drop of

$$\frac{I.R = 0.225 \times 4.7k. = 1.06v.}{1000}$$

Now since the supply voltage is 4.5 volts, and the drop across the T_2 base resistor is 1.06v., the volts dropped across the load resistor of T_1 must be $4.5 - 1.06 = 3.44$ volts. But since the load resistor has a value of 4.7k., the total current through it must be $E/R = 3.44/4.7k. = 0.73 \text{ ma.}$

Now this current is the sum of the collector current of T_1 , and the base current of T_2 , which we have previously found is 0.225 ma. The collector current of T_1 must therefore be $0.73 - 0.225 = 0.5 \text{ ma.}$

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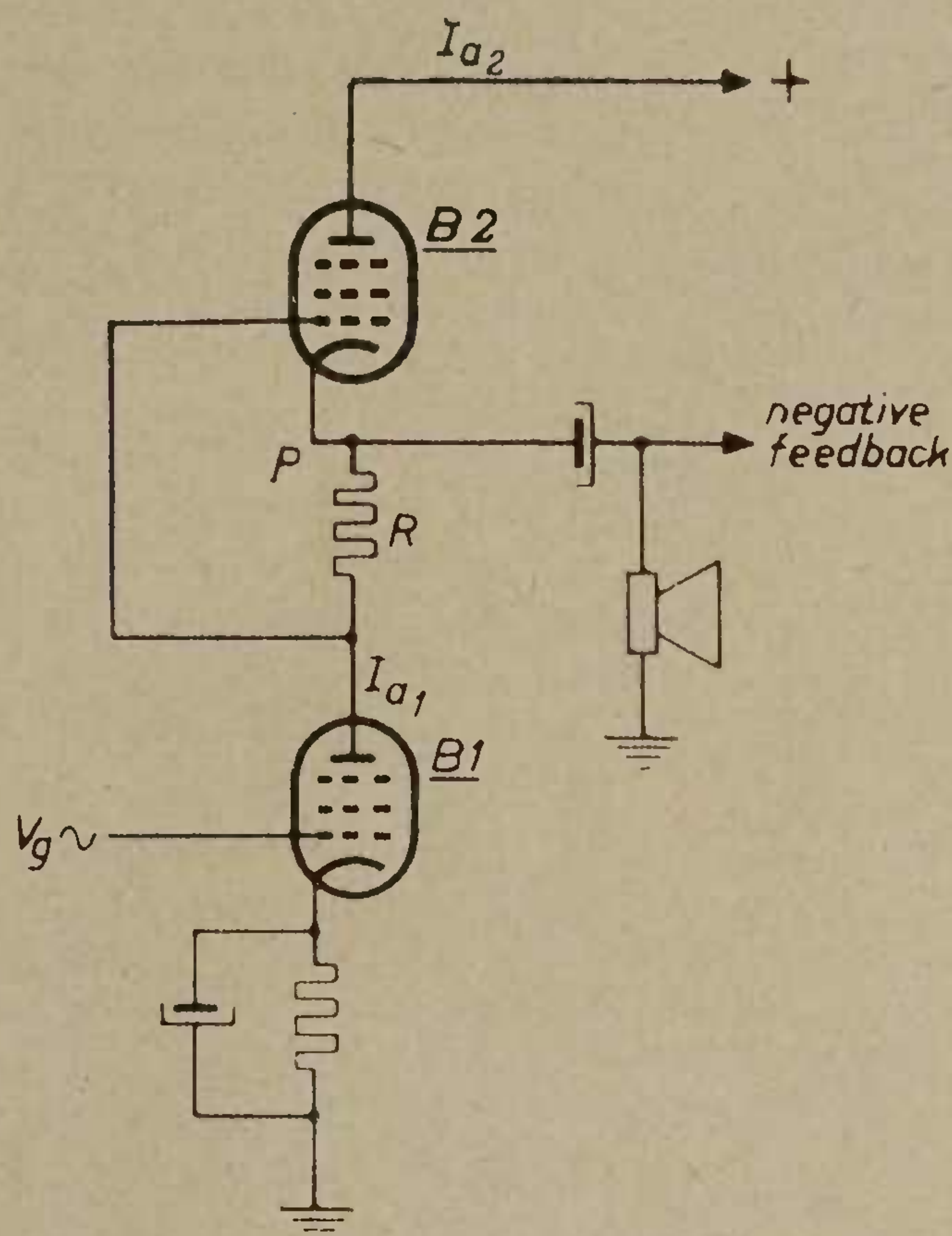
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WHAT IS HI-Z?

has just made its appearance in the world, here are some facts about 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 high impedance of the output valve, requiring a transformer. Unfortunately, the 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, however, no transformer is used. The loudspeaker itself is directly connected as a load to a specially developed output circuit, eliminating the major cause of distortion for this purpose. The high impedance loudspeaker is used in combination with PHILIPS special single-ended push-pull 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.

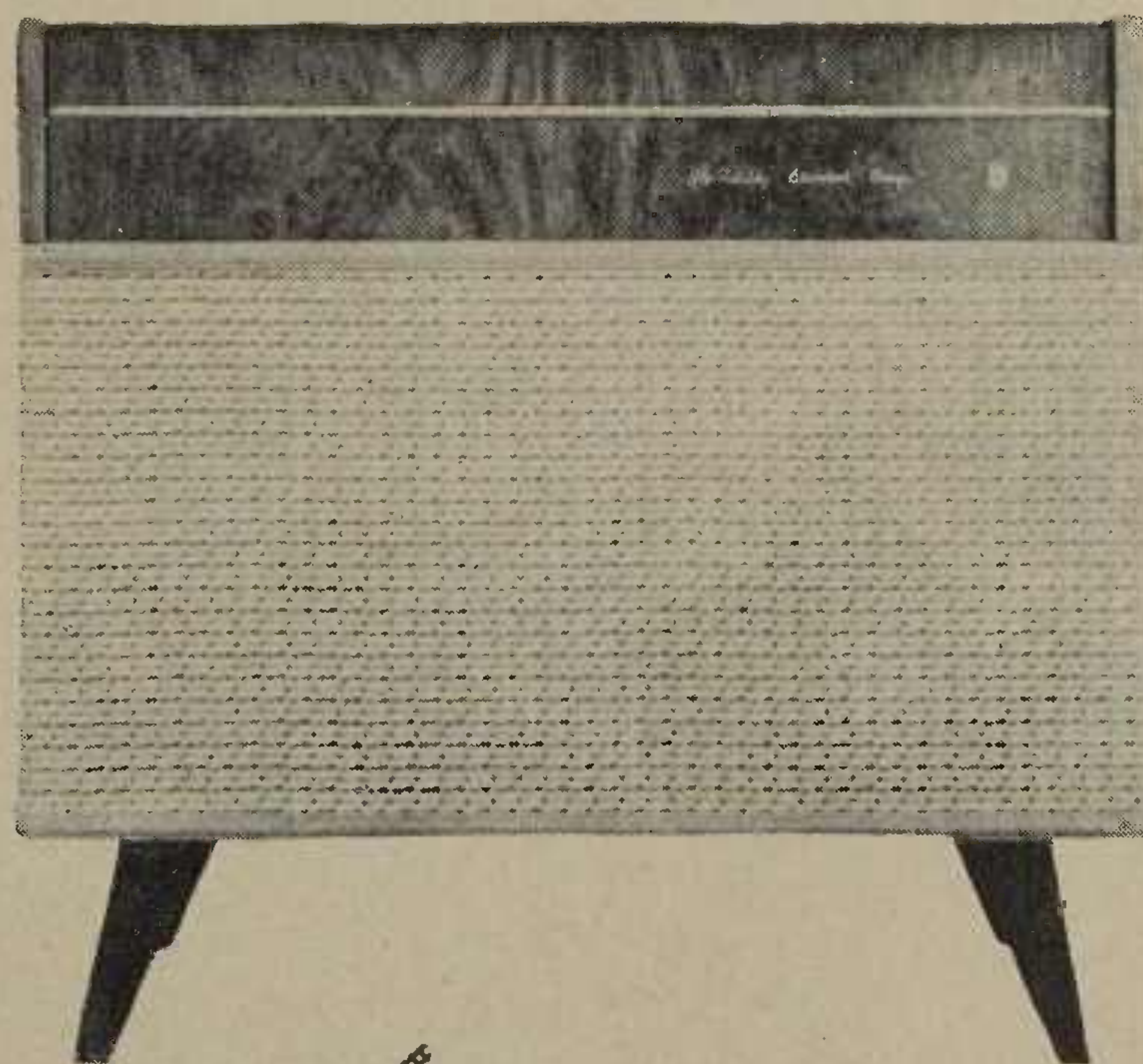
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- (4) If the current amplification of T_2 is 40 times, then the base current of this transistor is $0.5/40 \text{ ma.} = 12.5 \mu\text{amps.}$
- (5) We have thus worked out that a current change of 10 ma. in the output circuit is caused by a current change of $12.5 \mu\text{amps}$ at the input of the amplifier. The total amplification is therefore $10,000/12.5 = 800$ times.

If a transistor is used in either stage which has a higher current amplification than 40 times, the overall gain will be greater, but if the additional current gain is in the second stage, the increase in overall gain will be in proportion to the larger current amplification. In an actual case, overall gains somewhat greater than 800 times can often be expected, and much higher gains can be had if both transistors are chosen for high current amplification factors.

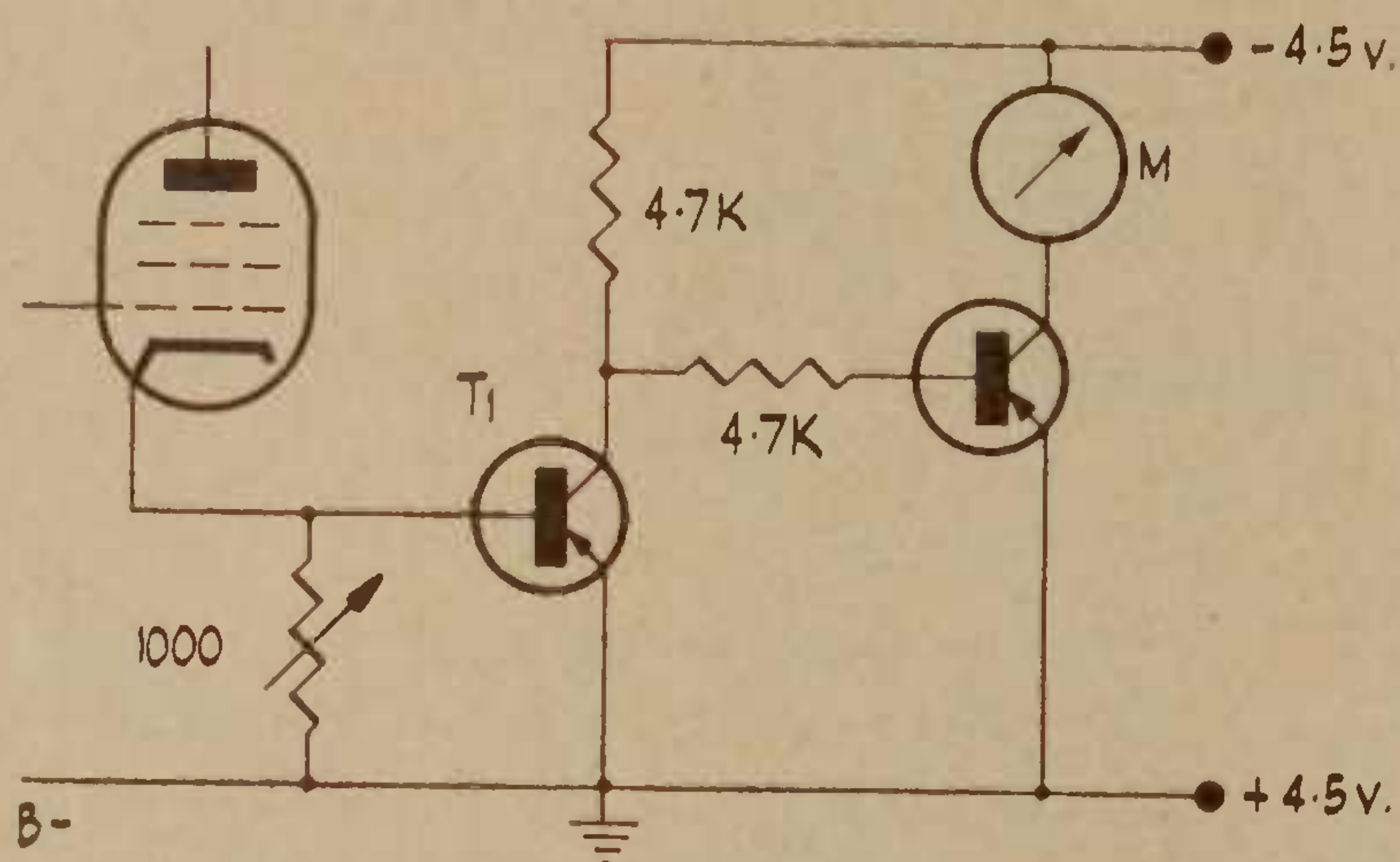


Fig. 4

Application

Perhaps the best applications for this simple circuit are those in which a simple on-off action is required, such as for operating a relay. In such applications, the effect of drift of the transistor currents owing to temperature changes is minimized, because one or other transistor is being operated at or near cut-off. For instance, if the circuit is remaining permanently in the condition in which T_1 is passing current and T_2 is cut off, T_1 will normally be "bottomed" (i.e., passing as much current as the circuit resistances will allow) any rise in temperature will increase still further the current in T_1 , holding T_2 still more firmly cut off. Thus, unless the circuit is used in such a way that the slightest changes cause the output device to function, temperature changes will not have an adverse effect. In this connection, it should be noted that since temperature affects both transistors simultaneously, and because their currents swing in opposite directions, the effect of temperature on the second stage will be small compared with that on the first stage. The second stage is unable to distinguish between changes in base current caused by an intentional signal, or by the effect of temperature on the first stage.

Reduced Sensitivity

For applications where the required sensitivity is greater than can easily be obtained with a single stage

of amplification, but less than that easily got with two, it is possible to reduce the gain, and increase the temperature stability at the same time by including small resistors in series with the emitters of the transistors. The best stabilization will be obtained when each stage has its gain reduced by the same amount, but it may not be possible to do this, because including emitter resistance in the circuit of T_2 will reduce the maximum current obtainable from it.

Operating the Amplifier from a Valve

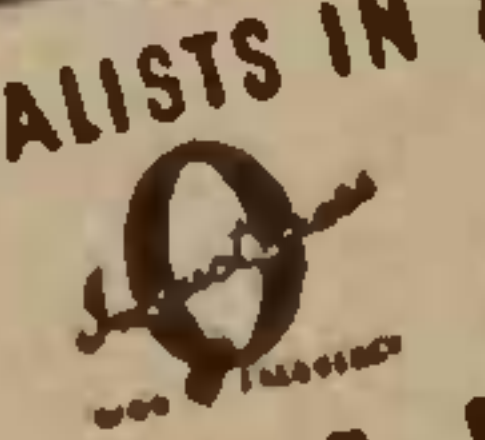
It is sometimes necessary to couple a D.C. amplifier of this sort to the circuit of a valve, so as to amplify the current change occurring in its cathode or plate circuit. Fig. 4 shows how this can be done. The resistor shunted across the input of the transistor amplifier is necessary in the common case of a current change which is only a small proportion of the standing valve current. It is adjusted until the volts dropped across it are just sufficient to reduce the current in T_2 to a suitably low value. Then, any decreases in the valve current decreases the current in the base circuit of T_1 , and causes the current in T_2 to swing upwards.

If the current change in the valve is an increase, the circuit can be made to operate so that the current in T_2 drops. Alternatively, the connections of the input terminals of T_1 can be reversed, so that the increase in valve current still causes an increase in the current of T_2 .

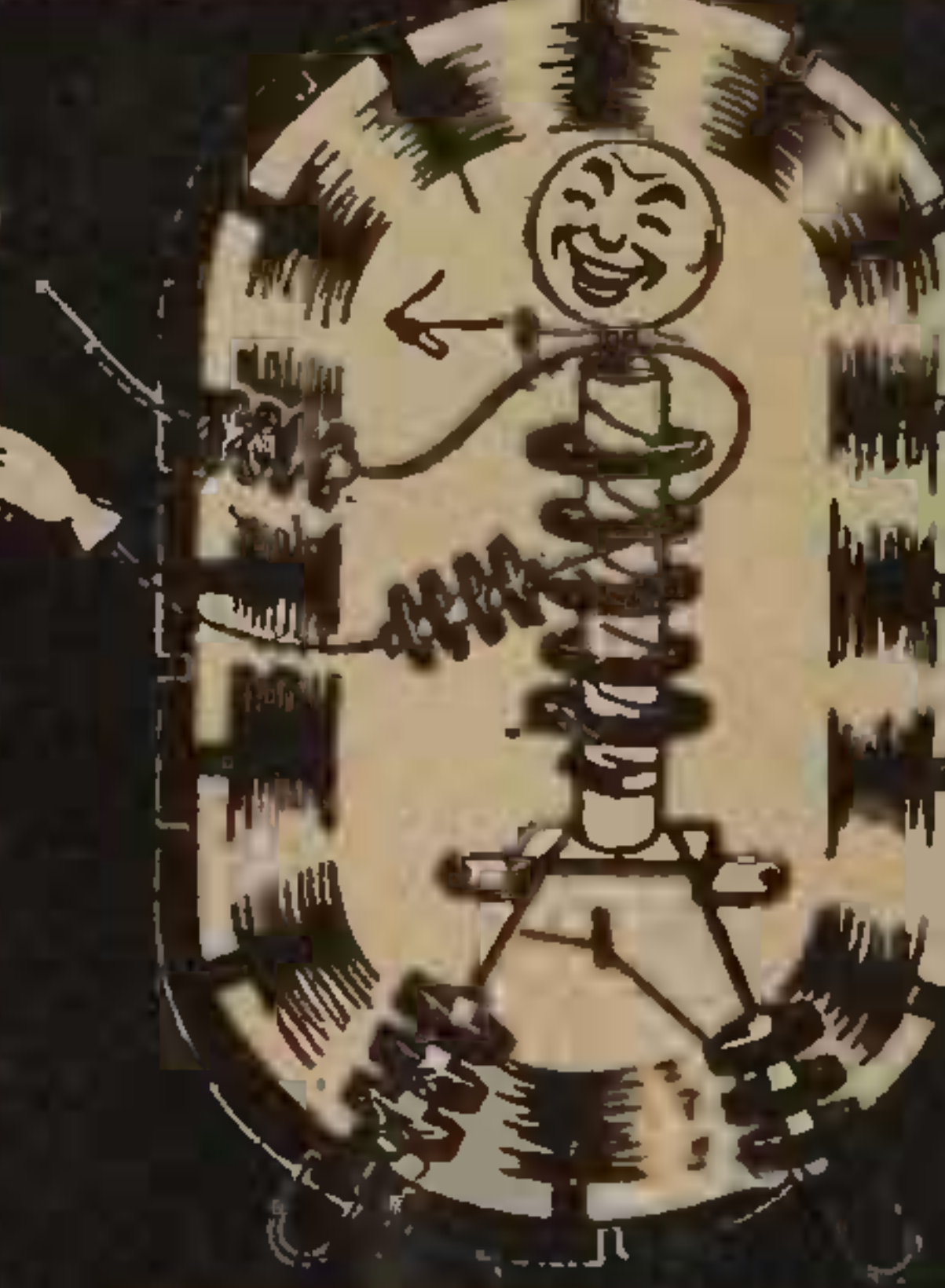
Though not a precision circuit, the arrangement described in this article can be extremely useful in many applications where extreme sensitivity is required, without the necessity for fussy or difficult adjustment.

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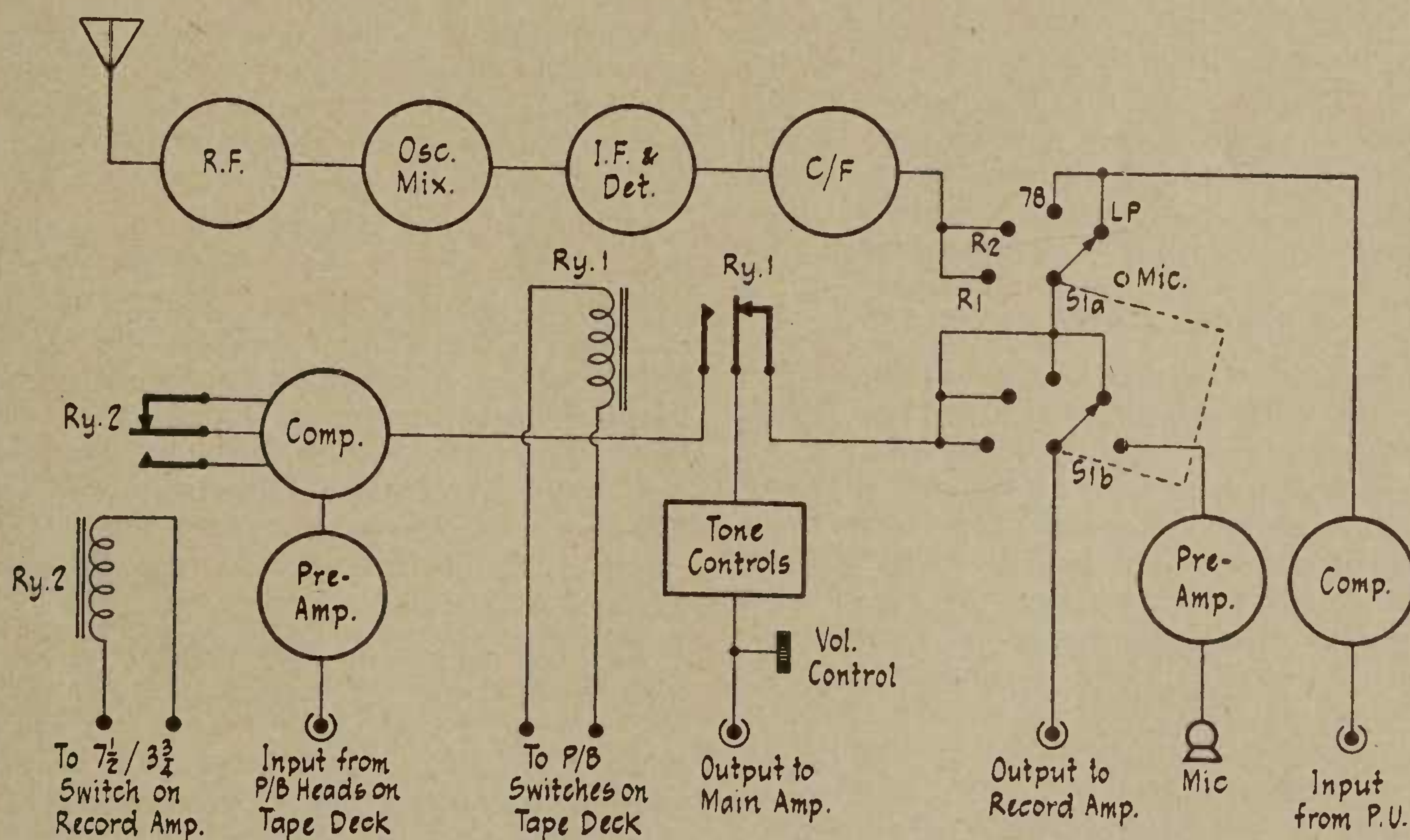
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A RECORDER-GRAM CIRCUIT FOR AMATEUR CONSTRUCTORS—Part 2

Part 1 of this article, which appeared last month, described the scheme of the complete recorder-gram, and commenced a detailed description of the circuit by giving a recommended arrangement for the main power amplifier and its power supply, which together form one of four units, which make up the complete outfit. This month's instalment presents the circuit of the tone and volume control portion of the set, and shows how this fits in with the general scheme of the block diagram given last month.



General Considerations

It might be a little surprising to some readers to see a whole instalment of this story devoted to a description of the part of the circuit which provides the tone and volume control. However, we propose to do this to show how the various parts are fitted together into a harmonious whole, which is most important. It is almost as important as the proper design of the various circuits that make up the completed outfit, and it is in co-ordinating a number of pieces of separate circuitry that many amateur designers find the most difficult.

What it amounts to is that the whole thing has to be designed as a system, and not as a collection of unrelated bits and pieces. Each part must do its own work efficiently, but it must also be able to fit into the system without prejudice to either its own efficiency

or that of any of the other component circuits with which it must co-operate. Let us see what we mean. The point is well illustrated by a type of question which we are very frequently asked by readers, such as, "What is the best sort of tone control circuit to use?" The answer, of course, is that there is no best kind. Many circuits can be designed to do the job of providing the variations of frequency response that we normally lump together under the general heading of "tone control". If properly designed, all will work equally well, provided that their own particular attributes are peculiarities that are considered by the user. For instance, the block diagram of the present system shows that the tuner feeds through the main selector switch to the tone control circuit, which is followed by the volume control. So do the tape playback pre-amplifier, and the gramophone pick-up pre-amplifier.

These three things each consist of quite widely different circuitry, and yet each must feed the same circuit, when selected by the switch. The tone control circuit, therefore, has imposed upon it not only the automatic condition that it must act efficiently as such, but also a second one, namely that it must not have any adverse effect on the performance of three different circuits which may feed signals to it. About the only effect which it could have would be to load one or other of them too heavily, thereby reducing either the output voltage, the signal-handling ability, or both. The requirement is therefore that the tone control circuit shall have an input impedance that is at least several times the output impedance of any of the three circuits which may feed it. Certain tone control arrangements that could possibly be used would not meet this requirement. Others, such as the Baxandall circuit, might not be suitable because of possible reaction upon them by the circuits which precede them. Thus, we hope to have proved that the choice of tone control circuit is to a large extent dependent on the circuits with which it must work. It might be possible to say that a certain tone control arrangement is the best for use in *this particular situation*, but that is a very different thing from saying that it is the best for any set of circumstances.

Signal Levels

It is an unfortunate fact that no tone control circuit functions except by attenuating, or reducing, the output at certain frequencies. For instance, if we want to produce the effect of bass boost, we must use a circuit which attenuates the middle and high frequencies. Then, by varying the amount by which we also attenuate the bass frequencies, we can vary the proportion of bass contained in the signal as a whole. In so doing, we use a circuit which is fundamentally an attenuator, or, in other words, a de-amplifier. Where we had a signal of, say, one volt. at the input to the tone control network, we may easily lose as much of it as nine-tenths, so that we say that the network has an attenuation, or insertion loss, of ten times, since the output is only one-tenth of the input. If after this we need to build the signal up to one volt again, we must use an amplifier with a gain of ten times.

From the last paragraph, it should be clear that the position in the circuit in which the tone control is placed is important.

It is especially so when we are dealing with very small signals, such as those from microphones or tape playback heads. This is the reason why in such cases the signal level is brought up by ordinary amplification to a reasonably high level before any attempt is made to modify its frequency response. In a radio set, the question hardly arises, because there is usually a signal of several volts available at the detector output. Here, where we have a high-output device, like the radio tuner, side by side with low-output devices such as the tape deck, and possibly the pick-up too, it is essential to build up the signal

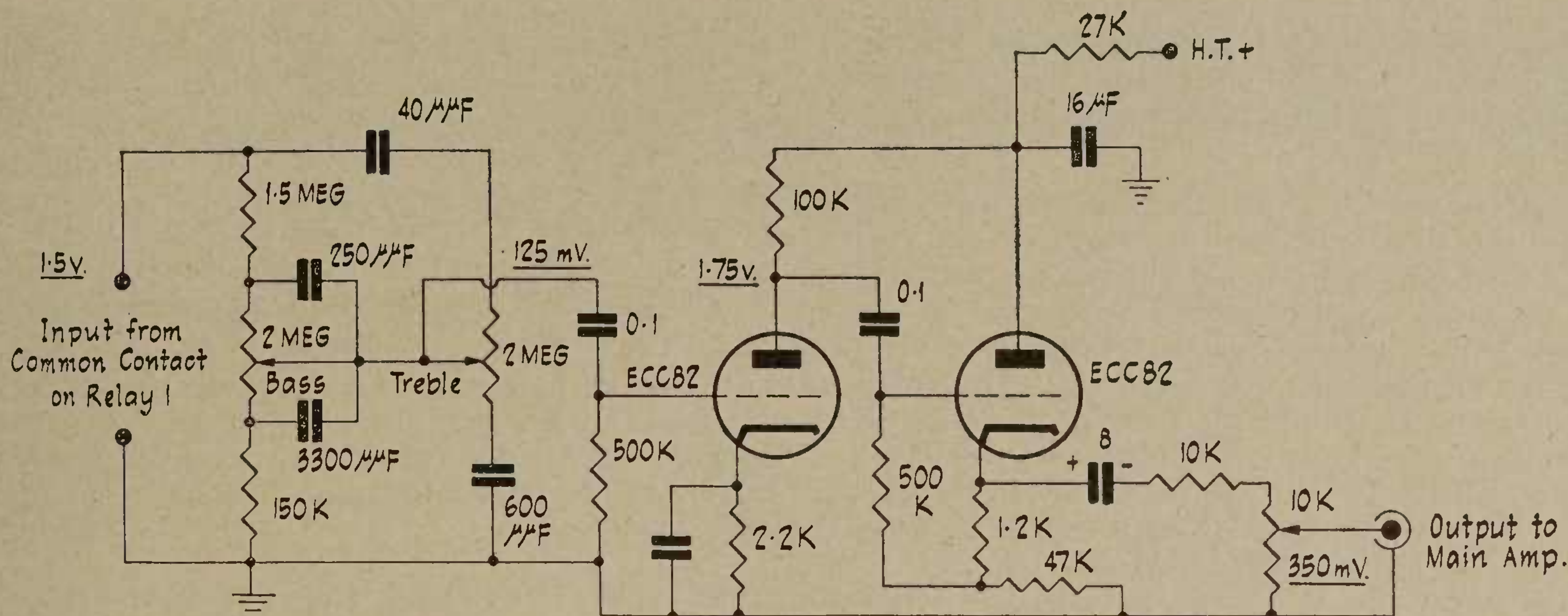
level of the low-output devices to a fairly high level before they go through the tone control circuit, which actually gives an attenuation of twelve times at the middle frequencies.

This being the case, the level to which the various input devices have their signals amplified before being applied to the tone control circuit, must be high enough for this degree of attenuation not to matter. The output of the tape pre-amplifier circuit has a peak value of 1.5 to 2 volts, while it is a simple matter with practically all pick-ups to obtain an equalized output of this order from the pick-up compensating stage. The radio tuner, too, can easily supply this voltage, so that in the first instance, we can assume that any signal source that feeds the tone control circuit, will have an output of, say, 1.5 volts peak.

If the tone control circuit attenuates this by a factor of twelve times, the signal level at the output of the tone control circuit will be $1.5/12 = 0.125$ volts, or 125 mv. This is not a very large signal, but with modern valves, much smaller signals can easily be handled before hum or noise becomes troublesome. Thus, it is not necessary to apply a higher input voltage to the tone control network.

Having got our signals as far as the output of the tone control system, it is necessary to feed them to the main amplifier, whose circuit we printed last month. This amplifier requires a signal of 0.35 v., or 325 millivolts, in order to develop its full output of 5 watts. It is clear, therefore, that some small amount of amplification will be needed between the tone control circuit and the main amplifier. Furthermore, there must be some means of controlling the input to the amplifier, for so far we have made no provision for a volume control.

At this point, another consideration enters the picture. It is the fact that the main amplifier will be some distance from the chassis on which are the radio tuner, the various pre-amplifiers, and the tone and volume controls. It is necessary, then, to feed the signal through a shielded cable to the main amplifier, and this in turn requires that something be done to prevent high-frequency loss in the capacity of the cable. If modern low-capacity cable is used, the capacity of three or four feet of it can be as much as 150 to 200 $\mu\mu\text{f.}$, while if a longer run of ten feet or more is contemplated, the cable capacity rises to some 500 $\mu\mu\text{f.}$ Because of this, it is not possible to use an ordinary high-resistance volume control to feed the cable, because this amount of capacity would cause severe loss of high frequencies. To give an idea of how great this loss would be, with a cable capacity of 500 $\mu\mu\text{f.}$, and a volume control of 500 k. ohms, a simple calculation shows that in the worst case, i.e., when the control is in its mid-position, the response would be 3 db. down at a frequency of only 1250 c/sec. At other settings of the control, the effect would not be so great, and it is this wide variation of effect with volume control setting that makes it an almost impossible job to compensate for it. The best way out of



the difficulty is to use a low-resistance volume control, or to follow the control with some circuit having a low output impedance. For example, if the volume control potentiometer were reduced to 50,000 ohms, a capacity of 500 μf . would cause a top loss of 3 db. at 12,500 c/sec., and this would in the majority of cases be quite unnoticeable.

An obvious way out of the difficulty would be to insert a cathode follower after the volume control. This would have an output impedance of only a few hundred ohms, so that the response would extend to several megacycles, and there would be no effect at all inside the audio range. Unfortunately, however, this is not a very practical answer to the problem for another, quite different reason. A cathode follower circuit places the unbypassed cathode of the valve at a quite high D.C. potential above ground, so that a certain amount of heater-cathode hum is unavoidable. Provided that the valve is at all times handling a signal of half a volt or more, this hum is negligible, but in the present case, where the volume control is ahead of the cathode follower, the signal will most of the time be considerably less than this, and hum may become troublesome.

The answer to all this will be seen in the circuit diagram, in which the signal voltages throughout have been indicated by the underlined figures. A double triode valve is used, the first half as a simple resistance-coupled amplifier stage. This has an amplification of approximately 14 times. The input signal is 125 mV., so that the output signal is $1\frac{3}{4}$ v. This is more than adequate to prevent all traces of hum from appearing, either in the amplifier tube itself, or in the cathode follower which comes after it. At the same time, the use of the additional amplifier stage will not introduce distortion, since it is capable of giving an output of this amplitude with a good deal less than 0.1 per cent. distortion, while the distortion in the cathode follower stage will be quite unmeasurable. Further, it will be noticed that the full output of the amplifier stage is at all times fed to the cathode follower, and is much

more than enough to ensure hum-free operation of the latter. The cathode follower feeds the volume control potentiometer, which is of 20 k., with a further 20 k. in series with it. The series resistor is there merely to divide the output voltage by a factor of two, so that the signal at the upper end of the volume control is approximately 0.6 volts after allowing for the slight loss in the cathode follower circuit as well as that of the voltage divider.

With a volume of 20 k., the high-frequency response for a output capacity of 500 μf . will be 3 db. down at 31,250 c/sec., so that high frequency loss is altogether avoided as far as the audio frequency range is concerned. For cables of less than this capacity, the loss will be even less. Indeed, the effect on the high-frequency response would still be quite unnoticed even if the output cable had a capacity of 1,000 μf ., corresponding to about 20 feet of low-capacity cable.

In order to couple the output to the cathode follower to such a low-resistance potentiometer, a large coupling capacity is required, in order to prevent loss of low frequencies. This is the reason for the use of an 8 μf . coupling condenser. It should be mentioned that where a 450-volt electrolytic condenser is used in this role, there need be no fear of breakdown. The condenser is being used with a D.C. voltage across it of under a hundred, and although this certainly is an unusual application for an electrolytic condenser, it will be found perfectly satisfactory in practice.

The Tone Control Circuit

The tone control circuit we have used here is typical of a large class of such arrangements, that are distinguished from each other only by the actual circuit values used, and by the degree of boost and cut which they make available. When using such a circuit, it is rather important to have some idea of how it works, because the effects can be quite startling if wrong-valued components are used by mistake, or if open or short-circuited condensers should accidentally

be used. Besides, if one understands the working of what looks a rather complex arrangement, it is possible to predict roughly what the effect will be of intentionally or unintentionally varying the values of any of the components.

The circuit is really a combination of two simple ones. As can readily be seen, it consists of two chains of components in series, one element in each chain being a 2 meg. potentiometer. The outputs of these are connected together, and the junction forms the output terminal of the whole network. To see in a qualitative way how the circuit works, the best thing is to imagine that one of the networks is disconnected, and then examine the other. To do this, place a piece of paper so that it obscures the right-hand part of the circuit altogether. We are then left with the 1.5 meg. resistor, the 2 meg. bass control potentiometer, the 150 k. resistor, and the two condensers. For the moment, we need not concern ourselves with the values of the latter.

Imagine for a start that the bass control is moved so that the sliding contact is right at the bottom of its travel. In this position, the lower condenser, of $3,300 \mu\mu\text{f.}$ is short-circuited by the potentiometer, and we are left with the other four components. If now we imagine a very low frequency being fed into the circuit, the $250 \mu\mu\text{f.}$ condenser can be thought of as an open circuit, because its reactance will be very much higher than the values of any of the resistors in the circuit. This leaves us with only the three resistors, and the output will be determined only by the way in which these act as a voltage divider. The moving arm of the control it will be remembered, is at the lower end. Thus, the output will be that of a voltage divider consisting of 3.5 megs. in series with 150 k., with the output taken from the junction between the two. The output will therefore be $150/3500 = 3/70$ of the input voltage. Now, with the control in the same position, imagine a very high audio frequency fed in. The $250 \mu\mu\text{f.}$ condenser will now have a very low reactance, and so we can imagine it as a short-circuit. Since it is connected across the whole of the 2 meg. potentiometer when the slider is at the bottom, we can say that at a high audio frequency, the circuit reduces once more to a resistive voltage divider, but this time consisting of 1.5 meg. in series with 150 k. The output will now be approximately $150/1500 = 1/10$ of the input voltage.

This simple calculation has shown that with the slider of the bass potentiometer in the lower position, the output varies from $3/70$ to $1/10$ of the input voltage, according to the frequency being fed in, and the higher output is obtained at the highest frequencies concerned. This obviously means that we are getting bass cut, and you will notice that we have not as yet had to say anything about the actual value of the condenser that is active when the control is set in this way. If the condenser is very small, it will act as a short circuit for the 2 meg. potentiometer only at very high audio frequencies, while if it is made

large enough it will short-circuit the resistor at reasonably low frequencies. Thus, as we bring up the frequency from zero, the output will gradually increase until at a frequency determined by the size of the upper condenser, it will cease to increase any further. In practice, the frequency at which this is arranged to happen is about 500 c/sec., and in this way the control is made to affect only the bass end of the scale, the middle and high frequencies being attenuated equally to a tenth of their input value.

From the figures we have already worked out, we can find further that the maximum bass cut will be approximately 5 db. This is not very much, but in practice it is found that a large amount of bass cut is never required.

How Bass Boost Arises

To see how bass boost can be provided by this circuit, all we have to do is to imagine the bass control moved to the upper end of its travel. In this position, the control short-circuits the $250 \mu\mu\text{f.}$ condenser, so that it is inactive, and leaves the lower one in the circuit. If we go through the same performance as before, putting in first a very low, and then a very high frequency, and thus seeing what happens when the $3300 \mu\mu\text{f.}$ condenser acts as either an open or a short circuit, we find that at low frequencies, the output is equal to the input voltage multiplied by a factor of $1.5/3.5 = 3/7$.

At high frequencies, the condenser once more short-circuits the 2 meg. potentiometer, so that the output is approximately $1/10$ of the input. This time, therefore, there is bass boost, by a factor of $30/7$, or just over 13 db. The circuit thus controls the extreme bass frequencies from -5 db. to $+13$ db., compared with a flat response. When the bass control is in some intermediate position, both condensers are active, and the situation is much more complicated, but it is self-evident that there must be some position in which neither boost nor cut is obtained, so that the resulting response is flat.

The High-frequency End

If, now the bass part of the circuit is blocked off, the same sort of procedure that we have been following will tell us how the treble control works. It is not proposed to wade right through it, as we have done for the bass end, but the interested reader will find it instructive to do this for himself. It so happens that the circuit values are chosen in such a way that the bass part has little or no effect on the response of the treble part, and vice-versa. We thus end up with a circuit in which two potentiometers give complete control over the response curve, without any effect on the apparent volume. Moreover, the controls can be set in such a way that the response is quite flat, and their settings marked, so that when the controls are being operated, one always knows roughly how much boost or cut is being used. This is a very great ad-

(Concluded on page 50.)

ELECTRICAL AND TRADE SECTION

ARCTIC RADIO GEAR MADE IN NEW ZEALAND

In last month's issue of this journal, mention was made of the six battery-operated transmitter-receivers that have been sent to Sir Edmund Hillary's party in the Antarctic for use by sledge parties. These sets were designed and built by Messrs Collier and Beale Ltd., of Wellington, and we have pleasure in printing the accompanying photographs which illustrate some of their unusual features. In the first picture the sets are seen in and out of their special cold-weather packing. Also in the picture can be seen the headphones and the aerial. The latter is not "erected" in the usual sense of the term. It is merely spread out along the "ground". However, since this consists of ice, many feet thick which has very good dielectric properties, the aerial is, in effect, supported quite high in the air, as it would be if seen from the real "ground". One of the main difficulties that had to be surmounted was in obtaining suitably insulated wire for the aerial. Polythene, of the variety used so freely in radio work these days, merely hardens in the very low temperatures encountered in the Antarctic, and if rolled up, breaks when an attempt is made to unroll it. Natural rubber insulation is one of the very few kinds that does not do this, and as there was not time to import the special synthetic-insulated wire than can be had overseas, the problem was solved by using motor ignition cable!

Since the set had to operate from batteries, a great deal of proving work had to be done in refrigerators while development work was going on. Moreover, the type of refrigerator that had to be used was not commonly available, since domestic ones do not get nearly cold enough to simulate antarctic conditions! At very low temperatures, dry batteries lose their activity, although they regain their normal attributes when they have warmed up again. Thus, before these sets can be used, the party will have to take them inside a warmed tent, and raise the batteries to a suitable temperature beforehand. This must be a great nuisance, but there is nothing that can be done about it. It is because of the low efficiency of cold batteries, and also because a full 5 watts output was called for, that quite a large box of batteries has to be carried for each set. The sets, therefore, hardly qualify as "portable".

In the second photograph a set is seen, taken from its protective "clothing", and open ready for use. The lid to the part containing the set proper can be seen chained to it, to prevent loss of the lid. This would be disastrous, because the lid is hermetically sealed by a rubber strip when in position, and prevents moisture from getting into the works. Since the gear is battery-operated, precautions (which cannot be seen in the

photo) have been taken to prevent the lid from being put back on unless the set is switched off beforehand. The transmitter is crystal controlled, on a number of spot frequencies, and there are facilities for either 'phone or CW.

The third photo shows the inside of the set itself. For those interested, the transmitter's final amplifier consists of four DCC90 double triodes, all sections being in parallel! The receiver is a quite conventional superhet circuit with a stage of R.F. amplification.



TRADE WINDS

Marconi Radar for Rongotai Airport

Following an exhaustive evaluation of equipment available both in Europe and America, the Civil Aviation Administration (Air Dept.) of New Zealand has awarded a contract to Marconi's for the supply and installation for two complete surveillance radar systems. One is for Rongotai, to supervise the airfield area and Cook Strait, while the other is for use at Ohakea, which is perhaps the busiest of R.N.Z.A.F. aerodromes. Both installations incorporate duplicate high-powered radar equipment of an entirely new type, the S624A, with fixed-coil display units.

The Rongotai installation will possess many unusual technical features, notably the provision of a microwave radio link between the radar head and the Airport Control Centre. Signals from the radar head terminal will be beamed to a hill-top overlooking Wellington and the airport. On this hill, an array will serve to split the incoming radar information, one portion being deflected to the airport itself to feed two fixed-coil display units, the remainder being beamed to the Airways Control Centre in Wellington city, which is to have four similar display units. Full remote control of the radar head will be effected over the link.

The above photograph shows an aerial view of the Wellington area taken from a high altitude, and showing:

- A = Site of the radar head
- B = Point at which signal is split
- C = Wellington city
- D = Rongotai airport.

Wellington's well-known earthquake fault line can be seen running from the bottom of the picture (to the left of "A") diagonally to the top. This area is prone to earthquakes (no need to tell Wellington people that!—Ed.) which is one reason why the microwave radio link is being used instead of a co-axial line. The photograph reproduced here is by courtesy of the R.N.Z.A.F., Central Photographic Establishment.

The topographical conditions in the Rongotai zone make the siting of a surveillance radar in the area particularly difficult and it will be necessary to erect the radar head on the top of one of the hills (elevation 1650 ft.). This in its turn makes it essential that the head should be capable of withstanding the high winds prevalent in this area. The Marconi radar head to be used—an entirely new design which among other things provides a marked increase in definition—will turn at full speed in wind velocities up to 60 knots, at half



speed up to 90 knots and is built to withstand the effects of a 120-knot wind.

Furthermore, the New Zealand authorities decided to provide both long-range airways cover and short-range airport approach and control in a single type of equipment, with the added requirement that its operation should be unaffected by heavy rainstorms. It was decided that these extremely exacting conditions were best met by the Marconi S264A equipment which operates on 50 cm and will work through any form of precipitation. Duplicate transmitter/receivers (one "main", one "standby") are to be installed.

In the past the usual practice has been to build the Operations Centre near the site of the radar head, the signals picked up by the aerial being passed to the display units via coaxial cable. At Rongotai, however, the site of the radar head lies some four miles from the Airways Control Centre in Wellington City, and a coaxial cable of this length is an extremely expensive proposition. Yet another problem arose because the area is subject to earthquakes and earth tremors, with the consequent risk of cable fractures.

Under these conditions the microwave radio link system introduced by Marconi's at the 1956 Farnborough Air Show provides an ideal solution on grounds of lower cost, reliability, and overall convenience. One terminal station will be erected alongside the radar head, with the signals beamed toward an aerial array mounted on a hilltop immediately overlooking Wellington and the Airport. This array will serve to split the incoming radar signal information, one portion being deflected to the Airport itself, where two fixed coil display units are to be installed, the remainder being beamed to the Airways Control Centre in Wellington City which is to have four similar dis-

play units. Full remote control of the radar head will also be effected over the radio link.

The provision of fixed coil displays together with the employment of the latest video map techniques will ensure the operational speed and accuracy which is vital to the efficient control of modern air traffic.

The second installation will be at Ohakea, a major R.N.Z.A.F. airfield from which jet fighters and long-range military transports are flown. Ohakea is also the alternative airfield for international civil aircraft, and the problems of air traffic, already acute here, are likely to be increased by the introduction of services using high-flying Viscounts.

To relieve these problems the airfield is to be equipped with duplicated Marconi 500KW radar transmitter/receivers type S264, an aerial head and three (perhaps four) fixed coil display units type SD1020. The equipment will thus be generally similar to that intended for Rongotai, but with a conventional coaxial link between the radar head and the Control Centre.

The total value of the order is approximately £300,000.

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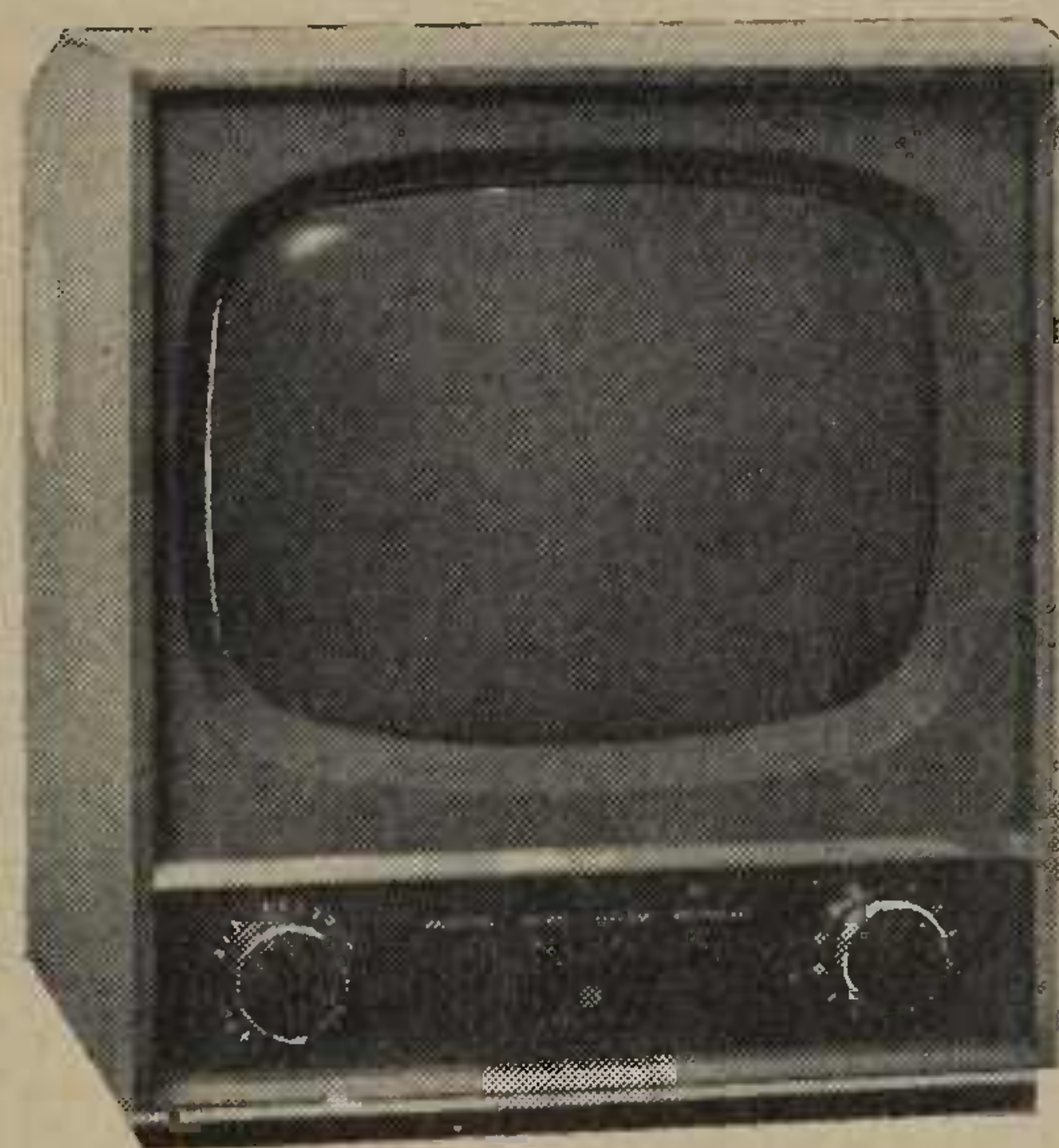
Pye TV Wins Honour from Council of Industrial Design Presentation by Prince Philip



In May of this year 3,500 different products were exhibited and judged at the Design Centre of the Council of Industrial Design in London. Twelve products were chosen to receive one of the coveted Design Centre Award Certificates. Pye entered the Robin Day designed TV Receiver, CS 17 (illustrated above), which gained one of the Award Certificates. Pye Chairman, Mr C. O. Stanley, was presented with the award by Prince Philip at a ceremony held in the Design Centre.

Readers may recall that industrial design has owed much to Prince Philip's encouragement ever since the

formation of the Council for Industrial Design some few years after the war. This latest extension of the Council's activities is to become an annual event; industrial design has "arrived".



The Pye Television Receiver to which the award was made was designed by noted industrial designer, Robin Day. The design incorporates Japanese Sen veneers, commended by the judges for being a "good practical colour for preventing eye-strain". They also praised the detail of the lettering and the knobs.

Pye are justifiably proud of the honour conferred upon them by Prince Philip and by the Council of Industrial Design. And they welcome the recognition given by the Council to the efforts Pye are making to improve the functional beauty of their products.

* * *

BRITISH COMPANY TO FLOODLIGHT NIAGARA FALLS

A contract to floodlight Niagara Falls with a new British-designed colour floodlighting system to replace the existing one has been awarded to the Amalgamated Electric Corporation Ltd., Canadian subsidiary of The General Electric Co. Ltd., an entirely British concern. The contract, awarded by the Niagara Falls Illumination Board, comprised of corporate members from both sides of the border, is worth \$153,000 (about £55,000).

The floodlights will be mounted on the Rotunda in the Queen Victoria Park, which is the hub of Niagara Parks commanding an unequalled view of the Niagara Falls where some 120 million gallons of water per minute drop 165 feet to the river below. Ten projectors will illuminate the 2,600 ft.-wide Canadian Horseshoe Falls 1,700 feet away; three more will be directed towards the Upper Rapids, two will light the rock face at the base of Goat Island joining the two falls, and five will illuminate the American Falls 3,000 feet away.

Although they will consume no more power than the 24 floodlights which they will replace, the brightness provided by the new G.E.C. floodlight projectors will be at least four times as great.

The floodlighting system was devised by G.E.C. lighting engineers working in conjunction with the Company's Research Laboratories, Wembley. The initial presentation of the scheme was made to the Niagara Falls Illumination Board last November, and to assist this presentation a tape recording supporting the more detailed and highly technical specification was flown to Canada.

Representatives of the Niagara Parks Commission some four months ago attended a large-scale working demonstration of a specially-designed G.E.C. prototype projector in a field at Stanmore, Middlesex. A distant hill chosen for its topographical similarity to the falls at Niagara was camouflaged and smoke and water used to represent Niagara Falls. A supply of smoke bombs was obtained from the producers of the new British film "Dunkirk", and cascades of water were supplied by hoses of fire brigades from the G.E.C. factories at Hammersmith and Wembley and the Company's Research Laboratories at Stanmore. "Walkie-talkie" was used to control the demonstration, the recorded sounds of Niagara were played as a background, and a running commentary was broadcast.

The prototype unit was subsequently shipped to Niagara, where the final decision was taken following a demonstration on the falls of the G.E.C. unit and an alternative American proposal. Senior representatives of the G.E.C., London, conducted this demonstration and took part in the final negotiations.

Twenty specially-designed, weather-proofed, high-current density, carbon-arc projectors, incorporating remote-controlled automatic colour-changing devices

and wide-beam arrangements will be used to provide a large range of dramatic lighting effects. The projectors, which will be supplied under sub-contract by Savage & Parsons Ltd., of Watford, will be equipped with a forced ventilation system which has been evolved to operate under the varying climatic conditions experienced at Niagara.

Despite modern developments in light sources, experiments at the Company's Research Laboratories proved that the best light source for floodlighting the falls effectively was the high-current density carbon-arc. The optical system is provided by a paraboloidal silvered glass reflector approximately 90 cm. in diameter, having a focal length of 42 cm. The centre brightness of the arc will be in the neighbourhood of 80,000 candelas per square centimeter, giving a beam intensity of 210 million candelas.

Attached to the front of each projector is a housing which provides automatic colour changes by a series of five 37 in. square colour filters held in metal frames. The filters can be used individually or in combination to provide a range of 15 colours. Each of the large filter frames will be operated by individual motors and the colour for each projector will be selected and brought into its operating position from a remote switchboard.

The weather-proof housing and the automatic colour change mechanism was the result of extensive experiments by G.E.C. lighting engineers. Forced ventilation from a high speed motor-driven blower is provided to prevent rapid fading of the colours due to the heat generated by the arc. This provides a positive air pressure within the housing, which is fitted with a non-return valve, thus ensuring that spray from the falls does not enter and damage the mechanism or destroy the colour media.

MISSING AND STOLEN RADIOS

Auckland:

Cromwell, 6-valve Broadcast, Colour, dark walnut. Chassis number 43529. Radio transmitter, Arc 5, for 80-metre band, cabinet painted black, black dial, T22-Arc 5, on blue panel on top.

Car radio, make unknown, push-button type, 12v. converted to 6v. The "12v." has been scraped off the case. Case is of grey metal, fitted into green bracket. Serial number 37127/35820. Value £25.

Christchurch:

Pacific console radio, darkish colour, lozenge shape. Value £6.

Dunedin:

Philco, 5-valve table radiogram, Model No. 1241. Serial No. 6499, white Collaro turntable, new condition.

Invercargill:

Philips radio, Model 267, "New Yorker", 5 valve, broadcast and shortwave. Black plastic cabinet with clear fluting in front. Serial No. 96186.

Nelson:

Bell "Colt" radio, red plastic case, size 11 in x 7 in. with

a square dial on the right hand side of the case. Three knobs under the dial. Serial No. 46415. Identifiable and valued at £9.

New Plymouth:

Philips 1953 model, portable radio, Model No. 645. Serial No. 32667. Cream plastic front and back, green leatherette over top and sides. Value £30.

Wellington:

Pacemaker portable, in cream plastic case, approximately 15 in. x 10 in. x 8 in. Serial No. 54751.

Missing Radios Recovered

Auckland:

H.M.V. radio, Serial No. 18007, reported stolen on 17th July, 1957.

12-volt "Air Ranger" car radio, reported stolen on 7th August, 1957.

Christchurch:

Portable radio, Japanese make, reported stolen on 1st July, 1957.

NEW PRODUCTS:

LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. For further particulars, contact Advertising Manager, R. & E., Box 6361, Wellington

Pencil Ribbon Microphone by Lustraphone

Based on the Lustraphone studio ribbon velocity microphone a new model VR64 has the firm's corrugated aluminium ribbon and ribbon clamping arrangement. Assembly is suspended internally by anti-vibration mountings and blast screens are used.



Lustraphone pencil ribbon microphone VR64, available in low or high impedance. Height 5 $\frac{7}{8}$ in., weight 12 oz.

The VR64 can be employed with most commercial equipment without pre-amplification. Frequency response is substantially maintained up to 14,000c/s.

Mounting is new type auto-swivel permitting positioning to within 30 degs. rearward from vertical. Height is 5 $\frac{7}{8}$ ins., diameter 1 $\frac{1}{4}$ in. Weight 12 oz. Finish, silver or gold hammer stove enamel with polished chrome swivel mounting.

Low and line impedance models have 20 ft. twin screened sheathed cable; high impedance model 9 ft. co-axial PVC sheathed cable.

Agents for Lustraphone Ltd. are Electronic Research Ltd., P.O. Box 375, New Plymouth.

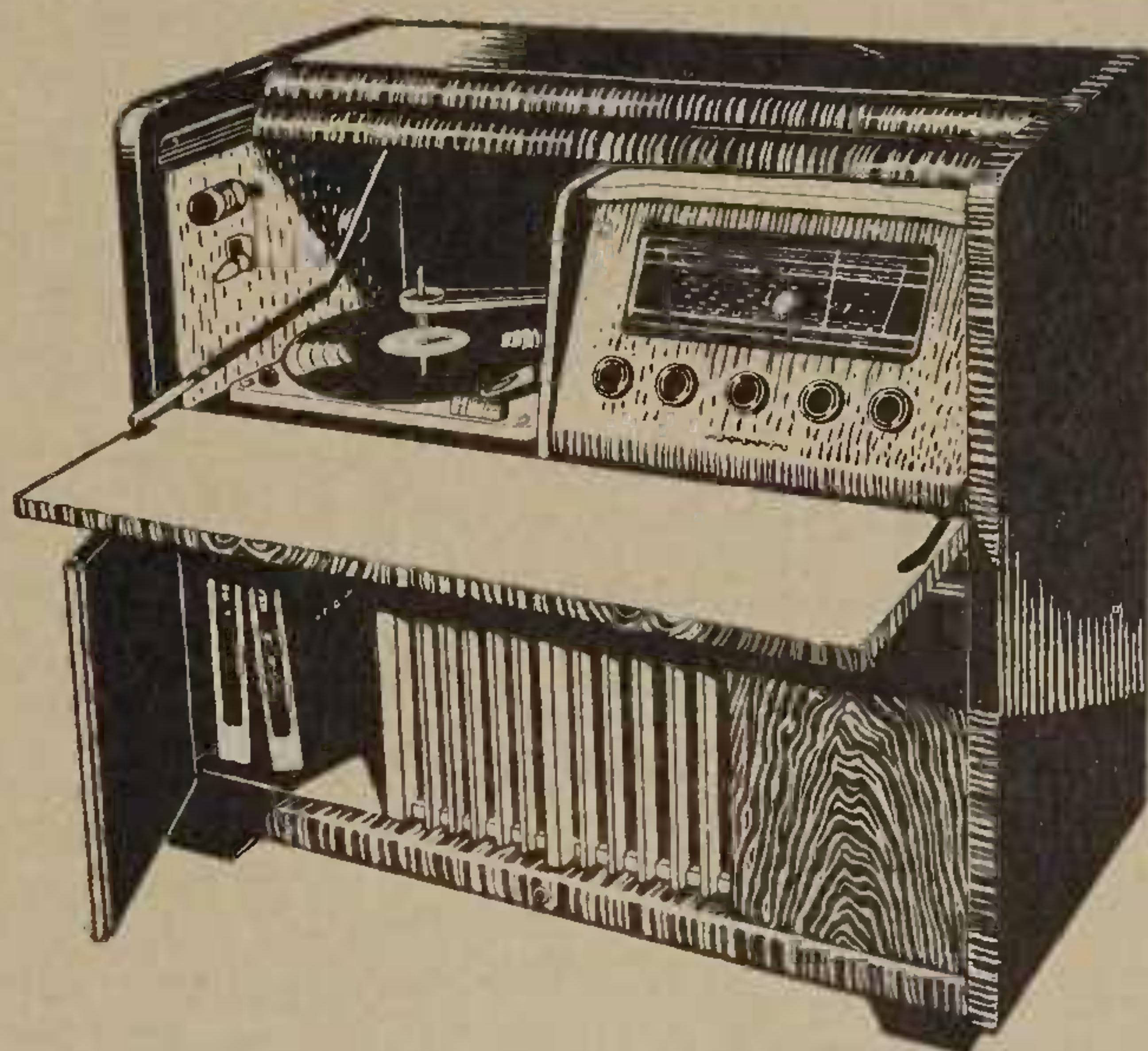
* * *

Three New Radiograms from Philips

October saw the introduction by Philips of three outstanding new radiograms. They are the "Festival Hall" Glide-o-Matic Gram with "Hi-Z", the "Grand Classique", and the "Copenhagen".

Philips "Festival Hall"

Another radiogram in the same class as Philips famous "Carnegie Hall", the new "Festival Hall" provides "Hi-Z" performance at a considerably lower price.



The Philips "Hi-Z" output stage which eliminates the need for loudspeaker transformers altogether and couples the power valve directly to special high-impedance loudspeakers results in extremely high-quality sound reproduction without distortion. As those who have heard the "Carnegie Hall" well know, "Hi-Z" is a really outstanding experience for the listener and, in fact, has been termed "The greatest development since high fidelity."

The "Festival Hall" is an 8-valve radiogram with Philips multi-purpose Noval valves giving performance equal to 12 valves. It provides world range reception with spread-band tuning on the 25 and 31 metre bands. There are three Philips high-impedance speakers directly coupled to the "Hi-Z" output stage, and extension speaker connections are provided for a high-impedance loudspeaker to be used.

As with all new Philips radiograms, the "Festival Hall" is fitted with sockets for plugging in a tape recorder. It is possible to record or reproduce from the tape, the radiogram amplifier giving much greater fidelity than most tape recorders.

Separate continuously variable tone controls are provided for bass and treble so that there is infinitely adjustable equalisation.

The record changer is Philips Maestro Golden Touch-o-Matic with two plug-in Piezo electric pick-up heads—one head with sapphire stylus for 78 r.p.m. discs, the other with diamond stylus for microgroove.

A 45 r.p.m. changer magazine spindle is supplied as standard equipment.

A feature which will appeal to the ladies is the patented Glide-o-Matic cabinet design, which means that the cabinet can be opened by means of a gentle push and closed again at a touch. There is no lid to lift, merely a sliding panel to be pushed gently forward to

actuate the door opening mechanism so that the record changer compartment and control panel of the receiver are brought into view.

Outside, the cabinet is beautifully finished in Italian-figured walnut veneer with carefully matched panels, while the interior is veneered in a warm blonde honey-gold finish. When the cabinet is closed no knobs or handles are visible, but a red indicator lamp is provided in the base so that it is possible to see when the set is operating even though the cabinet may enclose the lighted dial and record changer completely. Two large record storage cupboards have space for up to 150 records.

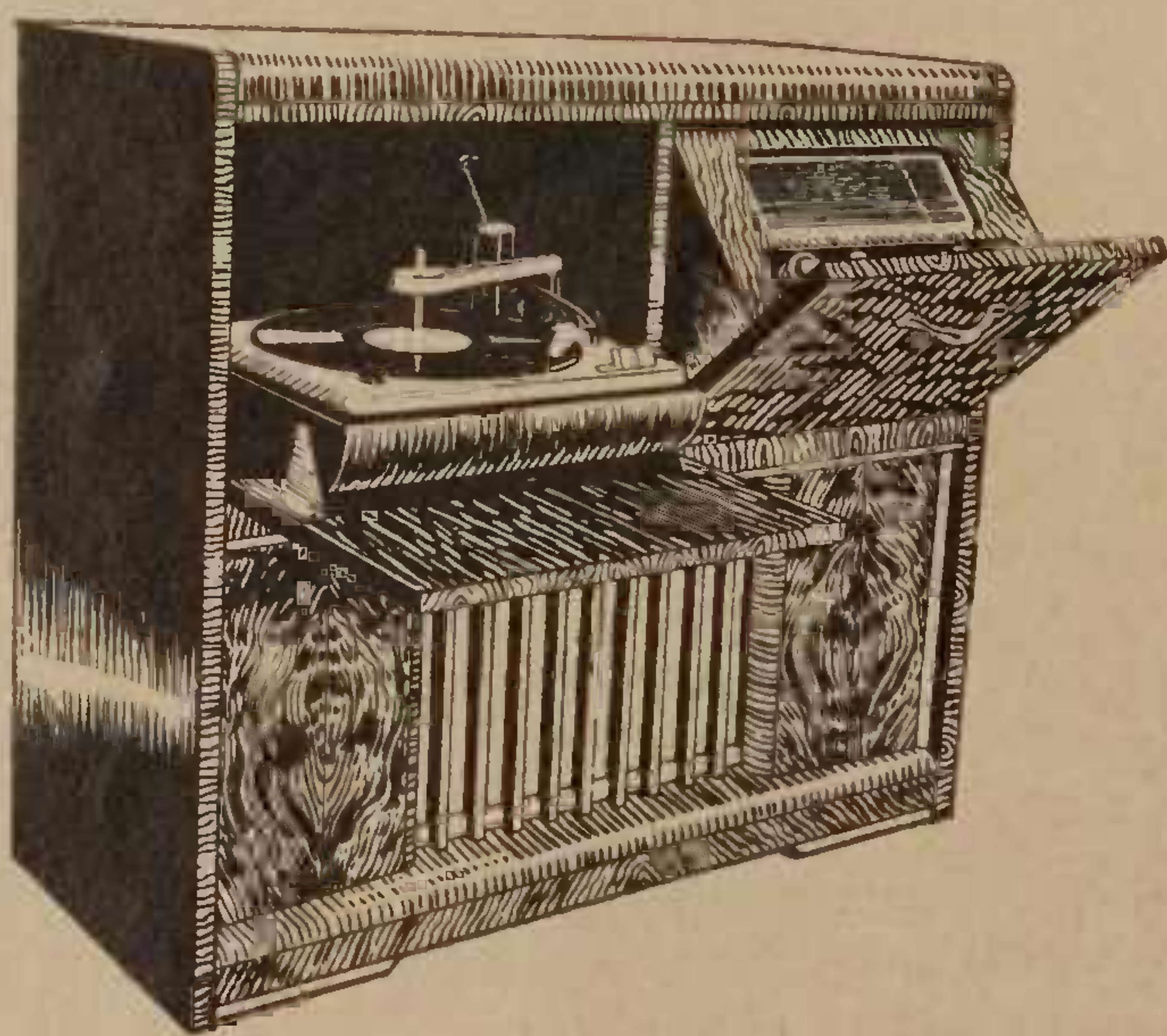
The "Festival Hall" is equipped with a built-in ferrite aerial rod which is insensitive to mains interference, provides good signal strength, and has a directional effect which reduces radiated interference. It is possible to rotate the aerial by means of a lever at the back of the cabinet so that the position of maximum sensitivity may be readily obtained. This is useful to improve the signal strength from a distant broadcast transmitter or to reduce interference from one particular direction.

The retail price of 155 gns. represents exceptional value for a radiogram of such outstanding "Hi-Z" performance.

The cabinet measures $34\frac{1}{2}$ in. wide, 32 in. high, and $16\frac{3}{4}$ in. deep.

* * *

Philips "Grand Classique"



Philips popular "Stockholm" radiogram in its contemporary Swedish-style cabinet has now been supplemented by an additional cabinet design housing the same chassis and record changer combination. This is the new Philips "Grand Classique", a classical design of tasteful dignity in high gloss florentine amber finish walnut veneer which will harmonise well with all traditional furniture.

There are two large record compartments, one on either side of the loudspeaker grille with ample space to store up to 150 records.

Ten-valve performance is obtained from 7 multi-function Philips Noval valves in this all-wave receiver with bandspread on the 25 and 31 metre bands.

Complete, one-knob tone control is provided with continuously variable treble compensation and a built-in bass switch. When the tone control is turned anti-clockwise as far as it will go, the reproduction has full bass and minimum treble. Turning clockwise increases the treble response while at the mid position the bass will be reduced without affecting the treble response. Turning the knob clockwise again reduces the treble until the reproduction has minimum treble and bass.

Philips "Grand Classique" is equipped with a built-in ferrite aerial rod for good signal strength without interference. Extension speaker terminals are provided, and you can plug in a tape recorder at the back of the cabinet either to record or reproduce from the tape through the radiogram amplifier with much greater fidelity than can be obtained from most tape recorders.

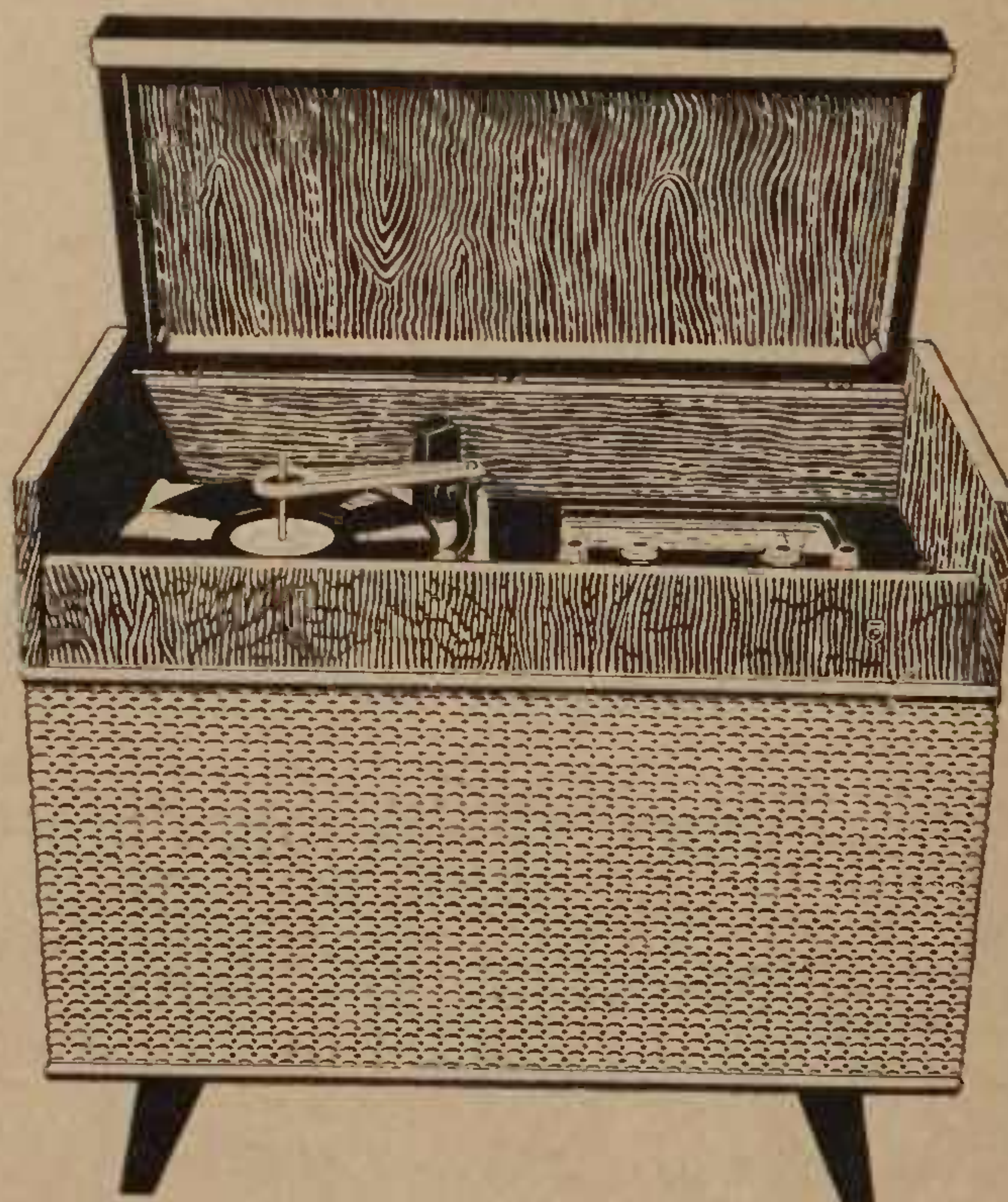
The Philips Maestro Golden Touch-o-Matic record changer, with two featherweight plug-in pick-up heads having replaceable sapphire styli, features completely automatic push-button operation.

Philips "Grand Classique" retails for 125 guineas—the same price as Philips "Stockholm" so that both versions may be offered in the same range for those who prefer either contemporary or traditional cabinet design in their homes.

Cabinet dimensions are: width $36\frac{1}{2}$ in., height $34\frac{1}{2}$ in., depth $16\frac{5}{8}$ in.

* * *

Philips "Copenhagen" Novosonic High-fidelity Radiogram



Extremely modern in appearance the new Philips contemporary radiogram, "Copenhagen" is of unique cabinet design incorporating free air space for four

loudspeakers with 360° sound dispersion. This Sonoramic cabinet with its free standing frontal baffle enables the wall of your livingroom to be used as an integral component of the acoustical design.

Its modern lowboy cabinet with full width lid provides access to the turntable, all controls and an easy accessible record storage compartment of the browser bin type. This is a great advantage for the quick selection of records. They are filed in an upright position in the bin, so that a choice can be made easily and quickly without removing other records.

Later on, Philips will bring out a tape deck to fit the browser bin compartment as an optional feature. Extension speaker connections are provided, of course,

and again it is possible to utilise a separate portable tape recorder for both recording and playback in conjunction with the radiogram amplifier. The Philips Maestro Golden Touch-o-Matic record changer is equipped with dual purpose Piezo electric plug-in pick-up head with twin sapphire styli for 78s and micro-groove.

Cabinet dimensions are 32 $\frac{3}{4}$ in wide, 30 $\frac{1}{4}$ in. high, 17 in. deep.

At the retail price of 95 guineas Philips "Copenhagen" is one of the most inexpensive quality radiograms on the New Zealand market.

Trade enquiries can be made to Philips Electrical Industries, N.Z. Ltd., P.O. Box 2097, Wellington.

TV ROUND THE GLOBE

New Aid to TV Advertising British Agency Installs Marconi Closed-circuit Television

A closed circuit television system for auditioning artistes and for direct viewing of packaging and films on a television screen has been installed by Marconi's for G. S. Royds Ltd., a leading British advertising agency.

The system, which uses the Marconi industrial vidicon camera, enables the telegenic qualities of a product and its packaging, as well as the artistes and action of a TV commercial, to be assessed in conditions identical with TV viewing in the home. Rehearsals and packaging can be viewed direct through the camera channel on a television screen, so that a producer can judge the qualities of a commercial before it is filmed.

The equipment can also be used for viewing the finished film on a TV screen, once again under home viewing conditions. A specially developed turn-table system enables "Double-head"* and "Married"† 35 mm films, 16 mm films, and slides to be shown over a closed circuit and viewed on the monitor screens. Previous to the development of this apparatus only a simulated effect of the visual of TV commercials could be obtained by means of back projection on a ground glass screen.

The closed circuit television system was designed and manufactured by Marconi's Wireless Telegraph Company Ltd. The camera channel consist of an industrial camera with 1 in. vidicon tube, and camera control unit. The equipment is arranged to operate on a 405-lines system, and uses three Bush 21 in. viewing monitors.

Marconi's also advised on the layout and lighting of the projection and viewing rooms which form part of the advertising agency's new premises at Royds

*"Double-head": Films in which the sound and visual are separate, and run independently but in synchronisation through the projector.

House, Mandeville Place, London, W.1., where the equipment has been installed.

John Beard, Head of Television at Royds, has commented:

"This Marconi equipment is, so far as we know, unique in the advertising business. There are some systems for telecasting artistes and packages, some for showing film . . . but none for doing both jobs through one circuit. We are particularly pleased with the versatility of the Marconi camera which has enabled us to set up the system."

Colour TV Tube Works After World Trip

A 21-inch RCA picture tube, which made a 25,310-mile journey around the world, has been installed in a colour TV demonstrator set and performs perfectly as a feature display at the RCA Exhibition Hall, New York City. The test was sponsored and directed by the Pressure Sensitive Tape Council of America in co-operation with American International Underwriters. The colour tube represented the heaviest, largest and most fragile of five packages selected to test the utility of self-adhering tapes for export shipping, under unusually rigorous conditions.

Travelling westward by ship via the Panama Canal from New York to San Francisco, Manila, Saigon, and Bangkok, the tube covered 15,560 miles and by air from Bangkok with stops at Karachi, Beirut, and London, back to New York, an additional distance of 9,750 miles.

Banks Install "Teller-Vision" Systems

Banking by "teller-vision"—a closed-circuit TV system developed by RCA for transmission of signatures and account information from centralized book-keeping departments to remote drive-in windows—is speeding depositor services at two banks in Florida and

†"Married": Film in which the sound and visual have been combined.

one in North Carolina. The "teller-vision" systems, built around RCA "TV Eye" closed-circuit TV camera chains, are in operation at the Pan American Bank of Miami, Coral Gables First National Bank, and Bank of Belmont, N.C.

* * *

Radio-TV Students Graduated

Two hundred and twenty-nine graduates received diplomas on May 16 from RCA Institutes, Inc., in New York City. Among the graduates who completed courses in radio, television, and electronics, were 131 veterans of the Armed Forces and students from Canada, South America, Israel, and Formosa. Dr E. E. David, engineer in charge of acoustics research, Bell Telephone Laboratories, Murray Hill, N.J., delivered the commencement address.

* * *

More Television Stations for Denmark

The Danish Posts and Telegraphs Department has ordered transmitting and aerial equipment from Marconi's for three new television stations which are shortly to be built at Aalborg, Vestjylland, and Naestved. The order includes monitoring and test equipment and flying spot glide scanning units.

The three new stations will have transmitting equipment consisting of a type BD.366, 4KW vision transmitter, and a type DB.317, 1KW sound transmitter, feeding into a sixteen stack quadrant aerial. The vision transmitters will operate to European 625 line standards and will be amplitude modulated, while frequency modulation will be employed by the sound transmitters. All three stations are designed to have an Effective Radiated Power of 60KW, but to conform to international agreement the Aalborg station will operate at a reduced power.

Both the 4KW vision and 1KW sound transmitters are of particular interest in that they are new designs representing a very important step forward in engineering practice. A considerable reduction has been made in the number of valves used and this has permitted a particularly clean, straightforward layout, and the incorporation of a simple, yet thoroughly effective cooling system. The cooling arrangements are such that the transmitter can be installed on any flat floor surface with installation time reduced to the minimum.

The need for under-floor ducting to carry the cooling air stream for the transmitters has been dispensed with by mounting the blowers inside the cubicles. Other important features include the unusual simplicity of operation and ease of routine maintenance procedure.

* * *

First TV for Peru with RCA Equipment

Radio America, one of South America's foremost radio stations, is now pioneering in TV for Peru. Antonio Umbert, president of the company operating Radio America, recently signed a contract in New

York for an RCA transmitter which will be the first to go on the air in Peru. The Government has assigned the first video licence to Radio America in Lima.

The broadcasting organization in Lima is acquiring an RCA 10KW transmitter with camera chain and complete studio equipment with provision for mobile operation. Radio America TV plans to be on the air in November, 1957.

Associated with Mr Umbert in the pioneering TV company are Nicanor González Vasquez and Avelino Aramburu Raygada. Mr Umbert says, "We are pleased to be an instrument of progress for our country. Peru, heart of one of the oldest civilizations in the world, is sure to bring new gifts to modern television. We are looking to television to hold us economically at home and to give the world new glimpses of the beauty and culture of our country."

RCA International Division demonstrated TV in Lima in April, 1955.

* * *

New RCA Victor TV Sets Unveiled

A completely new line of RCA Victor black-and-white television receivers, featuring what are described as "some of the most important styling and engineering innovations in television history," was announced on June 4 by Charles P. Baxter, vice-president, and general manager, RCA Victor Television Division.

Highlighting the new styling features are reduced cabinet depth in all models; picture tubes completely enclosed in the cabinet; a streamlined series of tapered portables; the first commercially acceptable corner cabinet sets; table models with swivels, and a wide choice of modern finishes. New performance features include improved tuners, 110-degree aluminized picture tubes in all 17-inch, 21-inch, and 24-inch (over-all diagonal) sets; "one touch" on-off controls, motor tuning, and remote control.

RCA Victor distributors and sales executives from the eastern seaboard, meeting in New York City, were given a preview of the new instrument, which was introduced to the public from coast to coast in July last. Similar advance showings were held for RCA Victor merchandisers in Chicago from June 6-8, and in San Francisco from June 9-11.

Mr Baxter said a new series of higher-priced RCA Victor colour television receivers were added to the current colour TV line in September last.

One new colour TV set—the Lockhaven, a deluxe console in mahogany or line oak grain finishes—was shown. It will be nationally advertised at \$695 and will be shipped to distributors in the next few weeks. This brings the number of colour sets in the current RCA Victor line to 11.

The new line of RCA Victor black-and-white receivers will include five basic portable models and 24

(Concluded on page 49.)

BOOK REVIEWS

"The Cathode Ray Oscilloscope"—Circuits and Practical Applications—by J. Czech. Published by the Philips Technical Library.

Over the years there have been published quite a number of books intended as introductions to the oscilloscope and its application. Most of these have been very elementary, and have confined themselves simply to stating the principles of the oscilloscope, and of the measurements and observations that can be made with it. Such books are often quite silent on the practical questions of what makes a good oscilloscope circuit, and why, and frequently assume that the user will automatically be using a commercially built instrument. Even if this is so, some explanation of the design features that are required and of how they are provided in practice, is extremely useful to the newcomer to oscilloscope techniques, even if it does no more than assist him in making an intelligent choice in purchasing an instrument.

This book helps a great deal to fill the gap mentioned. It has a great deal to say on the design requirements of practical instruments, and on practical circuits for making oscillographic measurements. It is liberally illustrated with sample oscillograms, which are excellently reproduced, clearly from very good instruments. Much emphasis is placed on the use of the 'scope in television work, and this feature should be of use to those in this country who are "genning up" on TV against the day when such knowledge will be required.

This reviewer can quite confidently say that this is one of the best books he has seen on this subject, and can confidently recommend it.

"L-C Oscillators", and "Resonant Circuits", two of the Rider publications in the "Electronic Technology" series, edited by Alexander Shure, Ph.D., Ed.D.

These small books are two of a series of short monographs on specific topics which will be found in any course of radio or electronics. They are clearly intended for students, and they can be quite well recommended to those who are attacking the subject on a non-mathematical basis—for example those who are sitting for such examinations as the Radio Servicemen's Examination, or the 1st Class P.M.G. of C.R.T. certificates. Taken together, these booklets form an excellent text book, each one being as it were a chapter. It is questionable, of course, whether one would not be better advised to invest in a single good text book covering the same topics. It is suggested, however, that where these booklets can find genuine usefulness is in supplementing text books. When one is struggling with a new subject, it frequently helps to read up any portion that is found difficult, in several texts. One writer's approach can frequently resolve a difficulty where another author has failed. Thus, these books can well

be used as an inexpensive answer to the problems of supplementary reading for students, and as such they are excellent.

* * *

PERSONALITY PARADE

Recent RCA visitors to New Zealand were Mr Rudi Tolnay, Managing Director of RCA of Australia Pty. Ltd., who was returning to Australia after a business visit to the United States, and Mr R. F. Cook, Manager, Manufacturing and Engineering Services of Radio Corporation of America. They were met at Paraparaumu airport by Mr W. L. Young, General Manager of Radio Corporation of New Zealand Limited, with whom RCA have an agreement covering pressing and distribution of their recordings in this market.

The nature of his position makes a globe-trotter of Mr Bob Cook. His technical knowledge covers a wide field in plant installation and works managing. Assignments may be the establishment of a valve making plant, as was recently the case in South America; the establishment of a record pressing plant or, perhaps, a radio manufacturing unit. Bob Cook can be considered a top-level trouble shooter in manufacturing problems. His comments regarding problems associated with manufacture in various parts of the world are most interesting. Asked if he had any observations on successful manufacturing techniques, Bob merely replied: "The answer is a simple one—evolve proper procedure based, if possible, on proven overseas experience and then strictly adhere to processes laid down."

On the social side the visitors found time to see something of our countryside and were particularly impressed with the scenery on the Rimutaka Hill and the Lake Ferry area. After the short stay in New Zealand Bob Cook went on to Australia and from there he goes to Europe prior to returning to the United States.

BACK NUMBERS OF "R. & E. R."

Back numbers are available from

S.O.S. Radio Ltd., 283 Queen Street, Auckland.

S.O.S. Radio Ltd., 1 Ward Street, Hamilton.

Webb's Radios Ltd., 11 Wellesley Street E., Auckland.

Tricity House Ltd., 209 Manchester Street, Christchurch.

Ken's Ltd., 142-144 Stuart Street, Dunedin.

Fear's Radio & Cycle Co. Ltd., 31 Willis St., Wellington.

The Radio Service Co., 83 Guyton Street, Wanganui.

Technical Book and Magazine Co., 295-299 Swanson Street, Melbourne, Australia.

ELECTRONIC HIGHLIGHTS FROM THE FARNBOROUGH AIR SHOW

Below are some of the highlights which were seen at the stands at Farnborough of members of the Radio Communication and Electronic Engineering Association and at the stands of some members of the Radio and Electronic Components Manufacturers' Federation.

British Thomson-Houston Co. Ltd.

Apart from a wide range of electrical equipment, including high-energy ignition units designed for gas turbine engines, this company is demonstrating for the first time a range of silicon rectifiers and reference diodes which are particularly interesting because of their ability to operate at high temperatures. The reference diodes can be used at temperatures up to 250° C; the rectifiers up to 200°.

A. C. Cossor Ltd.

A new primary surveillance radar, designed for the control of traffic at airports is shown in its mobile form. One of the major features of this equipment, known as the C.R.21, is its ability to "see" through rain and snow and to eliminate permanent echoes from mountains and buildings so that aircraft being watched are not "lost" on the screen.

The C.R.21 equipment has undergone extensive testing by the R.A.F. and orders have been obtained from Australia, New Zealand, and Southern Rhodesia.

In the exhibition hall, Cossor are showing their latest form of secondary radar transponders. These, apart from being able to identify an aircraft on the radar screen, enable the aircraft to be seen at considerably greater distances.

Decca Radar Ltd.

The integrated use of electronics in controlling dense air traffic is illustrated. A 15-minute "exercise", shows the movements of a large number of aircraft, with details of their identifications, height, track number, and even the aircraft call sign.

This control system gives not only a visual presentation of all the available radar information, but additional facts from non-radar sources. The whole comprehensive picture of the air situation is finally enlarged and projected on a screen, enabling it to be viewed by several controllers simultaneously.

Decca are also demonstrating their new doppler radar, an airborne navigation system which presents to the pilot position information either on meters, reading latitude and longitude, or in the form of a track drawn on a moving chart. Decca claim that this equipment, with a weight of only 100 lbs., is probably the most compact device of its type available.

Ekco Electronics Ltd.

Search radar that scans a sector of space ahead of an aircraft to give the pilot warning of turbulent cloud

formations at a distance of up to 120 miles is featured.

Three types of search radar are shown, as installed in the Bristol *Britannias*, the *Comet IV*, the Vickers *Vanguard*, and the *Boeing 707*. A feature of this radar is its ability to indicate the degree of turbulence in the cloud. Additionally, the equipment provides facilities of "painting" a map of the land lying ahead of the aircraft. The radar equipment is so stabilised that it can cope with 45° of roll by the aircraft in either direction and a wide range of pitch angles.

All outdoor exhibit by Ekco is the Airfield Approach Aid, providing talk-down facilities by combining a 3-cm radar unit with a VHF/DF receiver. The outstanding feature of this display is that it is "one-man" operated. It is sufficiently compact to be mounted on a vehicle.

Elliott Bros. (London) Ltd.

One of the main exhibits is a fully automatic integrated air data computer. This equipment provides, from measurements of pressures and temperature in the airstream, a centralised source of aerodynamic data for various services in an aircraft. It replaces the more usual arrangement whereby all instruments and services obtain their initial information individually. The air data computer results in economies of space and weight through the reduction of units and mechanical connections.

Elliotts are also showing a mock-up of an aircraft cockpit that shows the complexity of modern aircraft instrumentation. Operation of various controls in the make-believe cockpit cause the associated instruments to give appropriate readings.

One of the Elliott instruments is a fuel flowmeter which indicates the rate at which fuel is being consumed either by one engine or by all the engines in the aircraft.

The small components used in guided missiles which, as well as being miniaturised, have to be very robust to withstand the tremendous forces of acceleration imparted by rocket motors, are exemplified on the Elliott stand.

English Electric Co. Ltd.

The Controls and Electronics Division of the company is showing a memory drum and delay line components from their well-known Deuce electronic computer. There is also a photographic display of computer installations.

Ferranti Ltd.

Since 1949 the firm has been collaborating with Bristol Aircraft in the development of guided weapons for the air defence of Great Britain. The outcome is the "Bloodhound", a surface-to-air guided missile

(Concluded on page 48)

LATEST OVERSEAS DEVELOPMENTS

Third of the Three New Receivers from National Company

The NC109 is considered the lowest priced general coverage receiver available today with an exclusive "Microtome" crystal filter and separate product detector for CW and SSB reception. The NC109 also features new, modern styling.

Included is a big "S" meter, 4-band coverage (540 kc to 40 mc) voice, CW or SSB reception. The bandspread is calibrated for 10, 11, 15, 20, 40, and 80-meter amateur bands. An 11 in. indirectly-lighted lucite slide-rule dial, accessory socket for external adapters and other accessory devices, and 11 miniature tubes (including rectifier and voltage regulator) are among the receiver's other specifications. Housed in a two-tone metal cabinet, with chrome trim; measuring $16\frac{1}{16}$ in. wide by 10 in. high by $10\frac{7}{8}$ in. deep, weighing 35 lbs.

The NC109 is the third in a series of three new receivers introduced by National Company this year. The first was the NC66, a portable receiver; the second was the NC188, a quality "Amateur" receiver.

Complete details are available from National Company, Export Division, 89 Broad Street, New York 4, N.Y.

* * *

New Cossar Radar Tours Europe

A new British mobile high-power surveillance radar, produced by Cossar Radar & Electronics Limited, and known as C.R.21, has just left England for a demonstration tour of Scandinavia and Western Europe.

This is a medium range search radar, designed primarily for the control of air traffic at airports, landing grounds, or elsewhere, and can be used either in this mobile form or as a fixed installation. It sets a very high standard for reliability, and incorporates many new features, particularly its ability to "see" through rain and snow, and to eliminate unwanted permanent echoes from mountains and buildings so that aircraft being watched are not lost to sight among such obstructions.

The C.R.21 will first be shown in Stockholm, Oslo, and Copenhagen, and will then be on public exhibition at the International Air Show in Paris (Le Bourget) from 23th May to 2nd June. This will be followed by further demonstrations in Western Europe.

A prototype of this radar was on view at the Farnborough Air Display last year. Flight trials by the Royal Air Force have already been carried out, and a second equipment is starting on a demonstration tour in this country.

G.E.C.

Parts of Stardac, a large analogue computer which was first brought into being to solve the complex equations of guided missile flight are shown by the General Electric Company Ltd. The firm also shows radar test equipment that measures 300 different factors and gives immediate indication of any failure.

An experimental missile guidance receiver illustrates how by the use of transistors, printed wiring, and the casting sub-assemblies in plastics resin, complex equipment can be made small, light, and remarkably robust.

G.E.C. feature on their stand a working model of the deck-landing mirror sight, for which they have designed the special lighting equipment.

* * *

Semiconductors Limited to Build New Transistor Factory

Semiconductors Limited announce the construction of a specially-designed factory on the Cheney Manor Estate, Swindon, solely for the production of transistors. Special air-conditioning equipment will regulate temperature, humidity and dust concentration in the main production areas, to ensure that the manufactured transistors will be free from impurities which could reduce reliability or cause deviation from the designed electrical characteristics.

It is claimed that the Philco electro-chemical techniques to be used in manufacture give unusually close control of tolerances and permit automatic control and transfer methods enabling the production of high performance transistors of outstanding reliability at a reasonable cost.

Production at the new factory is expected to start during 1958 with the manufacture of the high frequency Surface Barrier and Micro-Alloy types of transistors for military and other specialist applications currently made by the Lansdale Tube Company, U.S.A. Transistors in this range provide useful amplifier service up to 40 Mc/s and can be employed for switching at rates in excess of 20 Mc/s.

Other types of transistors to be produced include silicon alloy versions for high frequency operation over a wide range of temperatures. Germanium Micro-Alloy diffused transistors will be available later in 1958, to provide switching at rates well above the limits of thermionic valves with amplification at 250 Mc/s or higher.

To enable the industry to develop equipment, incorporating these transistors, Semiconductors Limited is making sample quantities available from the U.S.A.



John Gray

JOHN GRAY'S RECORD PAGE

RECORD OF THE MONTH

Anna Russell's Guide to Concert Audiences. Anna Russell, with Eugene Rankin at the piano. Coronet KLP (12 inch LP).

RECORD OF THE MONTH

The First Lady of satire has been wowing audiences at the Edinburgh Festival, just a few weeks ago as I write this. It will not be many months before she arrives back in New Zealand, and she can be confidently expected to repeat and perhaps surpass her triumph of three years ago. Last time Anna Russell came, her records were certainly known but were hard to get: this time there is at least one freely available and there will doubtless be others. Everything on this "Guide to Concert Audiences" is familiar from her previous appearance, and the whole disc is a priceless sample of her hilarious art. It is hard to resist her "old music hall" song, "I'm Only a Faded Rose", her "La Danza" which quite outdoes Spike Jones, or her Spanish group, which deals so mercilessly with the "flamenco" school of contortionist singers. Nor is this all—there are still her "German" beer-drinking song and the mad "Habanera Hoedown" in which Bizet goes West in more ways than one. This is a disc which gives the best of Anna Russell. Like all her records it was done with a live audience, whose obvious enjoyment sets the seal on the whole proceedings, and the fact that we cannot see her hardly counts in the face of such vivid characterisation and perfect diction. I can imagine hardly any music lovers—or haters—who would not welcome this as an ideal Christmas present. We are all eagerly awaiting the newest record of all, on which she treats us, among other things, to her new Verdi opera, "Hamletto".

Mention of Christmas reminds us that the season of giving will soon be with us again, and the potential sales of records are even greater than

SEASONAL GIFTS

in former years. Apart from the relatively small group of buyers who know exactly what they want, the average person setting out to purchase a disc for husband, mother, or boy-friend is apt to become lost in a bewildering mass of material. I am glad to see that one or two firms have introduced the gift-coupon system, whereby you pay the price of whatever category of record you decide on, and receive a coupon which can be exchanged for any record of that price. All the lucky recipient does is go to the shop and surrender the coupon for the record of his or her choice. But for those who would still like to do their own choosing, here are a few suggestions culled from the most recent available lists. There's a new record by Stanley Holloway, for instance. This isn't a re-issue of some of his earlier numbers but a brand new disc made in New York where he has been scoring a tremendous success in "My Fair Lady" (no, I'm sorry you can't buy that officially, as yet, though considering that almost everybody who wants it has by fair means or foul con-

trived by now to get it. I give it as my personal opinion that those responsible for holding it up had better hurry and do something about releasing it, or they will miss the bus). But back to our Holloway, who contributes, on Coronet KLP 590, a whole galaxy of old-time numbers which will revive many happy memories for the older folk.

There is, for example, a full-length version of "Sweeny Todd the Barber" which I cannot recall having heard before, and many other old songs of the "Any old Iron" and "Let's All Go Down the Strand" type. Above all is the sincerity and enjoyment of the whole thing, and it's good to hear how a veteran like Holloway, with years of training in the real live theatre, can hold his own with all to today's products of the microphone and the echo chamber. Harry Belafonte is one of the more likeable of the artists thrown up by the recent and short-lived "calypso" craze,

BELAFONTE SINGS OF THE CARIBBEAN

mainly because his appeal is not confined to narrow limits. No one would say he has a great voice, but he has a most engaging manner and a flair for putting across those whimsical numbers which make up the greater part of his repertoire. He is also one of the comparatively small group of popular singers who can sustain interest throughout a whole 12-inch LP record. His first scooped the pool in the most engaging manner; his second, strikingly covered and simply entitled "Belafonte Sings of the Caribbean", has appeared as RCA LPM 1505. The inclusion of "Island in the Sun" is a pleasant tie-in with Belafonte's current film success, and your feet could easily be set tapping by "Angelique-O" and "Lucy's Door." A local pressing, by the way, and a fine job of work, too. I find a considerable prejudice against New Zealand LP pressings, especially in the dearer categories. All such processes go through a "teething" period, and it is only fair to say that by and large, the locally pressed discs being offered at present have reached a standard quite comparable with that being achieved elsewhere. Cover design has been a less happy matter due to the different material used in this country, and doubtless the local producers will be giving this matter their earnest attention, for (let's face it) more records, especially those purchased as Christmas or birthday presents, are sold on account of their covers than many people would imagine, fantastic as it may seem. We are only human, and who, buying a record as a present for some near relative or friend, would ever hesitate between a sparkling, shiny cover and a dull, imperfectly processed one? I am speaking, of course, of those who just "want a record" and are not particular as to the exact contents or performers.

One by one a series of interesting recordings from Broadway musical comedies is making its appearance, and after so many years of nothing but "Student Prince" and "Desert Song" we are being offered recorded versions of shows which for long have been

SONGS FROM THE SHOWS

"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 19th OCTOBER

Title	Artist	Position last week	Record Make
1 Diana	Paul Anka	1	Columbia
2 Let's Have a Party	Elvis Presley	5	R.C.A.
3 That'll Be the Day	Crickets	3	Coral
4 Tammy	Debbie Reynolds	2	Coral
5 Love Letters in the Sand	Pat Boone	4	London
6 Island in the Sun	Harry Belafonte	6	R.C.A.
7 Wanderin' Eyes	Charlie Gracie	11	London
8 Teddy Bear	Elvis Presley	13	R.C.A.
9 Remember, You're Mine	Pat Boone	9	London
10 Whole Lotta Shakin' Goin' On	Jerry Lee Lewis	16	London
11 With All My Heart	Petula Clark	8	Nixa
12 Man on Fire/Wandering Eyes	Frankie Vaughan	12	Philips
13 Water Water/Handful of Songs	Tommy Steele	10	Decca
14 Last Train to Fernando	Johnny Duncan	7	Columbia
15 My Dixie Darlin'	Lonnie Donegan	15	Nixa
16 All Shook Up	Elvis Presley	14	R.C.A.
17 Call Rosie on the Phone	Guy Mitchell	20	Coronet
18 Be My Girl	Jim Dale	—	Parlaphone
19 Paralysed	Elvis Presley	17	R.C.A.
20 Stardust	Billy Ward	—	London

merely names, if that. Coronet recently began a Rodgers and Hart series, and now Festival have stolen a march on this with the release of the original Broadway version of "On your Toes" (FR12-1515). Quite a long time ago this was made into a film, starring Vera Zorina, and may be remembered as having featured that once popular ballet sequence, "Slaughter on Tenth Avenue", which is not so often heard nowadays. It is hard to realise that this sophisticated, modern-sounding show is all of twenty years old. Vera Zorina heads the recorded cast, and the chorus and orchestra are in the good hands of Salvatore dell Isola, who, years later, was to direct the original "South Pacific" recording. For those who appreciate something even more modern in style we can recommend Sarah Vaughan's "Great Songs from Hit Shows", on two Mercurys (Set MGP 2-100). The singer is backed by Harold Mooney's orchestra playing the conductor's own arrangements, and the selection of items is not nearly so hackneyed as one might imagine, in fact such scores as "Heads Up", "Finian's Rainbow", "Miss Liberty", and "Flahooley" are almost completely unknown in this part of the world.

When it comes to films there is the usual crop of 12-inch LPs featuring the background music from this masterpiece or other, and some of these lengthy soundtrack efforts are little more than a bore, even to those who have seen the film in question. What has undoubtedly sold better than any of them is a little 45 EP called "Debbie sings Tammy" (Coral CXP45-1528)—not only because this is one of the nicest tunes thrown up by the cinema screen of late, but because the singing of it has a sort of artless simplicity which cannot fail to appeal to the most hard-boiled of listeners. The other items on this disc are equally enjoyable,

High on the list of oddments comes Sophie Tucker's latest, which is called "Bigger and Better than Ever" (Mercury MPL 6513). Most

MISCELLANEOUS ENTERTAINMENT of our readers are well aware that Sophie has only one theme, at which she pounds away with unflinching gusto, but she is so completely uninhibited about it that only the most prudish could possibly take offence. Ted Shapiro's Orchestra is in support as usual. It is more soothing to turn to Deanna Durbin, whose youthful freshness meant so much in the years immediately preceding the war, and some of the best numbers she sang in those old films have been transferred to a Festival LP (FR10-1182). Also in the "Melody" category is Tony Martin's latest, "A Stroll through Melody Lane" (FR 12-1305). David Rose and Victor Young contribute the orchestral backgrounds to this and the titles are of old favourites such as "Cuban Love Song" which are not so well represented on modern discs as old-timers would prefer.

A sure seller is contained in the latest Minneapolis Symphony Orchestra disc from Mercury—Stravinsky's complete ballet of "Petrouchka", which is given a great performance under Antal Dorati on MG 50058. Ever since the dawn of LP the Decca version

CLASSICS IN HI-FI under Ernest Ansermet has been regarded as the standard recording, but techniques have advanced since 1950 and the new one has the edge over the old. Everything sounds clearer and sharper in detail and it's particularly good to see—or rather hear—that the engineers are able to give us a genuine piannissimo when called for. Dorati stands almost supreme among the internationally known con-

(Continued on page 49)

FARNBOROUGH AIR SHOW*(From page 44.)*

which, together with early warning from long-range tactical radar stations, forms a complete defence system.

"It is now," say the company, "the mainstay of Britain's air defence."

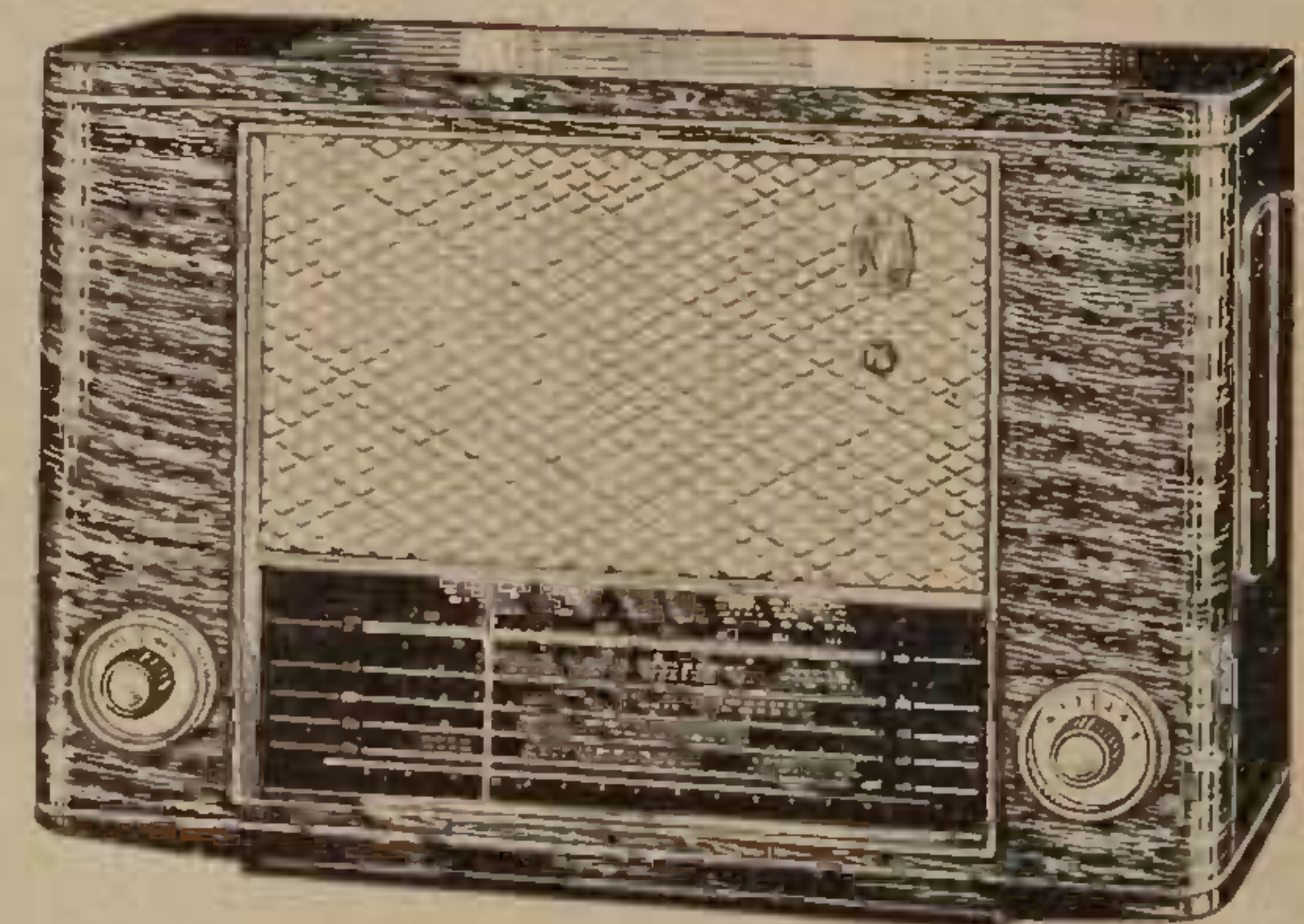
Ferranti have been responsible for the design and production of the intricate radar and electronic equipment which guide and control "Bloodhound", and the main feature of their display is a model demonstration of the missile chasing a moving target. Several of the components used in the control system are also shown.

Printed circuits are used in the missile equipment and Ferranti point out that these are suitable for a wide range of commercial applications, such as computers, radio, and television.

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UP-RATING OF OC72*(From page 20.)*

provide a transistor substantially better than the OC72 ratings now introduced. In the meantime, the OC72 should be used to obtain the performance now specified for the original OC76.

PYE MODEL 203

In last month's "New Products" page, we were unable to show an illustration of the Pye Model 203. The block has since arrived, and we have pleasure in printing it above.

The Model 203 is a high-class mantel set with several features usually found only in consoles. It is distributed by Messrs Pye Limited, P.O. Box 2839, Auckland, and 148 Tory Street, Wellington.

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JOHN GREY'S RECORD PAGE

ductors as an interpreter of ballet music. Completely a virtuoso piece of work, also, in his direction of "Swan Lake" (Mercury OL 3-102) which I have at last managed to hear, by the simple expedient of having it imported from England, at about half the price demanded here for the "De Luxe" edition. The three discs contain a considerable amount of material we have not heard before, and the sequence is in some cases quite different from that used in other versions. Some of Dorati's tempi, too, strike me as being beyond the leg-power of any dancer living, but what a wealth of melody, orchestration, and sheer brilliance is to be found in these three magnificently recorded discs. In fact it is so good that some people might well consider it worth the preposterous price to which it is scaled in New Zealand.

For those who prefer the tried and true classics, there is a wealth of new versions from which to choose. Two

ON THE BEATEN TRACK

Mozart piano concertos, for instance, are stylishly done by Ralph Kirkpatrick and an orchestra under Geraint Jones (HMV ALP 1454)—they are the dramatic C minor K 491 and the much less frequently heard F major, K 413. Max Rostal and Colin Horsley have made two very acceptable discs of Schubert's violin music; none of it very great but all of it enjoyable, and perhaps the first disc (CLP 1112) which includes the very beautiful and large scale Fantasia in C major, would be the better of the two, for those who want only one. Bela Siki, the fine and sensitive pianist who visited us here some years ago, has a well-made disc of Schubert's piano music on Columbia 33CX 1445—the little A major sonata and the Impromptus of opus 142. Music of the same school, but more rich and passionate, is contained in the second and third violin sonatas of Brahms, vigorously dealt with by Ruggero Ricci and Julius Katchen on Decca LXT 5270.

All the above will give varying degrees of satisfaction, but for the average music lover there is nothing quite so satisfying as a full blooded orchestral record. Everything from Beethoven symphonies to the most obscure modern works seems to be available nowadays. There is, for example, a welcome new version of Elgar's second symphony, lovingly played by the Halle Orchestra under Sir John Barbirolli (HMV ALP 1242), and one of the lesser known of Schumann's symphonies, the second in C major, is given a most powerful performance by the Israel Philharmonic Orchestra under Paul Kletzki on Columbia 33CX 1449. Room has been found, also, for a short and less frequently played work of Schumann's, the Overture Scherzo and Finale. This disc is one of the complete series of Schumann symphonies being made by the Israel orchestra. It is good to welcome back Sir Eugene Goossens, who begins a new series of records with the Philharmonic Orchestra on HMV. The first of these (ALP 1470) revives Scriabin's rather weird but quite listenable "Poem of Ecstasy", a composition which caused a sensation in the musical world of almost half a century ago. This voluptuous composition, by a man whose very name has almost sunk into obscurity, is well worth an occasional hearing and is set forth in an unusually rich recording. On the reverse we have the familiar shortened form of the Albeniz "Iberia" suite, as orchestrated by Arbos—which will be acceptable to those not wishing to invest in the full-length version, recently done by Eugene Ormandy and the Philadelphia Orchestra in a Coronet album of two records.

Finally, a de luxe package for wealthy buyers; all the Brahms symphonies, superbly played by the Philharmonic Symphony Orchestra of New York under the venerable Bruno Walter, and handsomely packaged in an album of four Coronet records (KLC 553-6). In addition, the discs contain the Academic Festival Overture and a short group of Hungarian Dances. It is worth pointing out, by the way, that any of the discs may be purchased separately,

but the whole album would be a wonderful gift for the right person. Of the older conductors still active, Bruno Walter must now be unrivalled as an interpreter of Brahms's symphonic music.

* * *

TV ROUND THE GLOBE

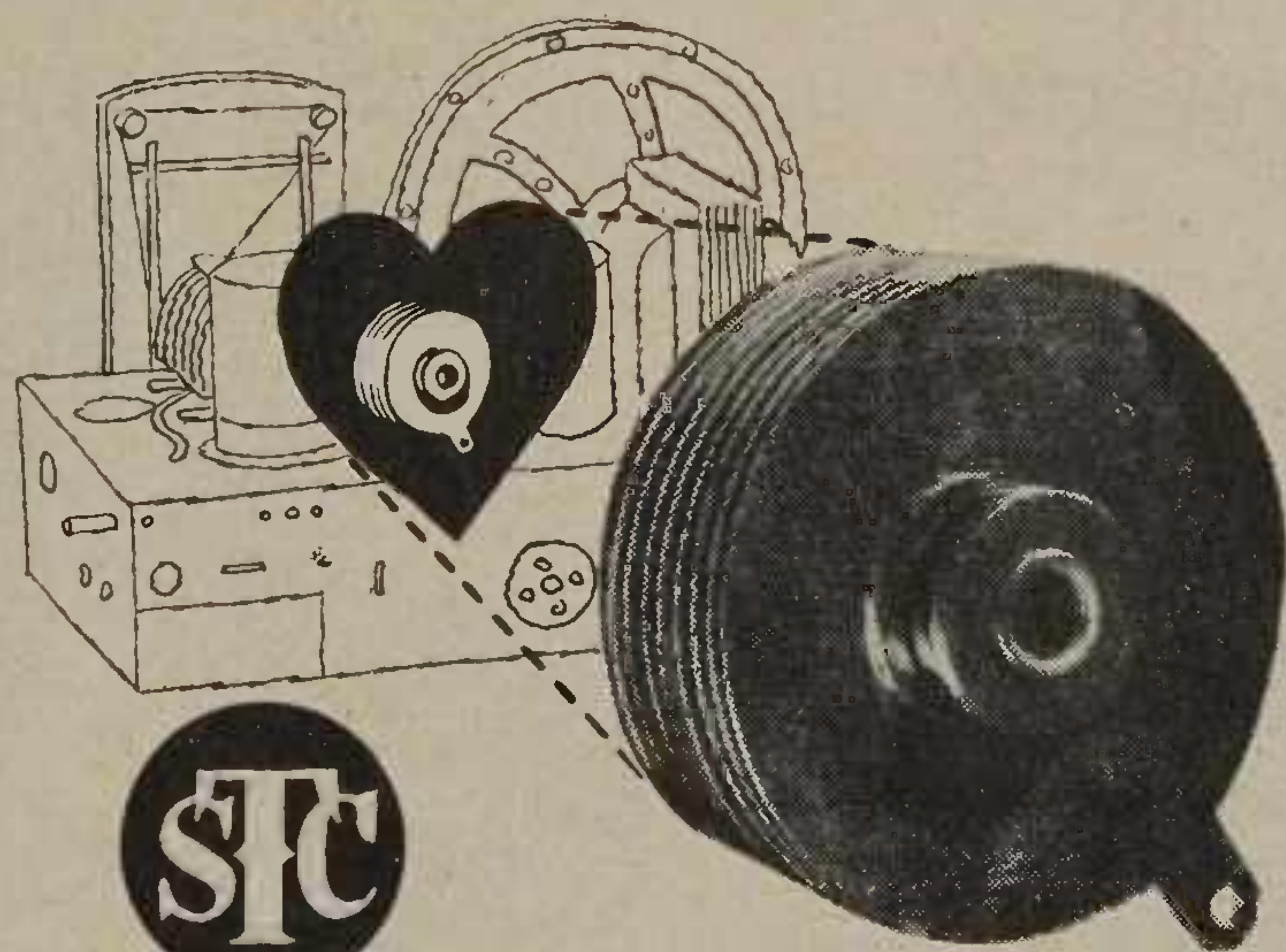
(From page 42.)

basic table and console models. Tentative nationally advertised prices will range from \$129.95 to \$395.

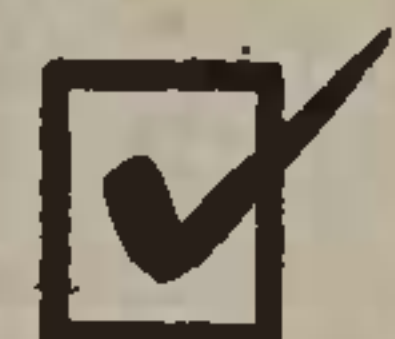
Pointing out that the nationally advertised prices of some models are slightly higher than last year, Mr Baxter said:

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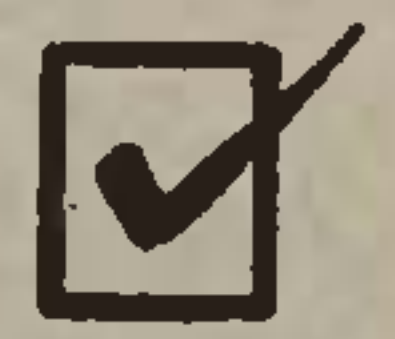
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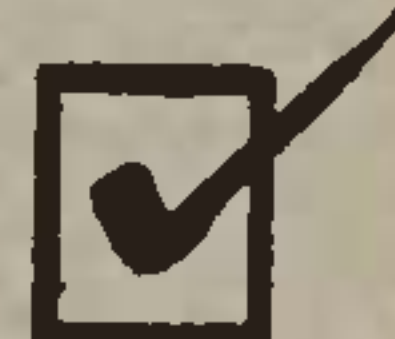
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(To be continued)

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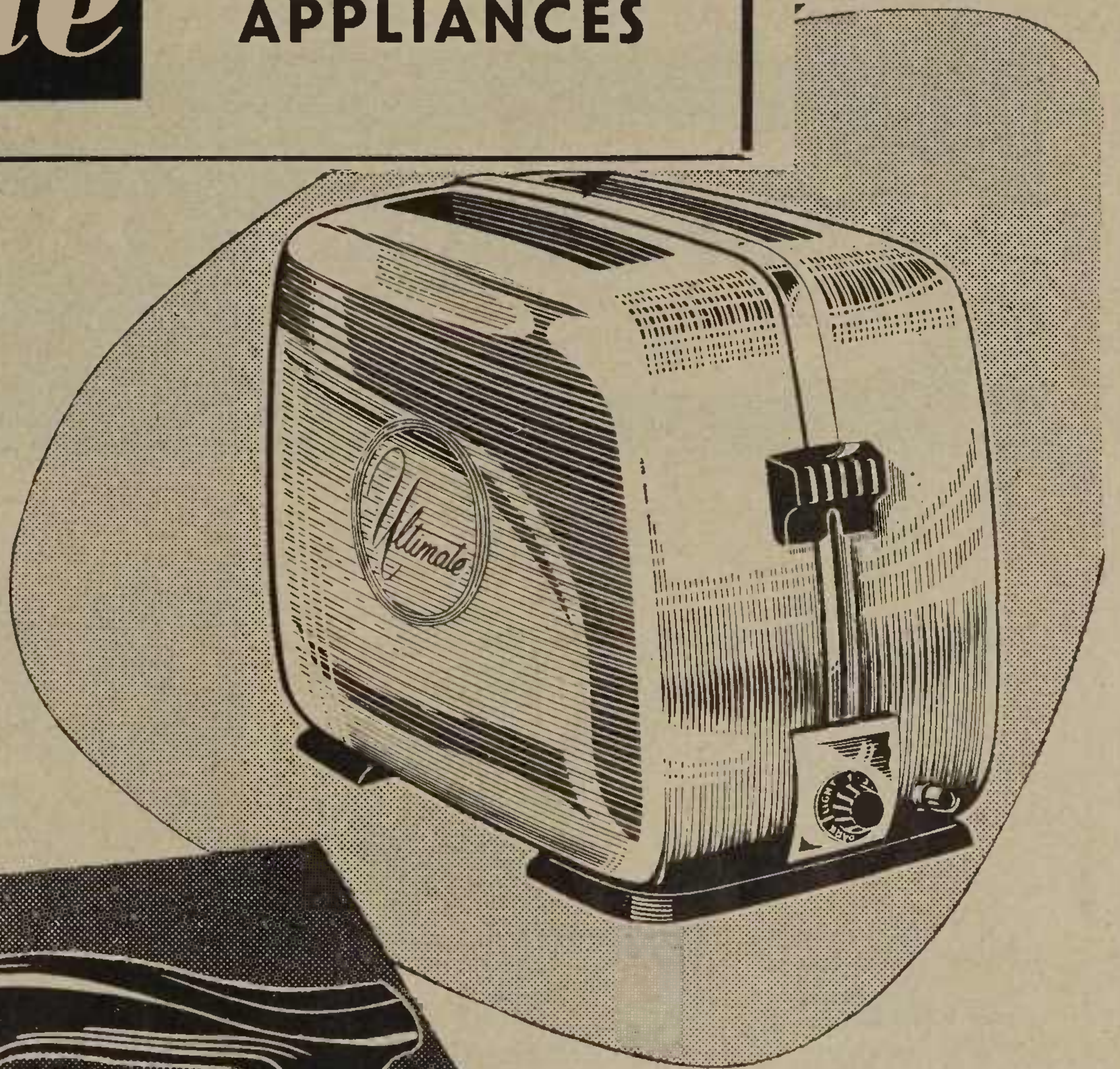
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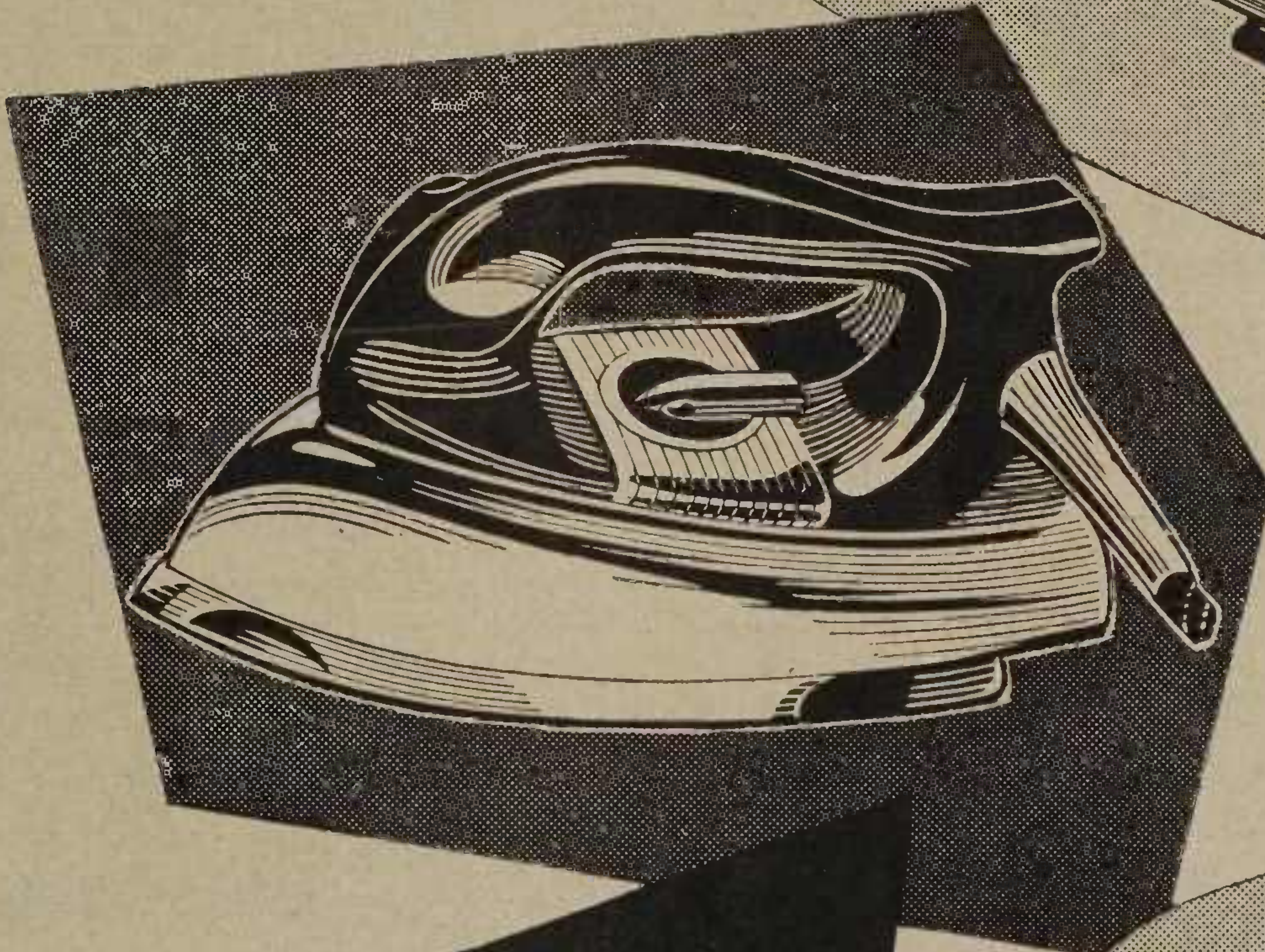
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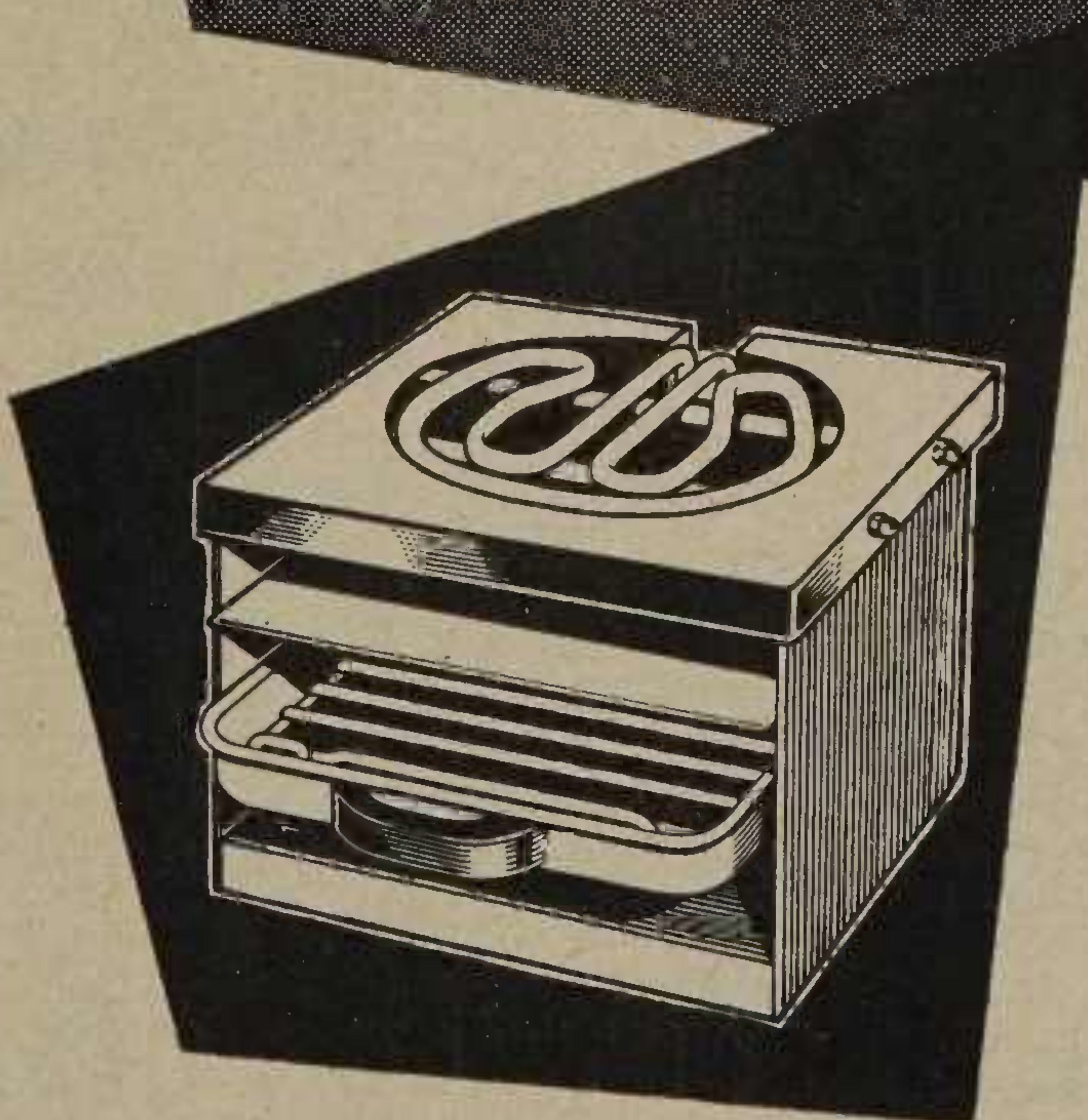


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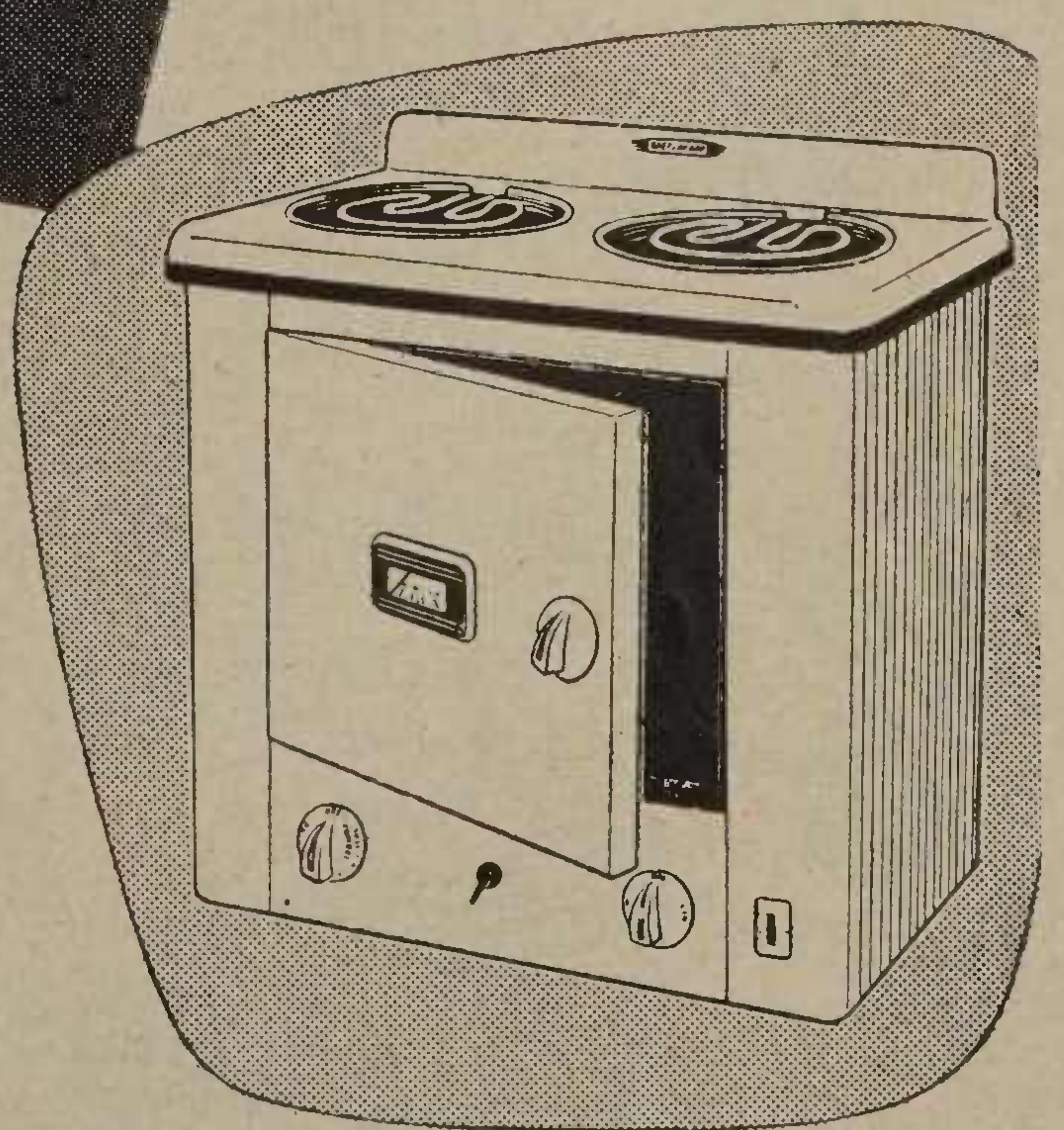


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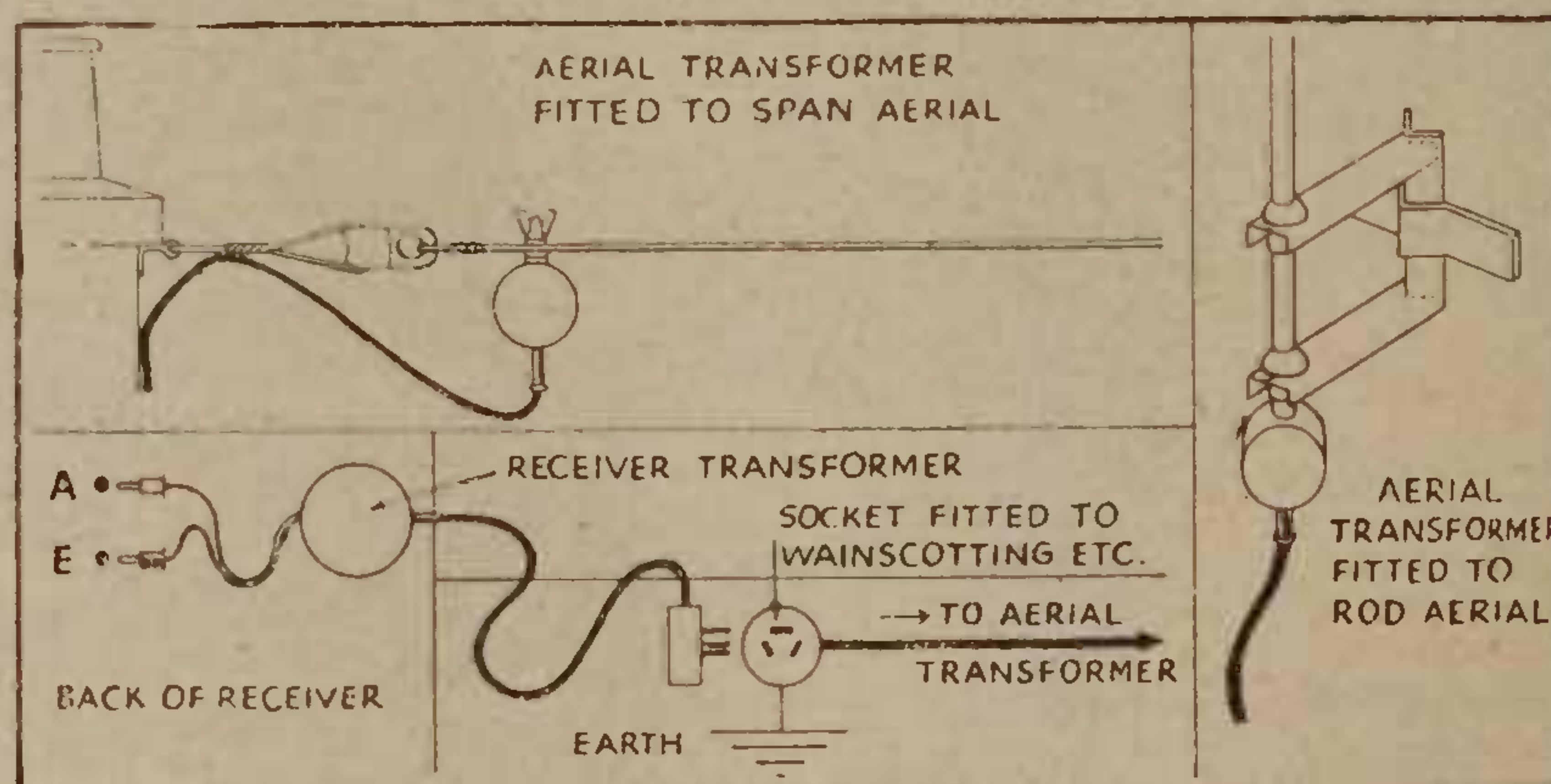
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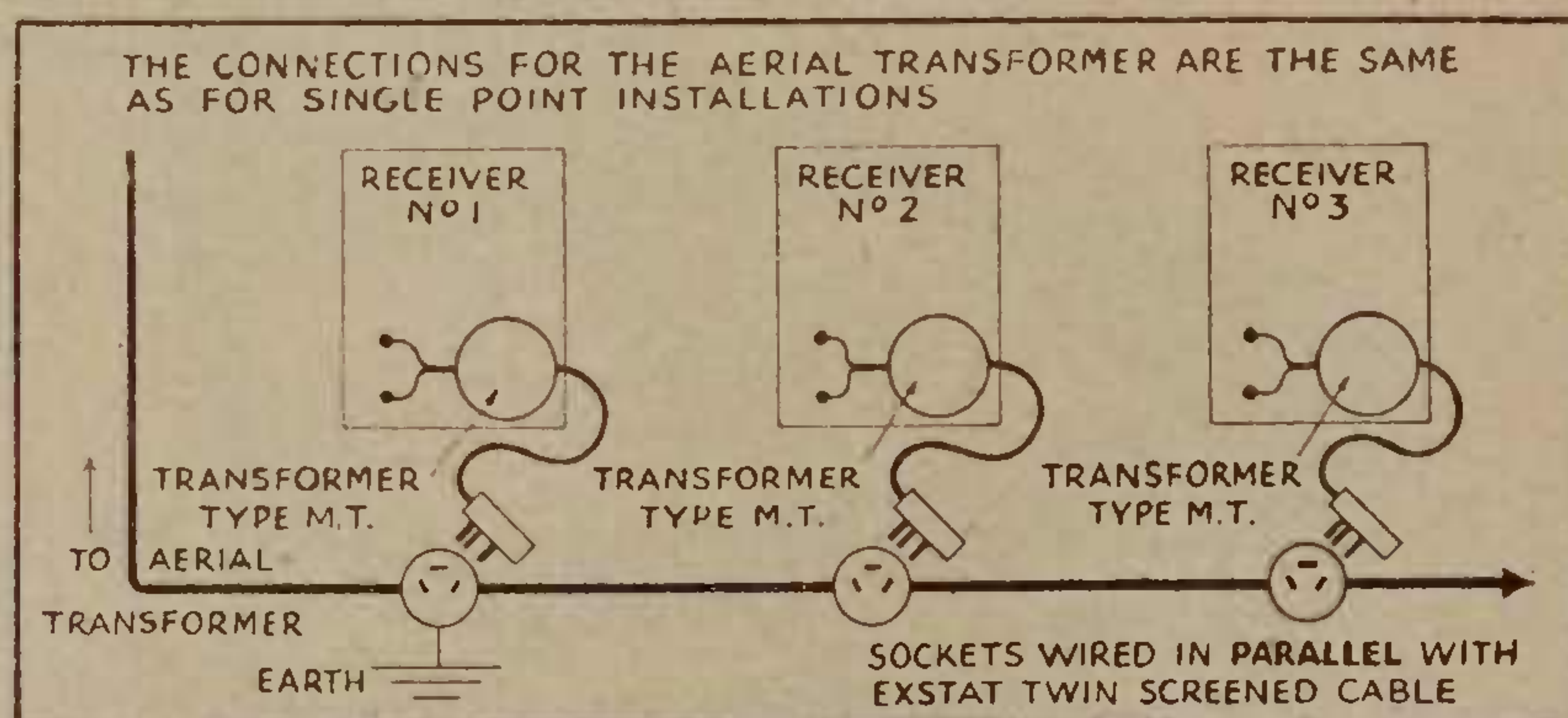
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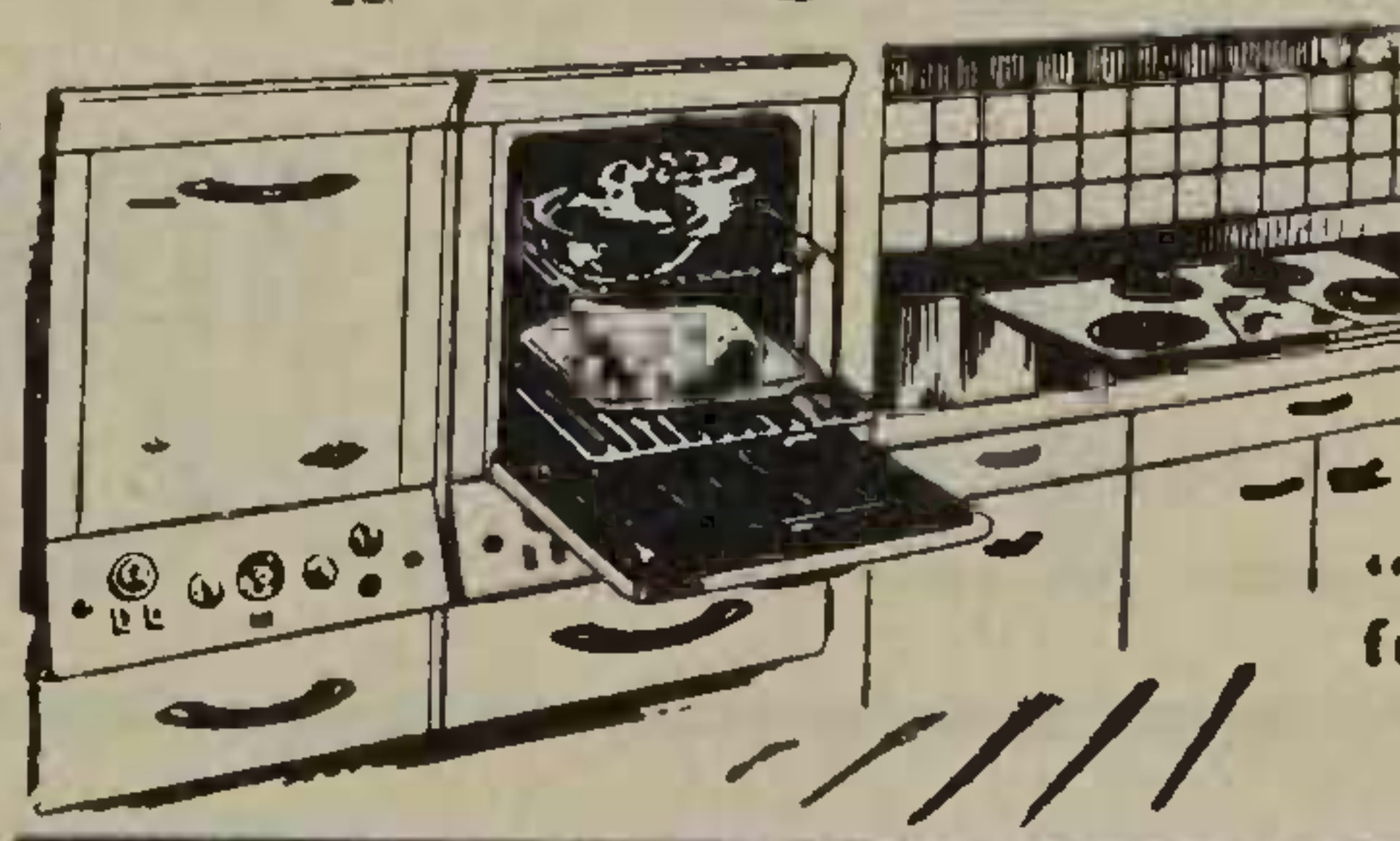


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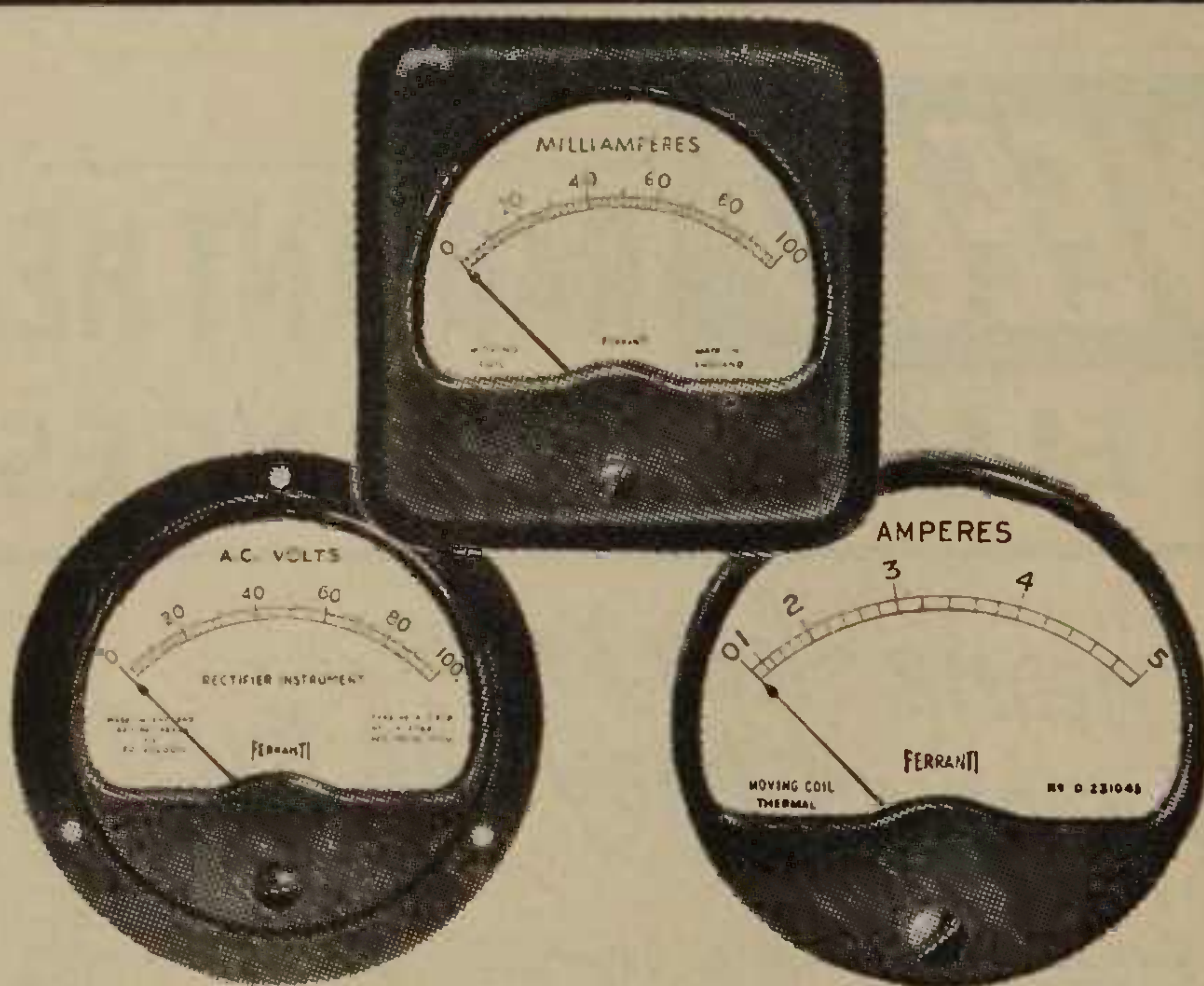
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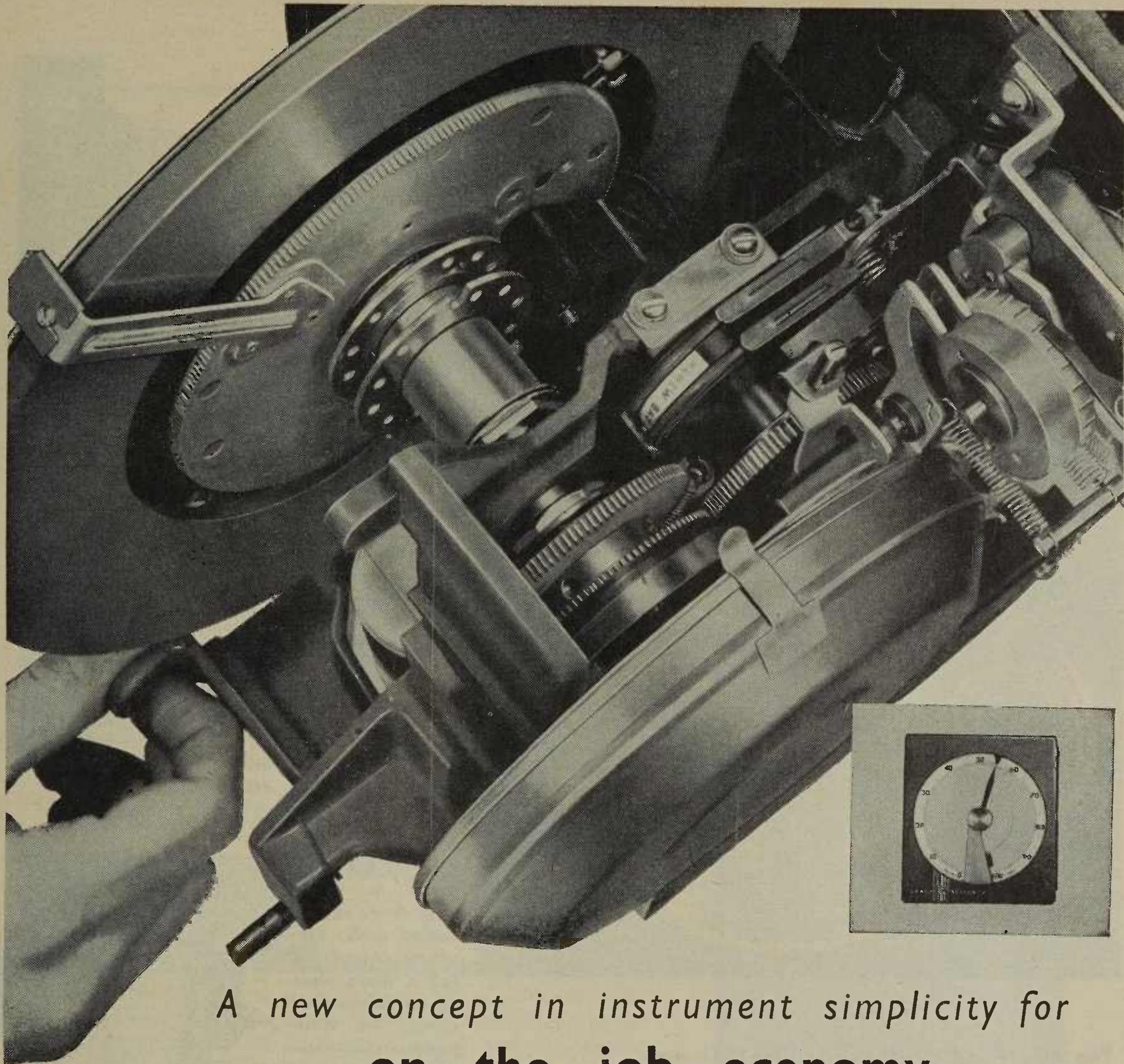
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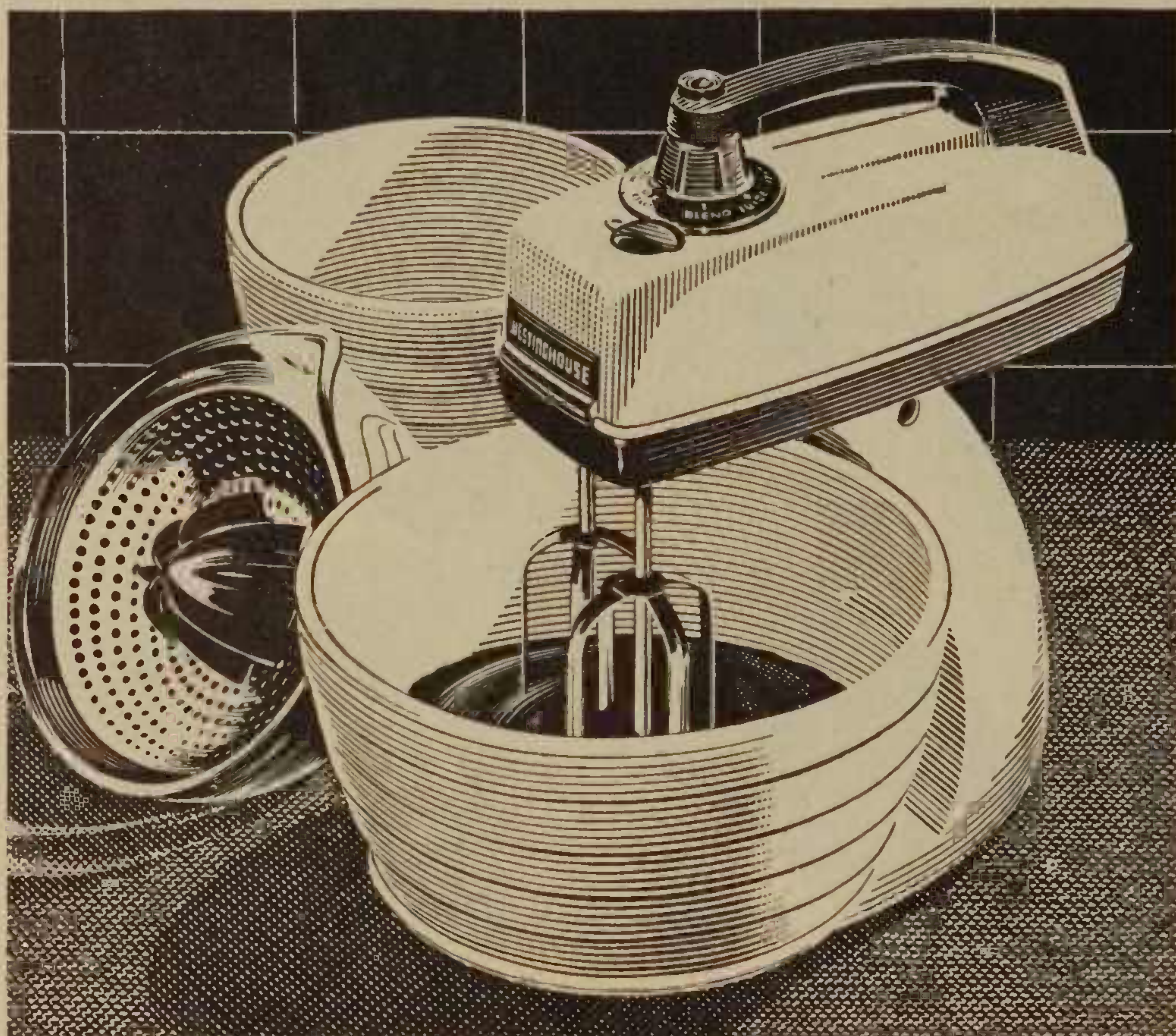
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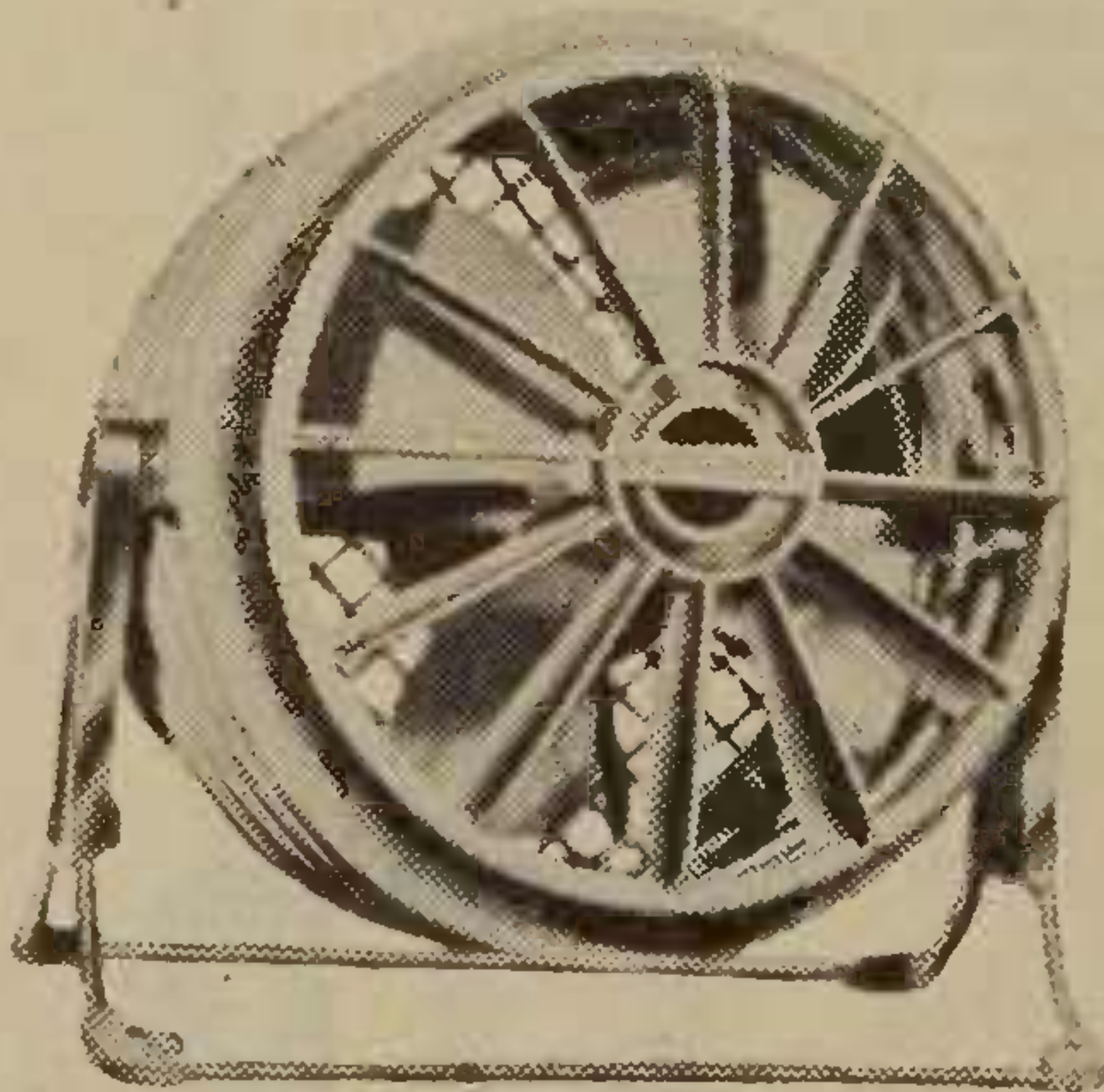
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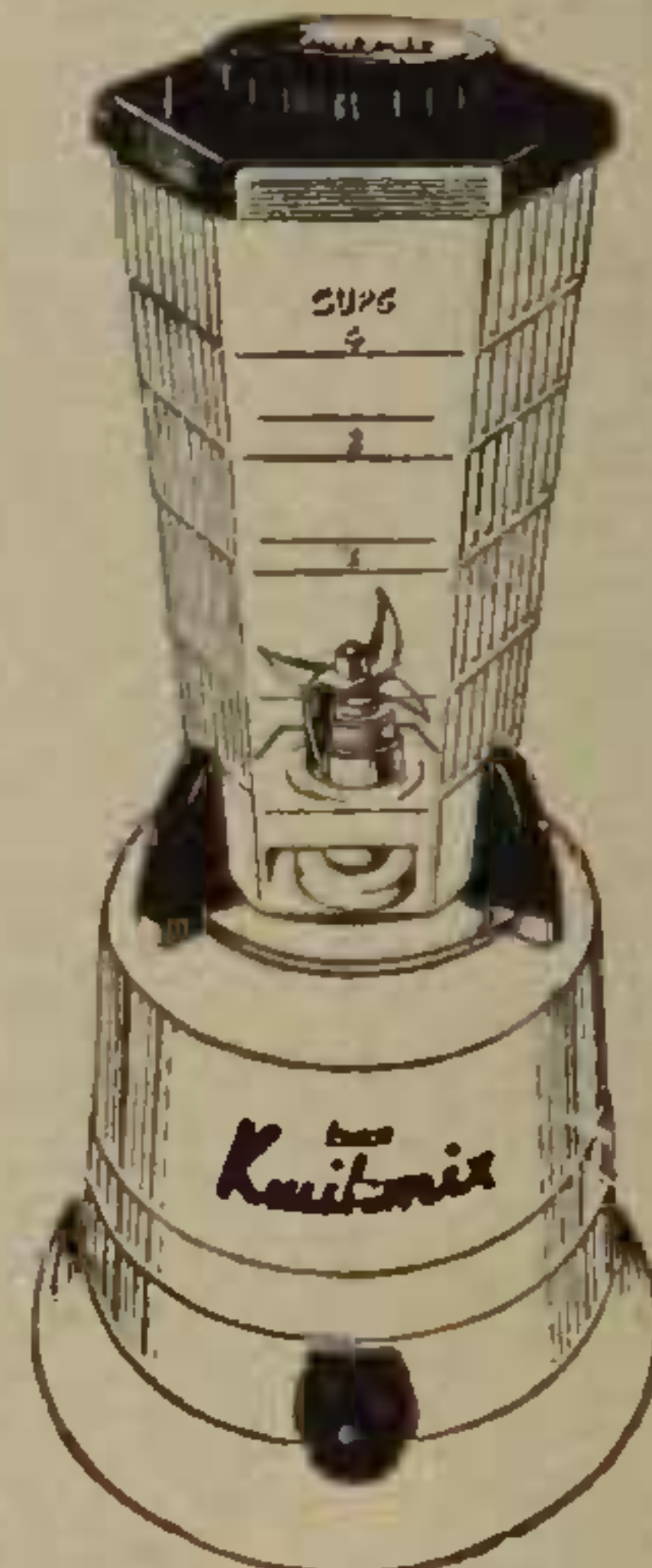


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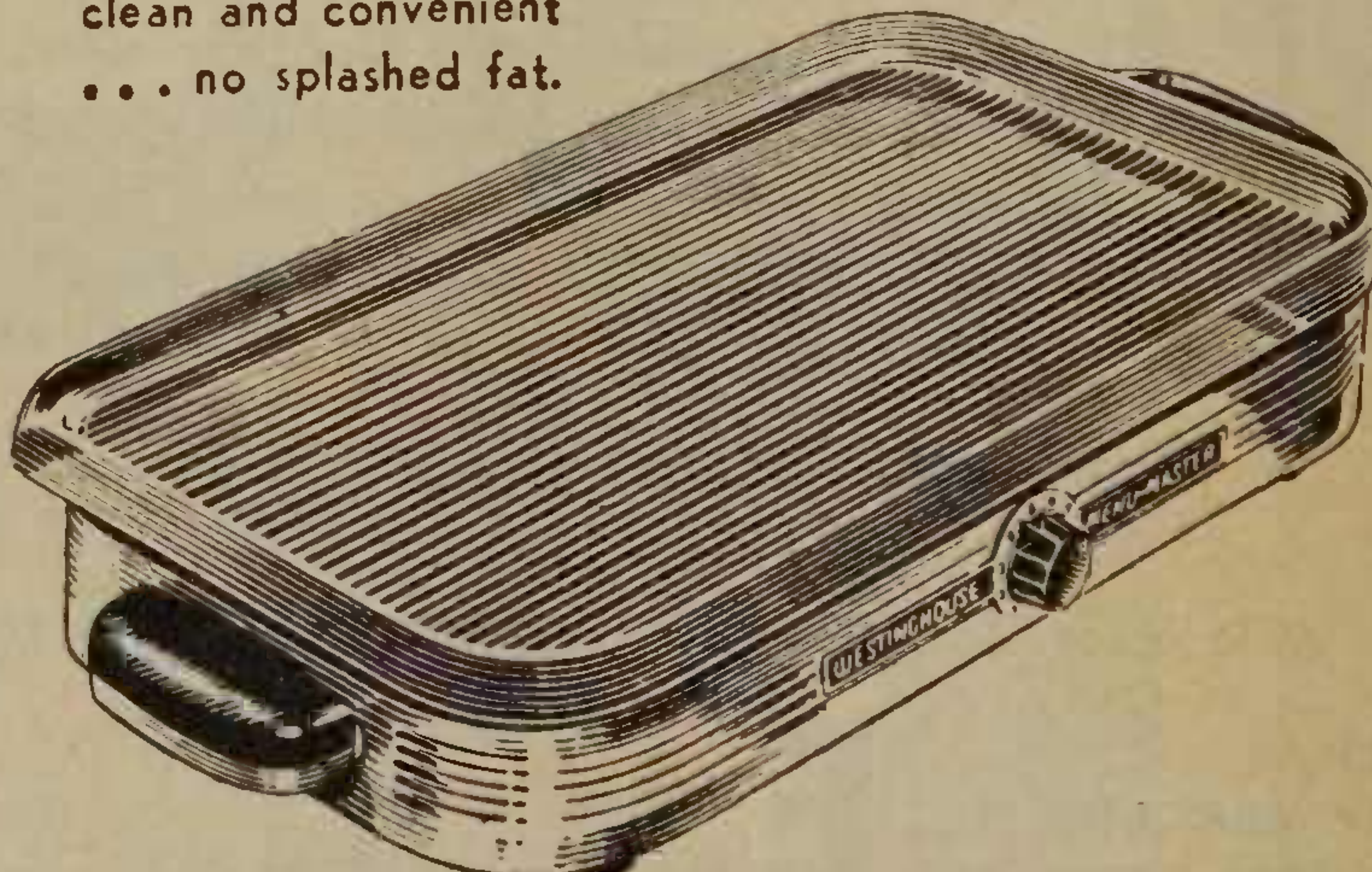
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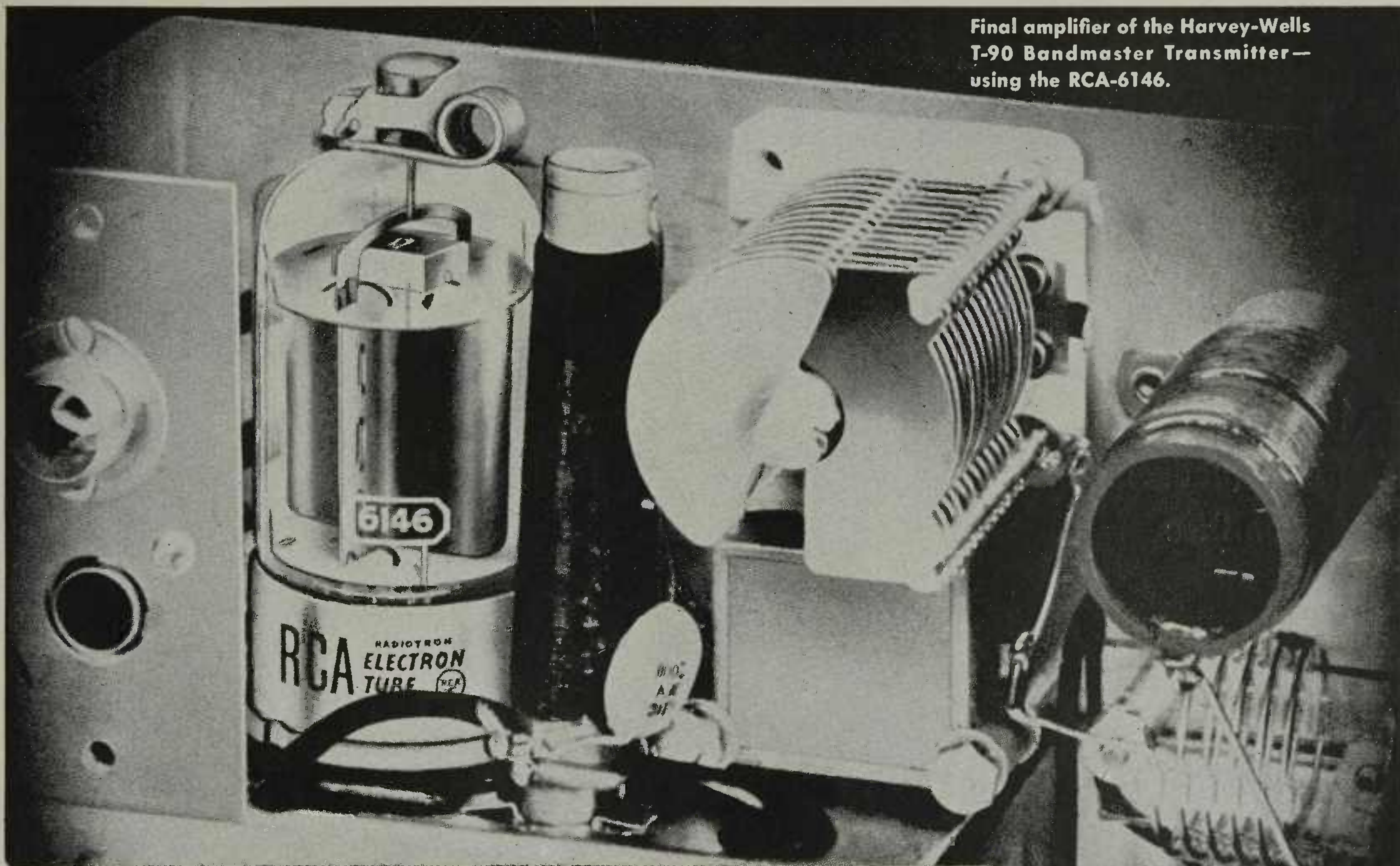
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RCA beam power tubes make it practical to use fewer components, fewer tuning controls—*fewer stages*. They lend themselves to bandswitching circuits—take full plate input with smaller drivers (a big help in reducing TVI). RCA beam power tubes give you the power you want *at lower plate voltages*.

RCA High-Perveance Beam Power Tubes are available at your RCA Tube Distributor—for amateur transmitters having input-power ratings up to a "gallon." For technical data on any specific beam power tube type including the 6146, write:



SOLE NEW ZEALAND DISTRIBUTORS:

AMALGAMATED WIRELESS (Australasia) LIMITED
P.O. BOX 830, WELLINGTON P.O. BOX 1363, AUCKLAND
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BEAM POWER TUBE RCA-6146

90 watts ICAS input on CW; 67.5
watts on 'phone. Full input to 60 Mc.
Reduced input up to 175 Mc.

Connoisseur *

PICK-UP and TRANSCRIPTION MOTOR



Fine Equipment For
Reproducing Sound
on Disc



Pick-Up (Mark II)

The Connoisseur Pick-up has a downward pressure of only 5 grams and has a frequency range from 20 c/s to 20 kc/s plus or minus 2 db on soft vinolite discs at 33 $\frac{1}{3}$ r.p.m. This is distinguished by its supreme quality and high-class finish. This is the unit for Hi-Fi enthusiasts.

1. 15 mV. obtained off a standard L.P. disc.
2. 100 per cent. screening of coil by magnet system.
3. Easily replaceable armature system.

Variable 3 Speed Motor

This is a hand-built product which meets with the most stringent requirements.

1. Three speeds with 4 per cent. variation by mechanical means. No braking action applied to motor.
2. The motor is a synchronous hysteresis type, running in substantial phosphor-bronze bearings.
3. The motor will remain in synchronization with 25 per cent. variation of line voltage.
4. Heavy full-sized die-cast platform, 15 $\frac{3}{4}$ in. by 13 $\frac{1}{2}$ in.

This unit is being used in considerable numbers by Recording Studios and Sound Installations.

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