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**MULLARD TAPE AMPLIFIER TYPE "C", Part 2**


VOLUME 12
NUMBER 5
DECEMBER
1958


# The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

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*Described by James S. Kent*

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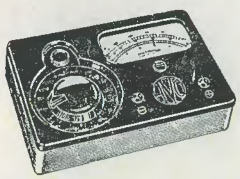

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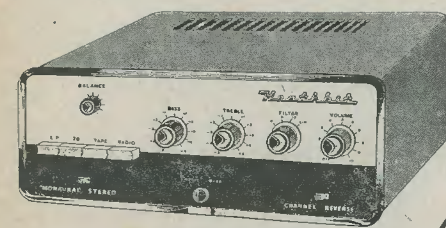

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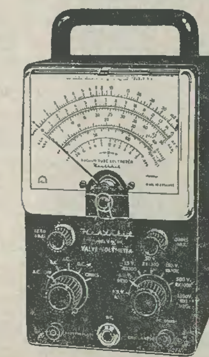

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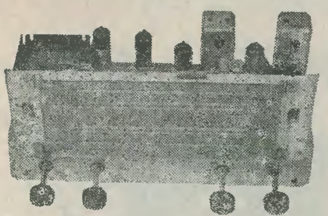

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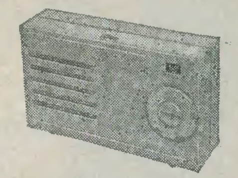

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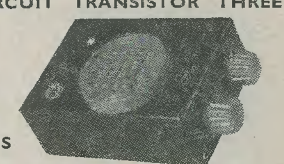

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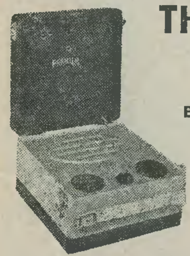

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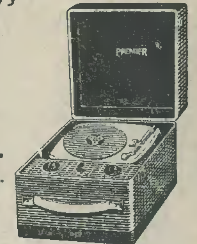

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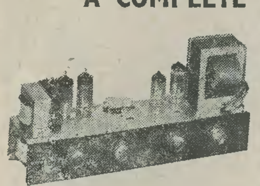

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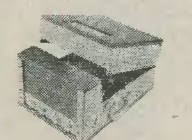

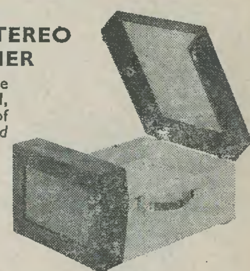

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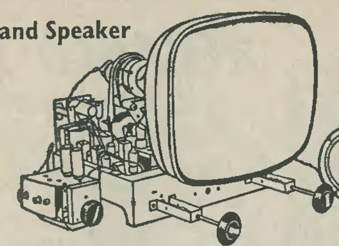

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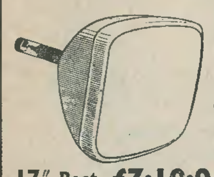

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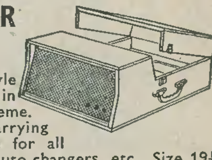
## RECORD PLAYER CABINET 39/6



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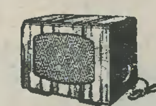

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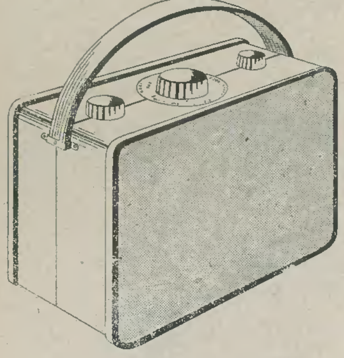

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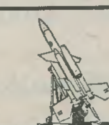

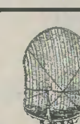

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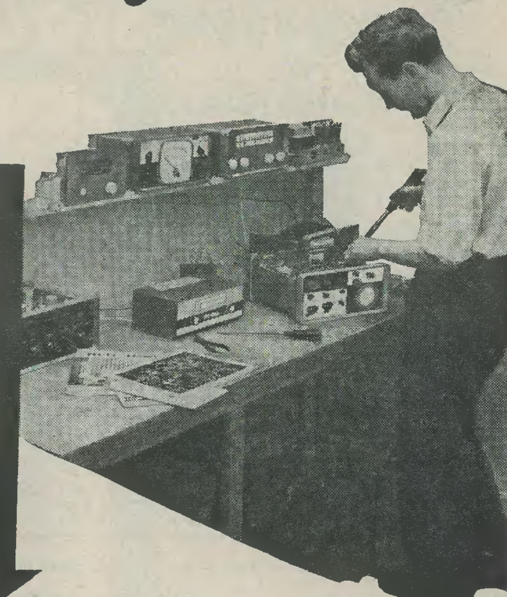

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# *The* Radio Constructor

*incorporating* THE RADIO AMATEUR

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*Editor*
C. W. C. OVERLAND, G2ATV

*Associate Editor*
A. C. GEE, G2UK

*Business Manager*
J. H. BURROWS, A C A

*Advertising Manager*
F. A. BALDWIN, A M I P R E

*Offices*
57 MAIDA VALE LONDON W9

*Telephone*
CUNNINGHAM 6141
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## NOTICES



ARTICLES appearing in this magazine which describe kits are inserted only on condition that such kits, or special components thereof, are freely available at a trade discount to all retail advertisers.

OPINIONS expressed by contributors are not necessarily those of the Editor or proprietors.

THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included.

ALL MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

TECHNICAL QUERIES should be submitted in writing. We regret that we are unable to answer queries, other than those arising from articles appearing in this magazine; nor can we advise on modifications to the equipment described in these articles.

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No. 97 A Short Wave Converter

# SUGGESTED CIRCUITS

*The circuits presented in this series have been designed by G. A. FRENCH, specially for the enthusiast who needs only the circuit and essential relevant data*

FASHIONS CHANGE IN THE FIELD OF commercial sound radio manufacture just as much as they do in other spheres wherein mass-produced articles are dealt with. Up to some four years or so ago the conventional domestic radio receiver nearly always boasted three wave ranges, these consisting of the long, medium and short wave bands. So far as reception conditions in the U.K. were concerned, the provision of a short wave band to a domestic receiver was normally more of a "sales point" than an actual aid to greater programme enjoyment. This was because few listeners ever bothered to leave the long and medium wave bands, being quite content to rely on the material transmitted on the Light Programme and Home Service. Over the last four years the growing popularity and availability of f.m. reception has considerably altered this state of affairs, and the "third wave band" of the average receiver is now almost always devoted to the v.h.f. band. Today, one rarely sees a domestic sound receiver in the normal price ranges which carries a short wave band.

Ironically enough, this situation is beginning to create a certain demand for short wave broadcast reception. The reason for such a demand is obvious enough. There is much of interest in the short wave bands and even the idlest of listeners can derive some casual satisfaction from occasionally swinging the dial of a reasonably sensitive short wave receiver. There seems to be, in particular, a marked interest amongst home-constructors for short wave converters, such converters being capable of installation before the aerial terminals of a conventional sound receiver and of taking advantage of the amplification and selectivity which that receiver offers.

### Design Problems

The circuit which is described this month is that of a short wave converter which may be connected to the aerial input terminals of most broadcast sound receivers. It offers reception on the single range of, approximately, 5 to 18 Mc/s (60 to 16.5 metres), and thereby includes most of the more important short wave broadcast stations. Such a range can be adequately covered by a conventional



500pF twin-gang tuning condenser, provided that trimming and stray capacities are kept reasonably low.

A notable difficulty encountered in the design of a short wave converter of the type we are considering here is that of obtaining an efficient r.f. coupling to the subsequent receiver. What is almost certainly the best coupling method consists of injecting the output of the converter into the receiver frequency changer at the a.m. intermediate frequency of the receiver. Unfortunately, however, this involves the provision of switching circuits around the receiver frequency changer stage and, whilst they might be fairly simple to install in an a.m.-only receiver, such switching circuits would be extremely difficult to add to an a.m./f.m. receiver wherein frequency changer wiring is complicated.

Because of the difficulties of coupling up at the a.m. intermediate frequency the short wave converter described here works on a different principle. Its output is fed into the associated receiver's aerial circuit at a frequency lying between 500 and 600 metres (600 to 500 kc/s); that is, at the lower end of the medium wave band. As a result the converter and the sound receiver function together as a double superhet, the short wave converter changing the frequency of the desired signal to one which appears between 500 and 600 kc/s (described in this article as the "first i.f."), and the frequency changer in the receiver converting this to the a.m. i.f., which is normally of the order of 465 kc/s. The main difficulty which follows from this method of operation is that it is possible for existing medium wave transmitters between 500 and 600 kc/s to break through into the "first i.f." circuits and cause heterodyning with any short wave signals which may be received. Fortunately, the lower end of the medium wave band usually appears to be less crowded than the remainder and it should be possible in most instances to find a frequency for the "first i.f." which is free from interference by existing transmitters. Heterodynes caused by short wave stations close in frequency to that required beating with medium wave stations close to the "first i.f." are reduced in the converter by reason of the fact that a relatively highly selective band pass circuit is included between the converter frequency changer anode and its output terminal. In an effort to further reduce heterodynes caused by existing transmitters, the aerial input is switched in the converter itself, coupling between this unit and the receiver being made via screened coaxial cable. In addition, a wave-trap tuned to the "first i.f." is inserted in series with the converter aerial coil. These measures should offer a useful protection against the formation of heterodynes at the "first i.f." Despite such precautions, nevertheless, some difficulty may still be experienced if the associated receiver employs a ferrite frame aerial for a.m. reception, because an aerial of this type is liable to pick up interfering signals on its own. In consequence, it is advisable to ensure that it is possible to obtain a completely "dead spot" in the 500 to 600 kc/s section of the medium band of a receiver employing a ferrite frame before attempting to use a converter of the type described in this article.

It should be pointed out that, due to the particular design employed, a signal generator is essential for alignment of the completed converter.

### Functioning

In a simple circuit of this nature it is possible to discuss most of the salient points of layout and practical construction whilst describing the functioning of the individual components.

In Fig. 1, which shows the complete converter, the incoming aerial signal is applied, after switching by $S_{1(a)}$, to the wave-trap provided by $L_1$ and $C_1$. This wave-trap is tuned to the frequency in the 500 to 600 kc/s range which has been decided upon for the "first i.f." After $L_1$, $C_1$ the aerial signal is fed, via the optional condenser $C_2$, to the primary of the short wave signal frequency coil $L_2$, $L_3$. This coil is tuned by the tuning condenser $C_5$, and trimmer $C_6$, in normal fashion.

Coil $L_5$ provides the oscillator tuned circuit in company with the tuning condenser $C_{12}$ and trimmer $C_{13}$, feedback being applied by the coupling winding $L_6$. Oscillator padding is provided by $C_{14}$. Both $L_2$, $L_3$ and $L_5$, $L_6$ may be conventional short wave signal frequency and oscillator coils intended for operation with a subsequent 465 kc/s i.f. amplifier, the only proviso being that $L_5$, $L_6$ must be a dust-cored component. Such a proviso is necessary because, although the "first i.f."—lying within the range 500 to 600 kc/s—is relatively close to 465 kc/s, some slight adjustment of the oscillator coil inductance may be required for accurate tracking. Preferably, $L_2$, $L_3$ and $L_5$, $L_6$ would be matched components from the same manufacturer, in which event a cored oscillator coil would automatically ensure that $L_2$, $L_3$ was cored as well.

The frequency changer functions in conventional manner, the intermediate frequency appearing at its anode. The conversion conductance of the frequency changer, and hence the overall gain of the converter, is varied by potentiometer $R_2$, this adjusting the amount of negative bias applied to $g_1$ of the valve via $L_3$. The slider of $R_2$ adjusts

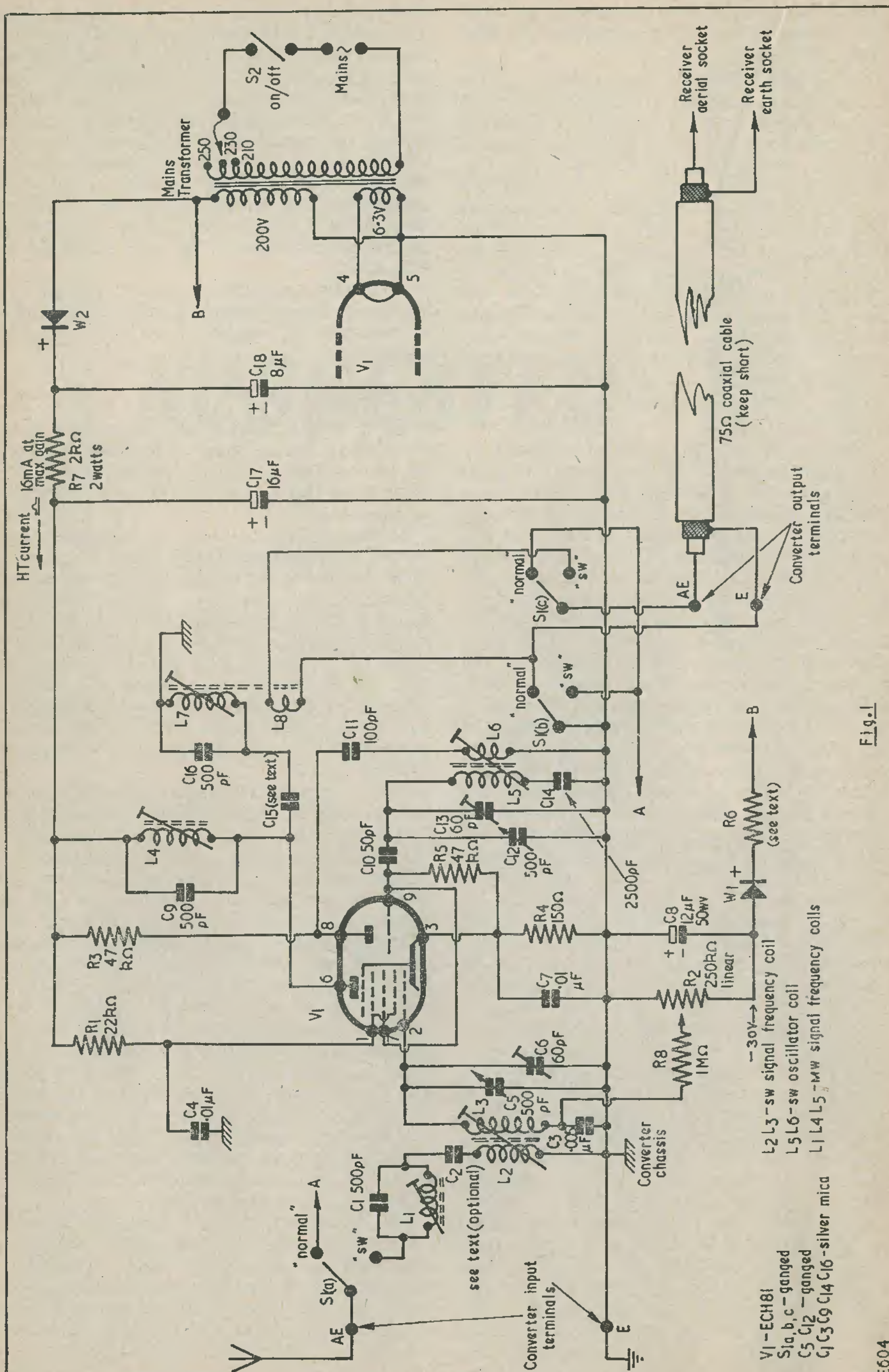


Fig. 1

the bias potential from zero to approximately −30 volts with respect to chassis, this negative voltage being obtained from the secondary of the mains transformer via the rectifier circuit $R_6$, $W_1$ and $C_8$. The value of $R_6$ is that which causes a potential of 30 volts to appear across $R_2$ and has to be found experimentally, as it will vary for different rectifiers in the $W_1$ position. It is advisable to start off with quite high values (of the order of 1MΩ) when determining that needed for $R_6$. Rectifier $W_1$ must be a component intended for operation at the mains transformer secondary voltage as, despite the low rectified potential, the peak inverse voltage applied to it will still be high. An important point to ascertain during construction is that the slider of $R_2$ truly provides zero voltage when it is at the earthy end of its track. Some potentiometer designs leave a little track resistance in circuit even when the slider is at the end of its travel, and such track resistance, if appearing at the earthy end of $R_2$, could cause a reduction in the maximum gain available from the converter. The range of control provided by $R_2$ is of the order of 40dB, and this should be more than adequate to prevent overloading of the associated receiver by strong short wave signals.

The anode of the frequency changer feeds into the band pass pair $L_4$, $L_7$, these being tuned to the "first i.f." In order to keep mutual inductance coupling between these two coils to a minimum they should be mounted several inches away from each other, preferably with their axes at right-angles. Alternatively, they may be screened from each other, say by mounting one above and the other below the chassis. The condenser $C_{15}$ coupling the two coils together has an experimental value, this being determined with the aid of a signal generator.

$L_8$ is a coupling winding and this couples $L_7$, via $S_{1(b)}$ and $S_{1(c)}$, to the coaxial cable which connects to the aerial and earth terminals of the associated receiver.

Whilst dealing with this part of the circuit it should be pointed out that coils $L_1$, $L_4$ and $L_7$, $L_8$ are conventional dust-cored medium wave coils. $L_1$ and $L_4$ may be single winding medium wave coils of the type used in bottom-end coupled circuits. $L_7$, $L_8$, however, should be a coil of the type employed for r.f. coupling, wherein the coupling winding has fewer turns than the tuned winding. If desired, $L_1$ and $L_4$ could also consist of coils of this type, the coupling windings being ignored. What are often described as "aerial coupling coils" (that is, coils whose coupling windings have many more turns than their tuned windings), must on no account be used in *any* of the three positions in this circuit as the coupling windings of such coils will almost certainly give undesirable absorption effects.

**Alignment**

The alignment of the converter is complicated somewhat by the necessity of setting up the band pass output circuit and the wave-trap before carrying on to short wave alignment proper.

The band pass circuit is set up first. The receiver, tuned to the "first i.f.", and the converter should primarily be switched on and allowed to warm up. The slider of $R_2$ should be set to the earthy end of its track (maximum gain) where it should remain for all alignment operations. The signal generator should next be connected to $g_1$ of the frequency changer, and set up to the "first i.f." Employing a very low capacity in the $C_{15}$ position (or, relying on stray coupling between the two coils, no capacity at all) the cores of $L_4$ and $L_7$ should be adjusted for maximum signal in the receiver. The tuning of these cores should be sharp. The value of $C_{15}$ should then be increased until a definite "broadening" of response is found as the signal generator is swung across the "first i.f." The "broadening" effect should be quite marked; and the capacity finally required of $C_{15}$ is that which causes the response of $L_4$, $L_7$ to be slightly less wide than that offered by the receiver i.f. stages. In practice the final value of $C_{15}$ may be quite low, 5pF being a representative figure. (The calculated value, for 6 kc/s peak-to-peak centred on 550 kc/s, and assuming no mutual inductive coupling between the two coils, is approximately 5.5pF.*)

$L_1$ has next to be adjusted. Alignment here is carried out by applying the output of the signal generator, set up to the "first i.f.", to the aerial input terminal of the converter. $C_2$, if fitted, should be short-circuited. The core of $L_1$ is then adjusted for minimum response from the receiver loudspeaker.

The two alignment operations just described assume that the output of the signal generator is sufficiently high to enable a useful signal to appear across the relatively low impedance offered by $L_3$. Should insufficient signal generator output be available, $L_3$ should be disconnected whilst aligning $L_4$ and $L_7$. Similarly, in order to align $L_1$, the right hand junction of $L_1$, $C_1$ should be connected direct to $g_1$ of the frequency changer, $L_3$ being replaced by a

* From $\frac{f_2 - f_1}{f_0} \simeq K$ and $K \simeq \frac{C_m}{\sqrt{C_1 C_2}}$ where $f_1$ and $f_2$ are frequencies at which peaks occur, $f_0$ is centre frequency, K is coupling factor, $C_m$ is mutual capacity and $C_1$, $C_2$ are tuning capacities. Cf. pp. 415 to 419 of *Radio Designer's Handbook*, 4th edition, Langford Smith, Iliffe.

10MΩ resistor. When $L_1$, $L_4$ and $L_7$ have been adjusted the circuit can then be returned to its correct state.

The alignment of the short wave coils proper then follows. This may be carried out in normal fashion, trimming $C_6$ and $C_{13}$ at the high frequency end of the band, and padding with the aid of the dust cores at the lower end of the band. Final alignment is liable to vary somewhat according to the value chosen for $C_2$, should this condenser be fitted. The purpose of $C_2$ is that of reducing damping of $L_3$ when a large aerial is used. With most commercially available short wave coils, good results should be given if $C_2$ has a value around 20pF.

**Operation**

Few difficulties should result in operation of the converter. As with all short-wave equipment, careful tuning is necessary, and it is essential that the tuning condenser be fitted with a good slow motion drive which is free from backlash.

Some slight difficulty may be given by mains modulation. If this occurs, the mains input to the receiver, or to the converter, should be reversed.

**A.G.C. Operation**

If the sound receiver with which the converter is to be used has a mains transformer and a chassis which is isolated from the mains supply it becomes possible to bond the receiver and converter chassis together. An a.g.c. voltage from the receiver may then be applied to the converter frequency changer, and the gain control circuit deleted.

The a.g.c. circuit is illustrated in Fig. 2. As will be noted, $R_2$, $R_6$, $C_8$ and $W_1$ of Fig. 1 are not now needed, a.g.c. from the receiver being applied via $R_9$ and $R_8$. $R_9$ must be fitted close to the a.g.c. diode load in the receiver.

When the sound receiver has an isolated chassis it may also be possible to derive h.t. and heater supplies for the converter from its power unit, thereby obviating the necessity of the mains transformer and h.t. rectifier circuits shown in Fig. 1.

The circuit of Fig. 2, and any common power supply arrangements, must **not** be used if the associated sound receiver has a "live" chassis.

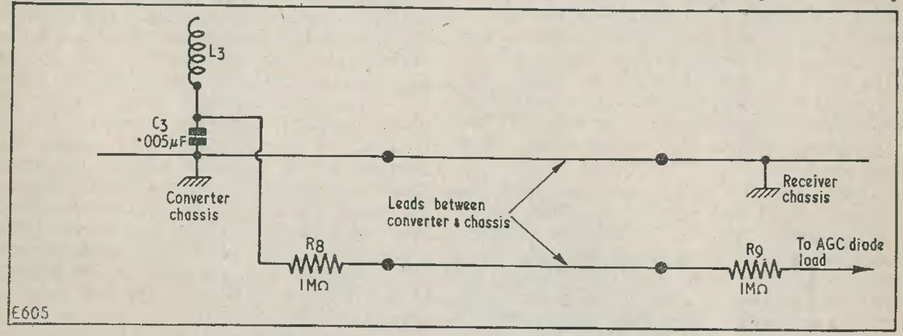



*Fig. 2. Applying a.g.c. to the converter*

## The "PRODIGY" and STEREO

Many readers of the last two issues will be wondering if it is worth while proceeding with construction of the "Prodigy" in view of the fact that in the near future they may wish to go in for stereo reproduction. The answer is definitely, yes!

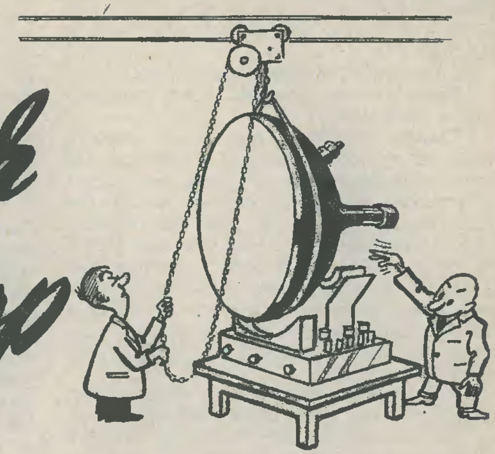
Indeed, at this time work is proceeding on the development of a stereo version. It is anticipated that this version will be made available early in 1959. At this time, also, a conversion kit will have been produced to enable readers who have already built the single-channel "Prodigy" to adapt it for stereo. This conversion will, briefly, consist of a separate control unit and an add-on unit which will provide the second channel output stage. Part of the existing chassis and practically all the components, including the control panel, will be utilised in the conversion, and in appearance the converted "Prodigy" will be only slightly less pleasing than the actual stereo version, while the performance will be identical.

It is hoped that this advance notice will enable readers who, because of financial or other considerations, cannot yet undertake to construct a stereo amplifier, to enjoy meanwhile the undoubted quality of performance given by the single-channel "Prodigy."





# In your Workshop



*Aided by his able assistant, Dick, Smithy the Serviceman continues to run the Workshop*

THERE WAS A LOUD, SUDDEN EXPLOSION, and the startled Dick jumped backwards from the smoking receiver on the bench in front of him. Involuntarily he held on to his soldering iron, whereupon its consequently tightened lead swept across the bench and caused all the components in its way to be pushed on to the floor. There was a heavy crash as several chokes and transformers bit the linoleum, this being accompanied by the rattle and tinkle of sundry resistors and condensers. There were also three distinct and separate implosions, these marking the demise of as many perfectly good valves. Dick's instinctive move backwards caused the soldering iron lead to become strained even further beyond its normal tension; with the result that, firstly, its hot barrel was pulled between his thumb and forefinger and, secondly, the leads at the plug began to pull away from their anchorage. As soon as Dick felt the heat of the soldering iron barrel he threw it away from him with a violent yell, whereupon it crashed to the floor and commenced to burn a hole in the linoleum. At the same time the bare ends of the wires pulling from the soldering iron plug had untwisted sufficiently from their terminals to touch together. There was a bright flash, and all the lights in the Workshop became extinguished. Shocked by the events which had so suddenly overtaken him, Dick stumbled clumsily across the darkened Workshop towards the cold water tap at the sink, knocking over on the way his stool, the Workshop teapot and a cup and saucer. He finally reached the sink, whereupon he turned on the cold tap and held his injured thumb and forefinger beneath it.

In the gloom of the December afternoon, the long-suffering Smithy turned round and stared quietly at the wreckage which was strewn around him. He heaved a long drawn-out sigh. For once he had no comment to make.

After some moments the Serviceman came to grips with the situation. His eyes becoming accustomed to the wintry light filtering through the windows, he looked at his assistant at the sink and saw that he looked somewhat pale. Smithy forgot the damage and assumed the role of ministering angel.

"Here," he said to Dick. "I can't see that cold water serving any particularly useful purpose apart, perhaps, from cleaning dirt away from your burns. You'd better sit down for a moment and I'll have a look at them."

Dick sat down obediently and Smithy quickly examined the burnt thumb and finger. Then he walked over to the first aid box.

"They're not so bad," he remarked. "In fact they're quite mild—just a reddening of the skin, that's all. What we want to do, therefore, is to put a spot of something nice and soothing on to them. First of all, I'll gently dab off the water you ran over your hand with this bit of cotton wool. Then I'll smear some Acriflavine cream over the reddened parts of the skin. After that I apply two pieces of lint, one to the forefinger and one to the thumb, and hold them in place with a bandage."

Smithy busied himself with his task.

"There you are," he said a few moments later. "Job done!"

"Thanks, Smithy," said Dick, making ready to rise from the seat. "Perhaps I'd better start clearing up the mess I've made."

"I should stay just where you are for the time being," chuckled the Serviceman. "After all is said and done, you *have* had a bit of a shock. And there's nothing like taking it easy for a minute or two after shock even when, as in your case, it's of rather a minor nature. Besides, the way you are now you'd probably start knocking everything all over the place again!"

Following the Serviceman's instructions, Dick sat silently in his chair watching Smithy as the Serviceman first took the still-hot soldering iron off the floor and, secondly, set about repairing the fuses. After a minute the Workshop was cheerfully lit up again.

"How're the burns?" asked Smithy, sitting down and lighting a cigarette.

"Not too bad," replied Dick, "although they're still hurting quite a bit."

"Not to worry," commented Smithy, soothingly, "they'll probably burn and irritate for an hour or two, but the pain should pass off after that. Do you feel ready to start clearing up the debris?"

"Sure," said Dick, "let's get at it."

### The Cause

"Well, Dick," said Smithy, after he had helped his assistant to return the components on the floor back to the bench, and had tut-tutted over the three broken valves, "we'll examine these bits and pieces later on. For the time being let's have a look-see at what started all this off."

A somewhat chastened Dick indicated the television chassis which had caused all the trouble.

"Ah," commented Smithy, peering closely at the receiver, "I see we have an open-and-shut case of blown-up electrolytic. Exploding electrolytics are by no means so common nowadays as they used to be when they were housed in cardboard containers. In fact, this is the first I've encountered for quite a few years. At any rate, the electrolytic we have here hasn't caused much damage in the receiver, despite the fact that it gave such an almighty pop. As an amateur student of ballistics I can see that it was aimed away from the chassis and the other components.

"Now the first thing to note," continued Smithy, "is that it is the 100+200$\mu$F h.t. electrolytic which has gone up. The question we must now ask ourselves is, why?"

The Serviceman turned an enquiring glance on his assistant.

"Well," volunteered Dick, "the history of this set is that it came in with low e.h.t. and low line scan. Before doing anything else I checked the h.t. potential, whereupon I found that this was down to about 150 volts or so. I decided to suspect the h.t. metal rectifier."

"A good diagnosis," said Smithy approvingly.

"The next thing I did," Dick carried on, "was to hunt around for a replacement rectifier. We seem to be running low on these, however, and all I could find was a rectifier at the back of the spares cupboard which looked as though it had already been used once or twice for checking circuits or something of that order. At any rate the varnish on it looked nice and new but there was evidence that leads had at some time been soldered to its tags."

"That doesn't sound too good," said Smithy. "I like to give my customers brand-new spares, if possible. Still, I *do* vaguely remember using a metal rectifier many moons ago for an hour or so for some test or another, so I'll let this pass."

"The only trouble," continued Dick, warming up to his story, "was that the red mark had got rubbed off the positive tag of the rectifier I found. So, before I connected it into the receiver, I checked its polarity."

Smithy looked interested.

"How did you do that?" he asked quickly.

"By using the testmeter on an ohms range," replied Dick with evident surprise at the sharpness of Smithy's question. "What I did was to pop the positive lead of the meter on to one end of the rectifier and the negative lead on to the other end. The meter indicated a very high resistance and so I presumed that the end to which the positive meter lead was connected was the negative end of the rectifier."

"After which you connected it into circuit?"

"That's right."

"How often have you used this particular check for h.t. rectifier polarity in the past?"

"Only twice before, and it worked O.K. then."

Smithy raised his eyes to the ceiling.

"One can only thank the fates," he remarked devoutly, "for having previously spared us from today's catastrophes, which have undoubtedly been caused by your connecting up the rectifier wrong way round. However, Dick, I must confess I really blame myself for not having previously told you how to check h.t. rectifier polarity. Let me just say for the present that the test you've described is of no use at all.

"To begin with, I think you're making an untrustworthy assumption when you suppose that the polarity markings on a testmeter's terminals bear any fixed relationship to the voltage which appears at those terminals when the meter is switched to an ohms range. One couldn't be certain about such a point until one had checked the meter's circuit or had connected another meter, switched to volts, across its terminals. There may, perhaps, be a convention amongst meter manufacturers on the question of ohmmeter terminal polarity, but I haven't heard of it myself.

"So I feel that you first made an error with your assumption of meter polarity. Your second error was much more naughty. You didn't reverse the meter leads to see whether the rectifier conducted when connected the other way round."

"Why?"

"Apart from the fact that a double check is always worth carrying out if it can be done quickly," said Smithy, "it would have demonstrated that the rectifier had just as high a resistance when connected the other way round as it had in the first case!"

"Hey?"

"That's right! Germanium diodes and other low voltage rectifiers would have shown different resistances, but such things as h.t. metal rectifiers would give you almost the same reading either way."

"Why is that, Smithy?"

"Because the forward resistance of h.t. metal rectifiers is very high at low voltages. The rectifier is able to work at high voltages because its forward resistance decreases as the voltage increases. As a matter of interest it is because of the non-linear resistance characteristic of metal rectifiers that you can use them for such jobs as expanding meter scales and so on. Thus, if you slap a rectifier of the right type across a meter (Fig. 1) that rectifier can cause the range of available readings to be considerably increased. When low voltages appear across the meter the rectifier offers a relatively high resistance and the meter sensitivity is high. When the voltage across the meter rises the rectifier resistance drops and the meter gets progressively less sensitive. The rectifier enables the meter to read quite high voltages whilst still being capable of measuring low voltages accurately. The result is that you get a meter scale something like this (Fig. 2).

"However, we're getting away from the point, which is concerned with detection of polarity of h.t. metal rectifiers when their markings are rubbed off. So far as I'm concerned there is only one simple foolproof method of doing this, and that consists of connecting up the rectifier in series with an a.c. supply whose voltage is the same as that it will eventually handle. Connect a moving-coil testmeter switched to a suitable voltage range to the other side of the a.c. supply and the remaining lug of the rectifier, and you

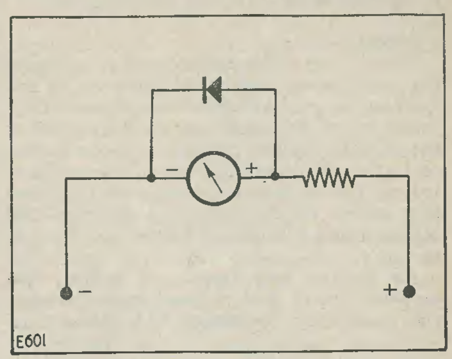



*Fig. 1. The effective scale of a voltmeter may be expanded by connecting a suitable metal rectifier to it in the manner shown here. The forward resistance of the rectifier decreases as the voltage across it rises*

will get a definite indication of polarity. (Fig. 3.) This method is so fool-proof that I feel it should be used even if an appreciable amount of time has to be spent in carrying it out. In actual fact the test takes only a few seconds. Most of the metal rectifiers we work with are intended to operate from mains voltages, whereupon it is usually necessary to make only two quick connections, and these can be done with crocodile-clip leads.

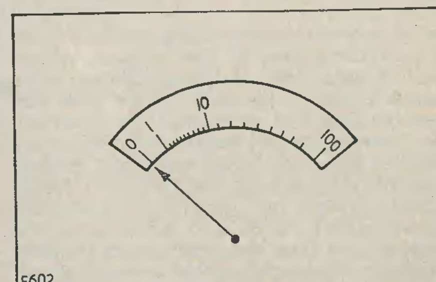



*Fig. 2. A typical instance of an expanded scale, as would be given by the circuit of Fig. 1*

"And, my boy, it is only *after* a check of that type," concluded Smithy, surveying the battered components now lying on Dick's bench, "that you should start wiring in your smoothing and reservoir electrolytics."

Dick looked at his bandaged hand.

"O.K. Smithy," he said. "I've been taught something today. And I've certainly learned it the hard way!"

**Clearing Up**

Smithy and Dick commenced to examine the components which had fallen on to the floor earlier on. As very often happens, what appeared at first sight to be damage of a considerable nature turned out to be not so bad after all. Apart from the three defunct valves, few of the components had suffered any injury which could not be corrected mechanically with the judicious use of a pair of pliers.

As Smithy had mentioned earlier, the receiver chassis had suffered little damage: the electrolytic condenser had blown outwards into clear space. Dick hopefully fitted a new component in this position, whilst Smithy unearthed a new rectifier from some secret cache of his own. Dick took this rectifier from him, examined it very carefully and, despite the fact that its positive lug was marked with very bright red paint, checked it in the manner suggested by Smithy before finally wiring it into the chassis. Somewhat apprehensively, Dick next switched on the receiver, but there were no signs of incipient eruption. Instead, to Dick's surprise and pleasure, the sound came up after the usual initial warming up period. A little later, the line output transformer commenced to sing its familiar 10,125 c/s song, and a nice bright picture appeared very shortly after. The set checked satisfactorily on both the local channels, and the h.t. line read a healthy 210 volts (this being some 10 volts or so in excess of what would be given when the new rectifier had "settled in"). Dick beamed. Even his burnt finger and thumb had stopped aching.

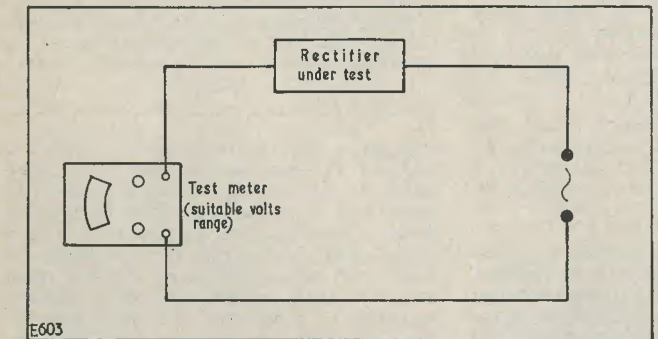



*Fig. 3. A fool-proof method of determining the polarity of an h.t. metal rectifier. The a.c. voltage used for the test is of the same order as that which would be applied to the rectifier under working conditions*

"There you are, Smithy," he exclaimed triumphantly. "Things aren't so bad after all."

"I suppose not," said Smithy guardedly, "but I have to remind you of the matter of the heavy costs you have incurred this morning. To wit: a needlessly burnt-out double electrolytic and rectifier, three good valves, and at least six inches of fuse wire. To say nothing of wear and tear on my ageing nerves."

"Honestly, Smithy, I'm sorry about the damage," said Dick contritely. "You'll have to dock it from my lolly next Friday!"

"No, I shan't do that," replied Smithy. "I don't think the overheads will totter too much under the strain."

Dick grinned, having expected this answer. He next pulled the aerial plug out of the socket on the chassis he had been handling, preparatory to switching it off and returning it to its cabinet. His cheerful expression changed to one of exasperation when he saw that what had previously been a perfect picture suddenly changed to a mass of small bright flashes.

"Oh, no," he groaned loudly. "Don't say that something else has gone wrong with this blamed set."

Smithy wandered over and looked at the receiver. Experimentally, he picked up one of the test prods of the bench testmeter and applied it to the centre conductor of the aerial socket. The white flashes became much more prominent.

"We have corona," pronounced the Serviceman. "And I would say with certainty that it's coming from an e.h.t. component inside the set. When the aerial is disconnected the a.g.c. circuit causes the receiver to work at full sensitivity, whereupon the wire inside the cabinet between the aerial socket and the tuner is capable of picking up the locally generated corona. I have a more sensitive 'local' aerial when I put the test prod in the aerial socket, and that is why the flashing on the screen increases in intensity when I do this. I think I'll have a sniff around."

Smithy carefully examined the e.h.t. components and wiring in the receiver.

"I can't see any very obvious corona," he remarked eventually, "which leads me to suspect the line output transformer or deflection yoke. Sometimes, one gets poor internal connections in line output transformers or deflection yokes, these sparking, especially during current pulses, and giving flashes on the screen which are rather similar to those given by corona. Ah, wait a moment, though!"

Smithy's eye had fallen on the final anode connector of the cathode ray tube.

"I think I can see a thin bluish haze here," said Smithy. "So before we start suspecting major components I am going to do a little elementary cleaning up."

Smithy switched off the receiver, discharged the e.h.t. terminal to chassis and pulled out the connector. The soldering of the polythene e.h.t. lead to this connector seemed satisfactory, with no stray strands of wire which could cause "spikes" and consequent corona. The Serviceman next picked a rag off the bench, applied it to the tube bulb around the connector and, with a wry expression, showed Dick the black greasy deposit he had cleaned from the glass. Smithy proceeded to clean the glass carefully with carbon tetrachloride, after which he applied some grease from a small tube. He then replaced the connector and switched on the receiver.

The flashes on the screen had cleared.

"There you are," said Smithy. "Just an instance where common-or-garden muck and nothing else causes trouble."

"You've certainly cleared the corona," remarked Dick. "What's in that little tube?"

"Oh, that's MS4," replied Smithy. "It's a silicone grease made by Midland Silicones Ltd. especially for electrical purposes. It's excellent for keeping moisture off things and for stopping tracking. In fact, any surface coated with MS4 becomes actually water-repellent. It's also a lubricant and contact grease; and one well-known firm of turret tuner manufacturers specifies it for their turret contacts. Further, like all silicone compounds it is a very stable material; it doesn't change its consistency due to long-term oxidation, nor does it melt. I certainly wouldn't be without a tube in this Workshop."

"That's all very well," said Dick, examining the small yellow-labelled tube. "But, very often, products of this nature are available to people in the trade only. Can amateurs buy this?"

"Certainly," said Smithy. "Any amateur can buy it. Perhaps the easiest way is by post from distributors."*

"Fair enough," said Dick. "I'm always doing a few odd jobs at home. I'll get some in for my own private use."

"As you like," said Smithy. "But I think I should back it up with plenty of Acriflavine cream!"

*MS4 is available to amateurs from Holiday and Hemmerdinger Ltd., 71 Ardwick Green North, Manchester 12.

# Catalogues Received

**AVO Ltd.**, Avocet House, 92–96 Vauxhall Bridge Road, London, S.W.1, have forwarded their latest Instrument Catalogue which is available to readers post free on request. Attractively produced on heavy art paper, it comprises some 38 printed pages, plus cover. All the current range of test instruments is fully described, each item being featured on two facing pages and each including an illustration of the instrument complete with descriptive text and the full technical specification.

The completely new A.M. Signal Generator, type 378, is one example, this instrument covering from 2 to 225 Mc/s on fundamentals in 7 ranges with adequate overlap and from 160 to 450 Mc/s on the harmonic range. The range details are: Range A from 2 to 4.5 Mc/s; B from 4 to 9 Mc/s; C from 7.5 to 16 Mc/s; D from 11 to 24 Mc/s; E from 22 to 50 Mc/s; F from 45 to 100 Mc/s and G from 80 to 225 Mc/s. The harmonic range 2G is thus the second harmonic of range G.

Another new product, featured for the first time, is the AVO "Prodclips." These patented spring-loaded test prods are invaluable for reaching those test points difficult of access, with which we all have to contend at some time or another.

**Home Radio (Mitcham) Ltd.**, 187 London Road, Mitcham, Surrey, have just produced one of the finest retail catalogues that we have recently seen. Of 100 pages, literally packed with over 4,000 items, it is available to readers at 2s. (1s. 6d. plus 6d. postage). Completely indexed and cross referenced, there is also a handy section finder card which greatly assists in the location of any item required.

In all the vast range of items listed, we can think of nothing that has been omitted—everything from nuts and screws to complete hi-fi equipments are featured. Well illustrated both with line drawings and photogravure, we recommend this complete catalogue to all our readers.

# UNDERSTANDING TELEVISION

PART 12

By **W. G. MORLEY**

*The twelfth in a series of articles, which, starting from first principles, describes the basic theory and practice of television*

Having completed our examination of the aerial input and signal frequency amplifier stages of the television tuner unit, we may now carry on to the oscillator and mixer.

The mixer carries out the function of converting the signal frequency to the intermediate frequency, so that amplification by the i.f. stages of the receiver may take place. Following normal superhet practice, this conversion occurs due to the injection into the mixer of an oscillator voltage, the oscillator frequency being spaced away from the signal frequency by the intermediate frequency. We shall now devote our attention to the oscillator circuit.

### The Oscillator

It is conventional practice in modern tuners to employ a combined triode pentode as oscillator-mixer valve, the triode section functioning as the oscillator. The oscillator circuit universally employed for television tuners has the basic form illustrated in Fig. 68 (*a*). In Fig. 68 (*b*) the inter-electrode capacities of the triode are added to the circuit, whereupon it may be seen that the oscillator is, in reality, of the Colpitts type. The inductance in the tuned circuit is provided by the oscillator coil itself, whilst the capacity tuning this inductance is given by $C_{ag}$ connected directly across the coil, and by $C_{ak}$ and $C_{gk}$ in series. (It is assumed that the series grid condenser has a value which is sufficiently high for it to be ignored when compared with the low values of the inter-electrode capacities.) The earth tap into the tuned circuit is made at the junction of $C_{ak}$ and $C_{gk}$, with the result that, at the resonant frequency, the voltages at anode and grid are 180° out of phase, and oscillation occurs. A grid leak is included in Figs. 68 (*a*) and 68 (*b*) and this, together with the series grid condenser, ensures that the valve is biased in conventional leaky-grid manner. The anode feed resistor allows positive h.t. potential to be available for the anode of the valve. At the frequencies involved in television tuner oscillators the impedance of the anode feed resistor is sufficiently high to prevent excessive damping of the oscillator tuned circuit. This point is, however, dealt with in greater detail later.

Whilst the circuit of Fig. 68 (*a*) is perfectly capable of oscillating as it stands, it requires a number of modifications if it is to work at optimum efficiency in a practical tuner. One of the first points which requires consideration is the position of the earth tap into the tuned circuit. For best results the amount of voltage fed back to the grid of an oscillator should be less than that appearing at the anode. In most practical instances the grid voltage should be one-third to one-quarter that given at the anode. The ratio between anode and grid voltages may be altered in Figs. 68 (*a*) and 68 (*b*) by varying the effective position of the earth tap into the tuned circuit, the simplest method of doing this consisting of adding an additional condenser between the grid end of the coil and chassis. The parallel combination of this additional condenser and $C_{gk}$ provides a lower reactance than is given by $C_{ak}$ on its own, with the result that the earth tap into the tuned circuit is brought closer to the grid end of the coil and the grid voltage becomes lower in relation to the anode voltage. By choosing the correct value for the additional condenser the ratio of grid voltage to anode voltage may be made equal to that which provides optimum efficiency. Fig. 68 (*c*) shows the oscillator circuit with the added condenser.

In Figs. 68 (*a*), (*b*) and (*c*), the series anode feed resistor is shown as being connected to the anode end of the coil. In practical tuner units, however, it is almost always connected to the grid end. There are two reasons for this. The first of these is that, as we have already seen, there is less oscillatory voltage at the grid than at the anode. In consequence, any damping resulting from the presence of the resistor will have less effect on the overall tuned circuit if the resistor is connected to the grid end instead of to the anode end of the coil. Secondly, if the oscillator circuit is used in a turret tuner, connecting the resistor to the grid end of the coil will ensure that the h.t. supply to the oscillator anode is broken if no coil happens to be presented to the turret contacts. Such a condition would occur when switching from one channel to the next, or if the tuner is inadvertently left in a position for which no coil segment has been fitted. Should an h.t. feed be maintained to the valve with no oscillator coil in circuit its grid bias would fall to zero volts and excessive anode current could flow. Fig. 68 (*d*) shows the anode feed resistor in its new position.

Finally, it becomes necessary to fit a fine tuner and, possibly, a trimmer to the oscillator circuit. The necessity for having a fine tuner is that it is difficult to ensure that the oscillator circuit will remain exactly on tune over long periods of time. A panel control, capable of offering small adjustments in oscillator frequency, overcomes this difficulty. At the same time, trimmers are employed, on most turret tuners, to ensure that production chassis may all present the same tuning capacity to the oscillator coils. Both fine tuners and trimmers consist usually of variable condensers, whereupon they may be connected between chassis and either end of the oscillator coil. Fig. 68 (*e*) illustrates a fine tuner and trimmer connected in parallel between the anode of the oscillator and chassis. This diagram also gives component values typical of those encountered in current

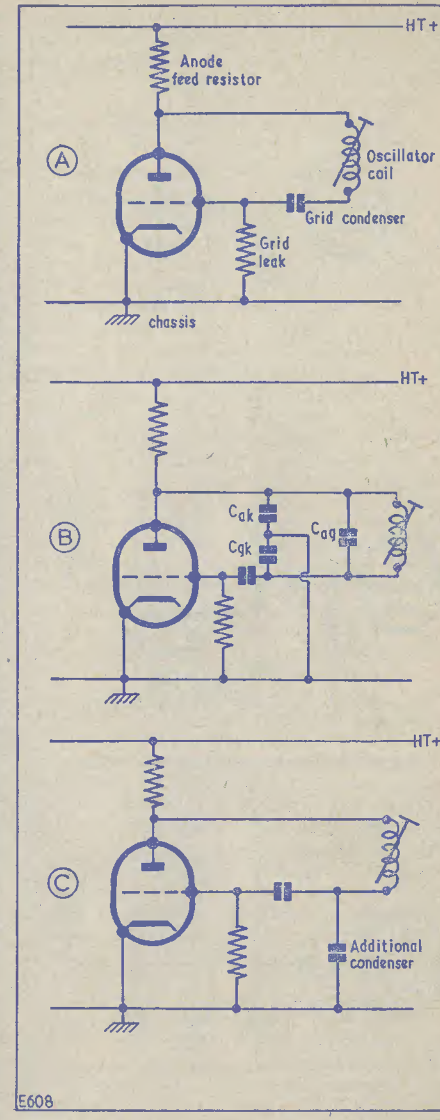



*Fig. 68. Successive steps in the development of a practical tuner oscillator circuit. (a) The fundamental oscillator circuit. (b) When inter-electrode capacities are shown it may be seen that the oscillator circuit is a Colpitts. (c) In order to provide an earthy tap into the tuned circuit which provides optimum oscillator efficiency, an additional condenser is connected across* $C_{gk}$.

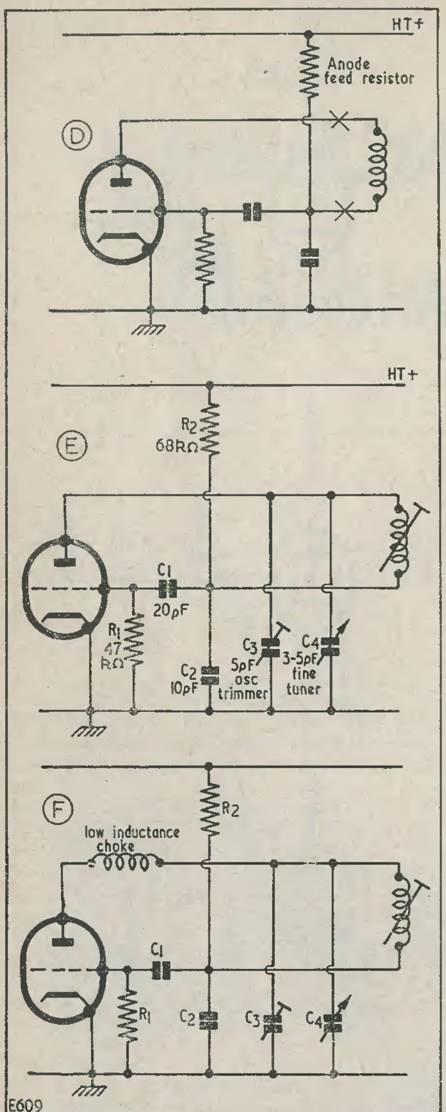



*Fig.* 68 (*d*) *Connecting the anode feed resistor to the grid end of the coil reduces damping. In turret tuners it also ensures that the h.t. supply to the oscillator is broken when no coil is in circuit. The crosses indicate the points at which turret contacts would appear in the circuit.* (*e*) *Adding a fine tuner and a trimmer brings the basic circuit of* (*a*) *into line with typical manufacturing practice. This diagram gives representative component values.* (*The oscillator trimmer is an optional item which is not fitted in all tuners.*) (*f*) *Some tuners employ a small choke in series with the oscillator anode to limit fine tuner range on the higher channels. The effect of the choke is described in the text.* (*Again, the oscillator trimmer is an optional item.*)

tuners. It should be mentioned that the addition of a fine tuner and trimmer causes a shift in the position of the earth tap into the tuned circuit. In practical tuners, the value of $C_2$ is chosen to give optimum oscillator efficiency when the fine tuner and trimmer are set to their mid-capacity positions.

Whilst the circuit of Fig. 68 (*e*) is typical of most modern tuners, some units may incorporate a small choke inserted into circuit in the manner shown in Fig. 68 (*f*). The choke has a low inductance and consists of a few turns of wire only. The reason for the addition of this component is as follows. In Fig. 68 (*e*) the fine tuner is liable to give increasing shifts in oscillator frequency as the latter increases (due to the selection of higher channels). This is because the capacitive range of the tuner remains unaltered despite the fact that the oscillator inductance decreases. In consequence, whilst the fine tuner may be capable of offering only a small shift in oscillator frequency at low Band 1 channels it may be capable of offering a disproportionally large shift at Band 3 channels. The circuit of Fig. 68 (*f*) causes this effect to be partly compensated. At Band 1 frequencies the inductance of the choke is very small when compared with that of the oscillator coil, and the range of the fine tuner is very nearly the same as would be given if the choke were omitted. At higher Band 3 frequencies the inductance of the choke becomes comparable with that of the oscillator coil and it contributes a significant amount of the inductance in the oscillator tuned circuit. As a result, the fine tuner is now connected across a smaller portion of the oscillator tuned circuit and its frequency range is reduced, becoming comparable with that provided at the lower Band 1 channels.

When the circuit of Fig. 68 (*e*) is used the fine tuner range provided in most British tuners is normally of the order of 1 to 3 Mc/s at Band 1, and of 2 to 6 Mc/s at Band 3. When the circuit of Fig. 68 (*f*) is used the fine tuner frequency range is of the order of 1½ to 3 Mc/s on all channels.

**Oscillator Drift**

Since it is the oscillator frequency which, by beating with the signal frequency, causes the latter to be selected and applied to the i.f. amplifier of the receiver, it is of the utmost importance to ensure that the oscillator frequency does not drift due to temperature rises in the tuner unit after the associated receiver has been switched on. Such rises in temperature are largely the result of heat dissipation by turret valves and components, the former usually providing by far the greater amount of heat. So far as components are concerned, that which dissipates most heat is the oscillator feed resistor. A further cause of tuner unit temperature rise is heat dissipation from other components inside the receiver cabinet, these affecting the tuner either by convection currents or by direct radiation. In a well-designed receiver this latter effect is kept to a minimum by mounting the tuner at a relatively cool part of the chassis.

Oscillator frequency drift results from temperature rises because these cause dimensional changes in coils and condensers, and in the inter-electrode capacities of the oscillator valve itself. Also, the dielectric constants of condensers may be altered. In practice, the effect of temperature rise on tuner oscillator circuits is somewhat complex, firstly because alterations in oscillator frequency given by changes in individual components may be in opposite directions and, secondly, because there is a time factor which causes some components to be affected more rapidly than others. At the instant of switching on the receiver in which the tuner is fitted, it may be assumed that all components in the tuner are at room temperature. The oscillator valve then begins to warm up, and after cathode emission commences, to dissipate h.t. power in the form of heat. There is, in consequence, a rapid increase in valve temperature over the first 15 to 30 minutes, after which it begins to stabilise at a relatively fixed temperature. The rapid increase in valve temperature causes changes not only in its own inter-electrode capacities, but also in the valveholder insulating material and in the components soldered directly to the valveholder tags. The remaining parts of the circuit rise in temperature more slowly (although there may be a quicker rise of temperature in components soldered directly to the anode h.t. feed resistor) and they do not reach a stable temperature until a longer time (normally one or two hours) has elapsed. Because of this, the effects of temperature rise in the oscillator stage of a television tuner can be described as being two-fold. There is firstly the "short-term" rise caused by the relatively abrupt temperature rise of the valve, and there is the "long-term" rise wherein all the components on the chassis gradually rise to a stable temperature.

Whilst good tuner design is always aimed at keeping oscillator components reasonably cool, the only practicable method of preventing oscillator drift due to temperature rise in commercially priced units consists of fitting components which compensate for the rise. The drift-compensating components which are employed in practice are condensers having special *temperature coefficients*.

**Temperature Coefficient Condensers**

All condensers exhibit a change in capacity when their temperatures are increased, this being caused, as we have already noted, by dimensional changes and, in some cases, by changes of dielectric constants. Changes in capacity become of considerable importance when condensers are employed in tuned circuits, as such changes will obviously cause changes in resonant frequencies.

In order to obtain a measure of the changes in value of fixed condensers of the types which are employed in tuned circuits, the term "temperature coefficient" is employed. The temperature coefficient of a condenser defines the change in its capacity for a given rise in temperature, and is expressed in parts per million change for a rise in temperature of 1° C. (A worked example is given later.) If, with a rise in temperature, the capacity increases, the condenser is stated to have a *positive temperature coefficient* and the coefficient figure is preceded by the letter P. If the capacity decreases with rise in temperature the condenser is stated to have a *negative temperature coefficient* and the coefficient figure is preceded by the letter N.

In turret tuners the type of fixed condenser universally employed for tuned circuits employs a ceramic dielectric. It has been found that different types of ceramic cause the condensers in which they are used to have different temperature coefficients; whereupon a condenser can be given a previously determined temperature coefficient by the simple process of employing the requisite ceramic during its manufacture. The normally-available range of temperature coefficients currently used by tuner manufacturers is as follows: P100, NP0, N030, N080, N150, N220, N330, N470, N750, N1500.[1] For economic reasons the cheapest of these condensers are N750 and P100, and condensers to intermediate coefficients are usually found only in positions (such as tuner oscillator stages) where temperature coefficients are most critical.

Before proceeding further, it might prove helpful to give a numerical example of the manner in which the temperature coefficient defines capacity change with relation to rise in temperature. As has just been stated, temperature coefficient defines the change in

[1] An NPO condenser is one whose capacity remains (within tolerances) unaltered by temperature rise. N1500 condensers are used for drift compensation very infrequently.

capacity expressed in parts per million per degree rise Centigrade. Let us assume that we have a condenser which, at a room temperature of 20°C, has a capacity of 100pF. The condenser has a temperature coefficient of P100, and, in service, its temperature increases to 70°C, this representing a rise of 50°C. What is its capacity at the elevated temperature?

Since the temperature coefficient is P100 the increase in capacity will be 100 divided by 1,000,000 and multiplied by 100 (the value, in pF, of the condenser) and by 50 (the number of degrees Centigrade rise). That is:—

$$\frac{100}{1,000,000} \times 100 \times 50\text{pF},$$

which is equal to 0.5pF.

The new value of the condenser at 70°C will, therefore, be 100.5pF.

Such an increase in capacity may appear small but, in practice, it could completely upset the working of a turret tuner oscillator.[2]

In practical tuner units the condensers employed in the oscillator tuned circuits have selected temperature coefficients which enable them to compensate for frequency drifts caused by other components. In order to compensate for "short-term" and "long-term" drifts temperature compensating condensers may be soldered direct to valveholder tags or wired-in some distance away. Most manufacturers aim at a frequency drift which is less than some 50 kc/s at Band 3 frequencies.

### Next Month

It is hoped, next month, to conclude our discussion of the tuner unit by a consideration of the mixer and its test points, together with alignment by the aid of a wobbulator.

[2] All else remaining constant, a change of 0.5 of 1% in the tuning capacity of a tuner oscillator would result in a frequency shift of 300 kc/s in 200 Mc/s, a quite unacceptable figure.

# Can Anyone Help?

*Requests for information are inserted in this section free of charge, subject to space being available*

**ZA.11324 U.H.F. Receiver Special Mk. 3.**—J. Edghill, 3 Albacore Crescent, Lewisham, London, S.E.13, needs information on this receiver, and will be willing to pay for any expenses involved.

**R.1155 and T.1154.**—S. McCrorie, 23 Newcastle Gardens, Whitleigh, Plymouth, Devon, wishes to obtain a circuit diagram for a power pack for the above.

**Philips Type 186A-IS 6-Valve Receiver.**—C. Davies, 102 Buckingham Road, Bicester, Oxon, would like to borrow or preferably buy the circuit diagram with component values, and also if possible modification data for reception of 50–200m. Valve line-up ECH35, two EF39, EBL31, AZ31, EM34

**German Communications Receiver R3.**—H. G. Odd, Verona, Harrow Lane, Knockholt, Sevenoaks, Kent, asks if anyone can supply information on this receiver. Three wavebands cover 2.5 to 6.8 Mc/s, 6.7 to 14.7 Mc/s, 14.7 to 25.7 Mc/s; valve line-up: EF13, ECH11, EF12, EBC11, EDD11, EBC11 BFO, EZ11. Any expenses gladly refunded.

**Pye P.C.R. 2 Receiver.**—R. J. Derk, Bankers Farm, Bucks Cross, Bideford, Devon, would like any details, circuit diagram, power supplies, etc.; also information on the **Admiralty Amplifier Type N.24.** Willing to pay, or would exchange real Devonshire Cream.

**Admiralty Receiver Type B.46.**—H. Knowles, 12 Fairview Road, Denton, near Manchester, offers to pay any fair price for either circuit details or handbook; would also like to correspond with anyone who has used or modified this receiver.

**P.C.R.2 and R.208 Receivers.**—J. Brookes, 1 Dean Street, Blackpool S.S., Lancs., wishes to obtain information on fitting "S" meters to these receivers. Any expenses refunded.

**Series 920 Valve and Set Tester.**—C. T. King, 13 Monks Brook Close, Eastleigh, Hants, wishes to borrow, buy or be advised where to obtain an instruction book or manual for this instrument, manufactured by the American firm Precision Apparatus Co., Elmhurst, Long Island, New York.

**Sobell TV Receiver T.89.**—A. E. Franklin, 12 Queensland Crescent, Chelmsford, Essex, wishes to obtain, and will gladly purchase, the circuit of this televisor.

**Ekco C.R.6.1. Car Radio.**—P. Broom, Burn Rew Farm, Willand, Cullompton, Devon, wishes to purchase a service sheet.

**British Blue Spot Model AC/5.**—G. H. Hamilton, 30 Wishmoor Road, Camberley, Surrey, is willing to buy or borrow service sheets (circuitry and alignment data) on this pre-war receiver, the line-up of which is FC4, VP4A, TDD4, PEN.A4 and IW3.

**High-Gain Band 3 Pre-Amp** (*Radio Contructor*).—V. Jeremy, 21 Incline Top, Penyard, Merthyr Tydfil, Glam., would like suggestions for modification of this unit where diplexer is on masthead and only one downlead is available—this attenuates B.B.C. almost to zero at present. Successful and inexpensive mods gladly paid for.

**RF24 Unit and LU.51.**—P. Burbidge, Park View Hostel, Abbey Road, Gt. Malvern, Worcs., would like to borrow or buy manuals for these and would like to know if anyone has successfully modified the R.F.24.





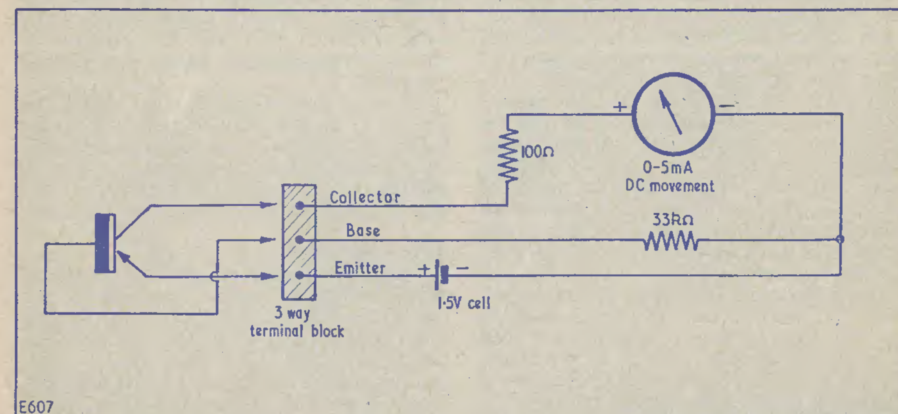
# A Simple POCKET TRANSISTOR TESTER

By W. E. GRIFFITHS

DUE TO THE LARGE SPREAD OF CURRENT gain in transistors, the writer has found a need for a very simple pocketable transistor current gain tester. The simple unit described here enables transistors to be tested for current gain in the earthed emitter connection (i.e. β or α′), and also indicates when $I'_{co}$ (i.e. leakage current) is excessive. The advantage of being able to make these tests at the time of purchase of the transistor is obvious.

This tester is only intended to be used as an approximate estimate of the "goodness" of a transistor where $I'_{co}$ is not considered too important unless excessive. With this in mind, the bias was arranged to operate the transistor at a collector current of 1mA for a current gain of 30, so that in most cases outside for connection to the transistor.

The scale is calibrated 0–150 and marked β or α′. To test for current gain, the transistor connections need not be screwed into the terminal block but may simply be held on by holding the leads in position, taking care not to hold the body of the transistor as this will cause the reading to rise due to temperature increase. To read $I'_{co}$, the collector and emitter leads only are connected and the reading noted. This should not be more than around 5 on the 0–150 scale (i.e. less than 200μA) and very often can be neglected. If the reading is *not* negligible, then after the base connection has been made and β read, the reading obtained for $I'_{co}$ must be subtracted from it. If it is desired to read $I'_{co}$ where this is excessive, the scale should be also calibrated 0–5mA and marked $I'_{co}$.




$I'_{co}$ will be small enough to be neglected.

The only components needed are a 2in 0–5mA moving coil instrument, a 33kΩ and a 100Ω resistor, a 1.5V penlight cell and a 3-way terminal block. These are wired as shown in Fig. 1 and are housed in a box which need be only a little larger than the meter instrument itself. By the use of the extremely small 1.5V hearing aid cells now available, it should be possible to build the components into the meter instrument case. The 3-way terminal block is mounted on the

The drain on the battery is so small that it can be soldered into the circuit. As the reading will be affected by falling battery voltage, a periodic check can be made on this by measuring the voltage at the terminal block between collector and emitter terminals.

Every care should be taken to correctly connect transistors into the circuit, but should a mistake be made, the current flow will be limited by the 100Ω resistor to 15mA maximum.

# Radio Miscellany

Already a number of letters have been received from readers advocating even further the widening of the range of interests covered in *R.C.* Radio and electronics are now used so much in the development of other branches of science that they have become almost inseparable from them. With the advent of the Space Age the relaying back of information by automatic communication and radio control are only parts of the role they play. Who can foretell what developments may take place in the transmitting of power to space ships?

The recent moon rocket, although it failed to achieve its objective and burned up on re-entry in atmosphere, penetrated nearly 80,000 miles into space and much valuable new knowledge of the universe was gained. It can be confidently expected that within the next few years reasonably certain control of space ships in orbit will be achieved. Unhappily they are likely to be used for military reconnaissance, but peaceful uses such as the relaying of t.v. programmes and long range weather forecasting will quickly follow. From that stage we may discover means of controlling the weather to some degree—an alluring promise to us poor inhabitants of the British Isles when we ruefully look back over our last two summers!

The implications, however, go far deeper. With the world's fast-growing population vast new areas for food production will need to be made available. It is a frightening thought when one considers it, that nearly a quarter of the land surface of the world is already desert. This area, too, increases annually at an alarming rate—in some places advancing as much as 30 miles a year on a frontage hundreds of miles long. The erosion of these fringe areas is accelerated by nomadic herdsmen overgrazing the sparse plant life and using the few remaining trees and scrub as fuel.

It was only when, during the war, I saw a little of the deserts that I became aware of the acuteness of this problem; although, of course, I had heard about it in a general sort of way. It came as rather a surprise to me to learn that deserts are not all sandy, flat wastes. Much of it is gravelly and strewn with broken rock, and it is far from flat. In an area where by repute there had been no rainfall for over four years I saw a sudden tropical downpour, following which plant life appeared as if by magic. The plants, too, grew at a seemingly fantastic rate only to later disappear for lack of moisture.

Since then the problem of deserts, of which Europe is the only continent to remain free, have held a fascination for me. Much of these areas could be made fertile if we had some measure of control over rainfall, and it is by no means impossible that we may yet learn to precipitate, from space, our passing clouds to make these barren areas food producing—or even to release some of our own unwanted rain into the Atlantic to ensure ourselves of a warm, dry summer *every* year.

At this point an odd thought strikes me. Should we discover how to guide rain clouds before precipitating them to the desired area, we in Britain will need to invent new opening gambits for our casual conversations, and also to find something else to grumble about.

**Rays—No Laugh**

The recent announcement that "sterilised zones" are to be formed extending up to a mile in the path of N.A.T.O. forward-scatter radio links located in the U.K. will have been noted with interest by many readers. For security reasons the sites are secret although, with the gradual clearance of their frontal areas, the secret may be hard to keep. The public, for their own safety, will not be allowed to remain permanently in these zones. Occupied farms and homesteads will have to be evacuated, nor will cattle be allowed to remain on the pastures. At present, even when concentrated into a narrow beam, the effects are unlikely to be very damaging; but with the early development of even more powerful equipment the local danger zone might well extend up to several miles. Modern tropospheric forward-scatter radio links operating with only 40kW



## *Centre Tap* talks about items of general interest

into highly directional aerials can produce a continuous beam of energy of around 40 megawatts, and even greater efficiencies are likely in the near future.

Such efficiencies are, of course, a very long way from becoming a "death ray" and such a ray is still a highly improbable development, but prolonged exposure to radiation may easily cause deep-seated heating inside the human body. Nor is one conscious that one is in the path of the beam. Some of the effects on the human body have long been known to the medical profession, and for years short spells of such radiation have been used for various forms of treatment. Indeed, I had two courses of such treatment earlier this year (and may yet have to have a third). Perhaps I am partially immune, but the only ill effect upon me was a mild feeling of sickness on a couple of occasions. A few other patients, however, did not get off so lightly—possibly due to other physical weaknesses.

An interesting sidelight was that the nurses and ward staff, who themselves never went near the carefully screened treatment chambers, often complained of ill-effects and frequently went sick because of it. They were firmly convinced that the effects they suffered from were due to re-radiation from us patients. At the time it seemed to me highly improbable that patients who themselves suffered little more than a feeling of general debilitation could re-radiate enough to affect normal and perfectly healthy people. I half-dismissed it as being largely psychological, but there may well have been more to it than I then thought. Recently special protective undies, even down to bras and girdles, have been designed. These are claimed to give up to 95% protection from radiation effects. Whether such clothing is to be available for nursing staffs whose only need for protection is from re-radiation from those who have been treated, doesn't seem to have been yet decided.

**A Different Tune**

Last month, in quoting a few of the later letters on the subject of the reproduction quality of the various "club" gramophone records, I wound up by saying that correspondents had been unanimous in their opinions. So they were, but alas I spoke too soon. The day following my copy going off to the printers, letters expressing exactly the opposite view began to arrive. Thus, in fairness to the latecomers I have to re-open the subject briefly this month, even at the risk of angering the non-gramo readers. Still, I suppose nearly everybody is interested to know if a line considerably cheaper than the standard article is as good in service, and if that's true it undoubtedly applies to gramophone records as much as anything else.

Firstly, E.F.G. of Malvern makes some criticism of "Classics Club" records (which were praised by earlier correspondents). He has tried a dozen titles and is obviously a lover of serious music, so his opinion is well worth quoting. While agreeing that many of their records are excellent in every way, he has found two or three of their discs lacking. E.F.G. adds that he has a friendly feeling for these records even after the occasional lapses, if only because their choice of titles has introduced him to a number of new musical pleasures. The only comment I would add to this clearly thoughtful opinion is that quite a few standard recordings suffer pre-emphasis, bass or top cut, imperfect balance or other pitfalls which make the lives of recording engineers difficult.

Now for a further opinion re the "World Record Club" discs (whose records came in for some criticism). G.A.N., who is a radio technician at London Airport, writes to say he has submitted them to most searching tests from which they emerged with flying colours. He has had experience in a manufacturer's test department and his judgment on the satisfactory reproduction of World Records is based on playings made under exacting conditions with top grade equipment. These and other belated letters in similar vein set me wondering whether people write more readily when they see something with which they disagree. If so, perhaps some of the original correspondents will return to the fray.

Also rather belated is a fresh title entered for our recent quest for the ideal "Test-cum-pleasurable-listening" record. It comes from J.N. (No. 1 Wing, R.A.F. Locking) who recommends "A Grand, Grand Overture" backed by "Sound Barrier" (Columbia SED5542). He says the music of both is excellent and exciting, but thrown in for good measure are vacuum cleaners, floor polishers, rifles, cannon, plus an organ and other weird and wonderful effects. Weird and wonderful at least to the world of music! On top of all this there are some rapid changes from double pianissimo to extra fortissimo, high density percussion groups and woodwind top notes

*continued on page* 373

Further Notes on the WIDE RANGE BATTERY OPERATED

# GRID DIP METER

By D. W. EASTERLING

Constructors often find that over a period of time operational experience makes desirable some modification or added refinement to apparatus which initially appeared to be completely satisfactory. A typical example was the grid dip meter designed by the writer and described in the October '58 issue of *The Radio Constructor*.

The changes made to the original design were aimed at increasing the usefulness of the instrument when used as an ordinary signal generator for test and alignment purposes. It was also considered necessary to make better provision for tests involving screened coils. The incorporation of these additional facilities necessitated the use of only a few extra components and no extra valves. Because the original unit was so compact, however, it was found necessary to rebuild into a slightly larger case. This led to further advantages such as room for a bigger and directly calibrated tuning dial, also slightly larger batteries could be used permitting more economical operation. The net result is an instrument simple in design, yet comparable with a signal generator for many purposes, plus additional facilities which the average signal generator does not possess.

It will be recalled that the principle of the grid dip meter is as follows: a valve oscillator generates grid current proportionate to the oscillator power. If some of the power is absorbed by an external circuit, the grid current will fall. Maximum absorption will occur when the resonant frequency of the external circuit is the same as the oscillator frequency. By tuning the oscillator frequency across the resonant frequency of the external circuit, therefore, the oscillator grid current will dip at the precise point where both frequencies are identical. If the oscillator is calibrated, and the grid current indicated, the unit may be used to determine the resonant frequency of an external tuned circuit. From this information, it is often possible to derive other information also.

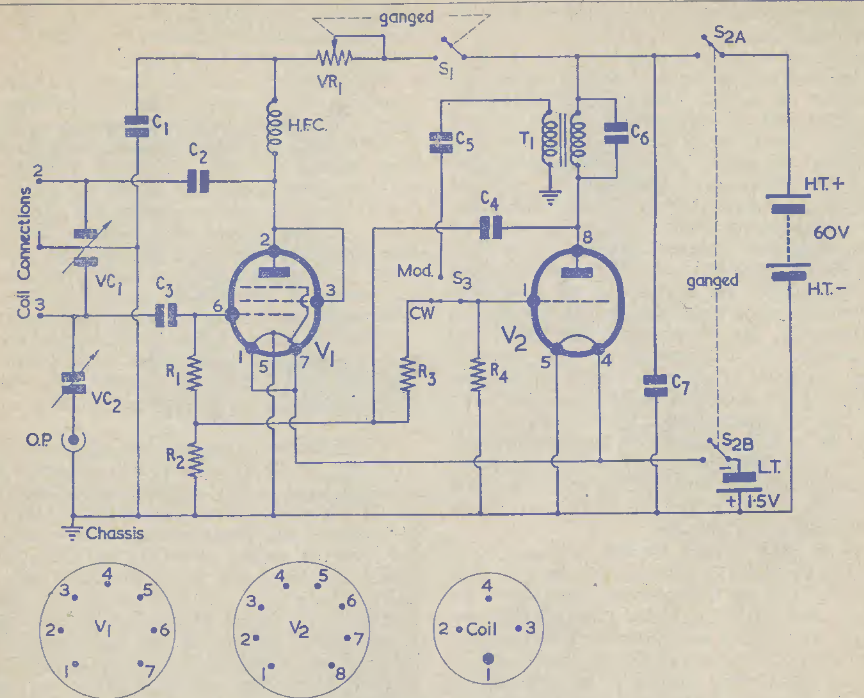
The original design consisted of a Shunt Colpitts Oscillator tuned by a two-ganged variable capacitor, with plug-in coils for each frequency band. The coils were arranged to protrude from the end of the unit, enabling direct inductive coupling to be obtained with the external circuit under test. A DM70 magic eye was arranged to indicate variations in oscillator grid current.

The revised circuit, which is basically the same as the original, is shown in Fig. 1.

**Components List**

$R_1$ 10kΩ ¼ watt resistor
$R_2$ 1MΩ ¼ watt resistor
$R_3$ 47kΩ ¼ watt resistor
$R_4$ 1MΩ ¼ watt resistor
$C_1$ 0.001μF tubular capacitor
$C_2$, $C_3$ 47pF silver mica capacitors
$C_4$ 0.001μF tubular capacitor
$C_5$ 0.005μF tubular capacitor
$C_6$ 0.005μF tubular capacitor (see text)
$C_7$ 0.1μF tubular capacitor
$VR_1$, $S_1$ 1MΩ potentiometer with s.p. switch
$VC_1$ 75+75pF two-gang capacitor
$VC_2$ 30pF (max) variable capacitor
H.F.C. H.F. Choke, Eddystone type 1066
$S_{2a}$, $S_{2b}$ D.P. On-Off switch } see text
$S_3$ S.P. changeover switch } see text
O.P. Socket Belling and Lee L604/s
L.F. Coils, wound on Eddystone formers, type 763
H.F. coils, wound on Eddystone formers, type 765
Coil Holder, Eddystone type 707
$V_1$ DL94 Mullard valve
$V_2$ DM70 Mullard tuning indicator
Batteries, case, knobs, valve holder, tag-strip, nuts, screws, wire, sleeving, etc.






Base Connections viewed from underside.

FIG.1.
Revised Circuit of the Wide Range Battery Operated Grid Dip Meter.

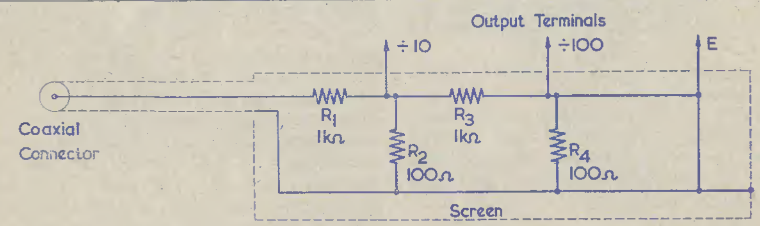



FIG.2.
A Simple Attenuator Network.

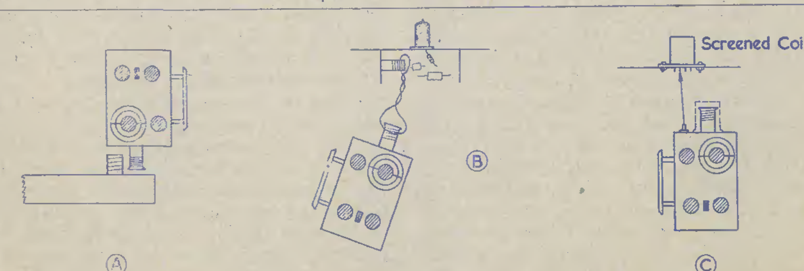



FIG.3
Different Methods of Coupling the Grid Dip Meter.

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Consider first the main changes in the r.f. oscillator circuit associated with $V_1$. An additional variable capacitor ($VC_2$) has been fitted connecting the grid end of the tuning coil to an output socket. The sensitivity control $VR_1$ has been moved from the grid circuit, where it is replaced by $R_2$, and inserted in series with the oscillator h.t. supply. Previously, variations in oscillator power due to different coils, etc., were compensated in the display circuit by adjusting the negative voltage derived from the oscillator grid current. This arrangement also enabled the display to be controlled when the unit was used as an absorption wavemeter, but in practice was found unnecessary. In the new circuit $VR_1$ controls the oscillator h.t., and hence its power, enabling the oscillator to be always operated at the optimum level. $S_1$, which may be ganged to $VR_1$, enables the oscillator supply to be cut completely, when the oscillator ceases to operate, and $V_1$ functions as a diode detector enabling the unit to be used as an absorption wavemeter.

Now take a look at the display circuit associated with $V_2$. It will be seen that with switch $S_3$ in the CW position, the grid of $V_2$ is d.c. coupled via $R_3$ to the grid leak network of $V_1$, permitting variations in oscillator grid current to be indicated by the display of $V_2$ in the usual way. When $S_3$ is switched to MOD, however, the grid of $V_2$ is coupled via $C_5$ to the transformer $T_1$. The magic eye then behaves as a normal triode in a tuned anode oscillator circuit operating at audio frequency. This audio signal is fed via $C_4$ to the grid circuit of $V_1$, thus modulating the r.f. signal.

The transformer $T_1$ is an ordinary intervalve transformer with a winding ratio in the region of 3:1. None of the component values associated with $V_2$ are critical, but $C_6$ may be selected to give the required frequency and waveform. Clean panel layout will be maintained if $S_3$ is incorporated with $S_2$ as a 3-pole, 3-way switch.

The anode current of $V_2$ should not exceed 100μA, and if the oscillation is too fierce it may be necessary to dampen the primary of $T_1$ with a parallel-connected resistor. An indication that $V_2$ is oscillating is given by the display, which appears fuzzy.

To obtain a nominal 20–30% modulation, the oscillator control ($VR_1$) should first be set to half illuminate the display of $V_2$ with $S_3$ in the CW position. If an audio signal only is required, the r.f. oscillator should be switched off by $S_1$, and $VC_2$ increased to maximum, when the output can be taken from the output socket. Due to low capacitive values associated with this circuit, the waveform at this point, although suitable for signal tracing purposes, is far from good. A better waveform may be obtained by fitting a special audio output socket connected via a 0.01μF capacitor to the anode of $V_2$.

When the grid dip meter is used as a signal generator, it is necessary to control the output level while limiting random radiation. The first step is to fit a screening can over the coil. This should be easily removable to permit coil changing, and direct inductive coupling when required. Unfortunately the can will tend to effect the tuned circuit, causing changes in calibration. This can be minimised to some extent by using a fairly large can made of non-ferrous metal. Even so, differences are bound to occur, and consequently it is best to calibrate initially with the can in position, as it is under this condition that the unit is used as a signal generator, when accuracy of calibration is most important.

A suitable screening can may be obtained from an old EF50 valve (VR91 available in quantity from ex-Government surplus equipment). This is of a convenient size, made of aluminium, and easily secured into position (yet just as easily removed) by using the special retaining clip made for this type of valve. To remove the can from the valve assembly, the flange at the base is carefully prised open, permitting the baseplate and valve to be withdrawn. The flange should afterwards be bent over with pliers to form a rigid edge.

With the coil screened, the output is taken from the special socket which should be a co-axial type such as the Belling and Lee L604/s (which takes the plug L734/P/AL). To reduce the effect external circuits may have on the oscillator, and also to provide further control of output level, the simple attenuator network illustrated in Fig. 2 may be used. This consists of two L networks, each attenuating by 10 (20dB), making a total attenuation of 100 (40dB). If desired, the network may be extended. The unit is constructed in a small screened container (a small tobacco tin, for instance), and is fitted with suitable sockets to take the output leads. A short length of co-axial lead suitably terminated is used to connect the attenuator network to the main unit. It is important that this should be less than 6in to prevent serious shunting of the oscillator.

When the instrument is used as a grid dip meter or wavemeter, coupling to external circuits may be made direct, as in Fig. 3 (*a*); via a low impedance coupling loop, as in Fig. 3 (*b*); or capacitively, with a single lead connecting the inner contact of the output socket with the "hot" side of the circuit under test, as in Fig. 3 (*c*). At all times, the variable coupling capacitor $VC_2$ should be set to minimum capacitance, consistent with reasonable results.



**MISCELLANEOUS**

# Experimental Chassis Construction

By B. T. DENVIR

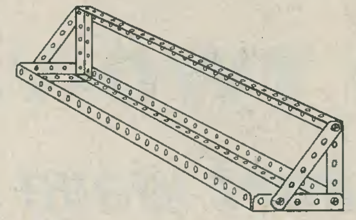

FIG. 1

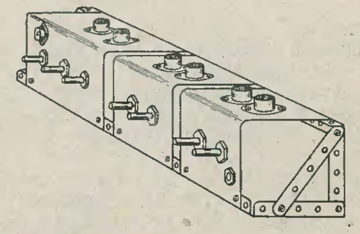

FIG. 2

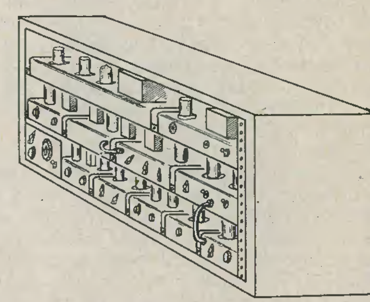

FIG. 3

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It is often found desirable to modify a receiver or improve it in some way; to add an a.f. stage, to put in an a.f. filter, i.f. crystal stage, a.f.c., a.v.c. amplification, etc., etc. When the set is already built on a chassis, this nearly always proves very difficult, or impossible, without entirely dismantling and rebuilding, possibly on another chassis. Many, quite reasonably, will abandon their idea, deciding that it is not worth the labour involved.

The following method of chassis construction was therefore devised, with the end in view of allowing modification and improvements, and general experimenting to take place with minimum dismantling and reconstruction, etc.

The basis of the construction consists of three 12½in Meccano girders. These girders have holes at ½in intervals, and are bolted to smaller 2½in girders as shown in Fig. 1. Then small "L" section chassis are made, measuring 2½in x 2½in, one for each "unit" of the set. (For instance, one for r.f. and f.c., one for i.f. amp., one for det. and a.v.c. and b.f.o., etc., as is convenient.) Incidentally, in the interests of stability, it is not wise to divide h.f. circuitry into several chassis; thus, for example, it is safest to put the r.f. and f.c. stages on to one chassis. These chassis are then bolted to the girder framework, as shown in Fig. 2, and components may be put in place and wired up. If it is more convenient, the order of these events could be reversed.

The only leads which need go from one chassis to the next are h.t.+, heaters, earth, and the signal lead; also possibly a.v.c., bias or some other such lead, depending on the application. A short stout wire for an earth lead must be used, as the painted surface of the girders is not a reliable conductor. Also, twisted pairs of wires must be used for the heaters, and these must not be earthed except at the power-pack, otherwise 50 c/s voltages will be set up across the earth leads, causing disturbing hum.

Thus, when a new unit is added, an i.f. stage, say, only five or six wires need be cut and resoldered, maybe less, and the chassis

*continued on page 373*

# a TWO-VALVE short wave receiver

By R. E. S. COULSON

### Description

THIS SET IS ESSENTIALLY VERY SIMPLE. THE first stage, round $V_{1A}$, is just a normal detector with reaction (or regeneration); the second, round $V_{1B}$, is a normal voltage amplifier. The third $V_3$, is the power output stage.

Signals are brought into the set through $L_1$ and the 300pF variable condenser $C_1$. This condenser is for avoiding aerial resonances, and thus eliminates "dead spots." $L_2$, $C_2$, $C_3$ form the tuning circuit. I used the two condensers $C_2$ (variable, 500pF) and $C_3$ (1,000 pF) because I had no 300pF tuner. The two in series behave approximately as a 300pF tuner and are cheaper, but there is no reason why a 300pF condenser should not be used. It should in any case be ceramic-insulated.

The signal, or at least some part of the signal, is rectified in $V_{1A}$, but some r.f. does get through. This cannot pass through the r.f. choke (which should be a S.W. one), and so has to pass through $L_3$ to earth. $L_3$ is tightly coupled to $L_2$ and thus some positive feedback is introduced; this is increased by the $C_4$, $C_5$ combination until just before the oscillation point. Here the set is most sensitive. It is often very difficult, even under the best of conditions, to keep the set uniformly sensitive over, say, 300 kc/s by adjusting $C_4$; $C_5$ has therefore been introduced to make the job easier. If it is still difficult and oscillation begins suddenly, it might be as well to adjust experimentally the values of $C_6$ and $R_1$. Audio signals are passed through the r.f.c. and $C_7$ to $S_1$.

$S_1$ is the radio/gramophone switch and $R_3$ is the main volume control, operating in both positions of $S_1$. $R_4$ is to drop the h.t. voltage on $V_{1A}$ down to about 200 volts. $C_8$ is to remove any trace of hum (at 50 c/s) from the detector, and of voice frequencies from the h.t. line and thus the rest of the set. The cathode resistance of $V_{1B}$ is unbypassed because this introduces slight negative feedback and also because it is cheaper. The

### Components List

*Condensers*

| | |
|---|---|
| $C_1$ | 300pF, mica, variable |
| $C_2$, $C_3$ | See text |
| $C_4$ | 300pF mica, variable |
| $C_5$ | 15pF, air, variable |
| $C_6$ | 200pF mica |
| $C_7$ | 0.05µF, paper—350 VDC |
| $C_8$ | 2 µF, paper—350 VDC |
| $C_9$ | 0.5µF, paper—350 VDC |
| $C_{10}$ | 25µF, electrolytic—25 VDC |

*Resistors*

| | |
|---|---|
| $R_1$ | 2.2MΩ |
| $R_2$ | 47kΩ |
| $R_3$ | 1MΩ potentiometer, log |
| $R_4$ | 220kΩ |
| $R_5$ | 1kΩ |
| $R_6$ | 270kΩ |
| $R_7$ | 330Ω |
| $R_8$ | 220kΩ |

*Valves*

| | |
|---|---|
| $V_1$ | 6SL7GT or 6SL7M |
| $V_2$ | 6V6GT or 6V6M |
| $V_3$ | 5Y3GT |

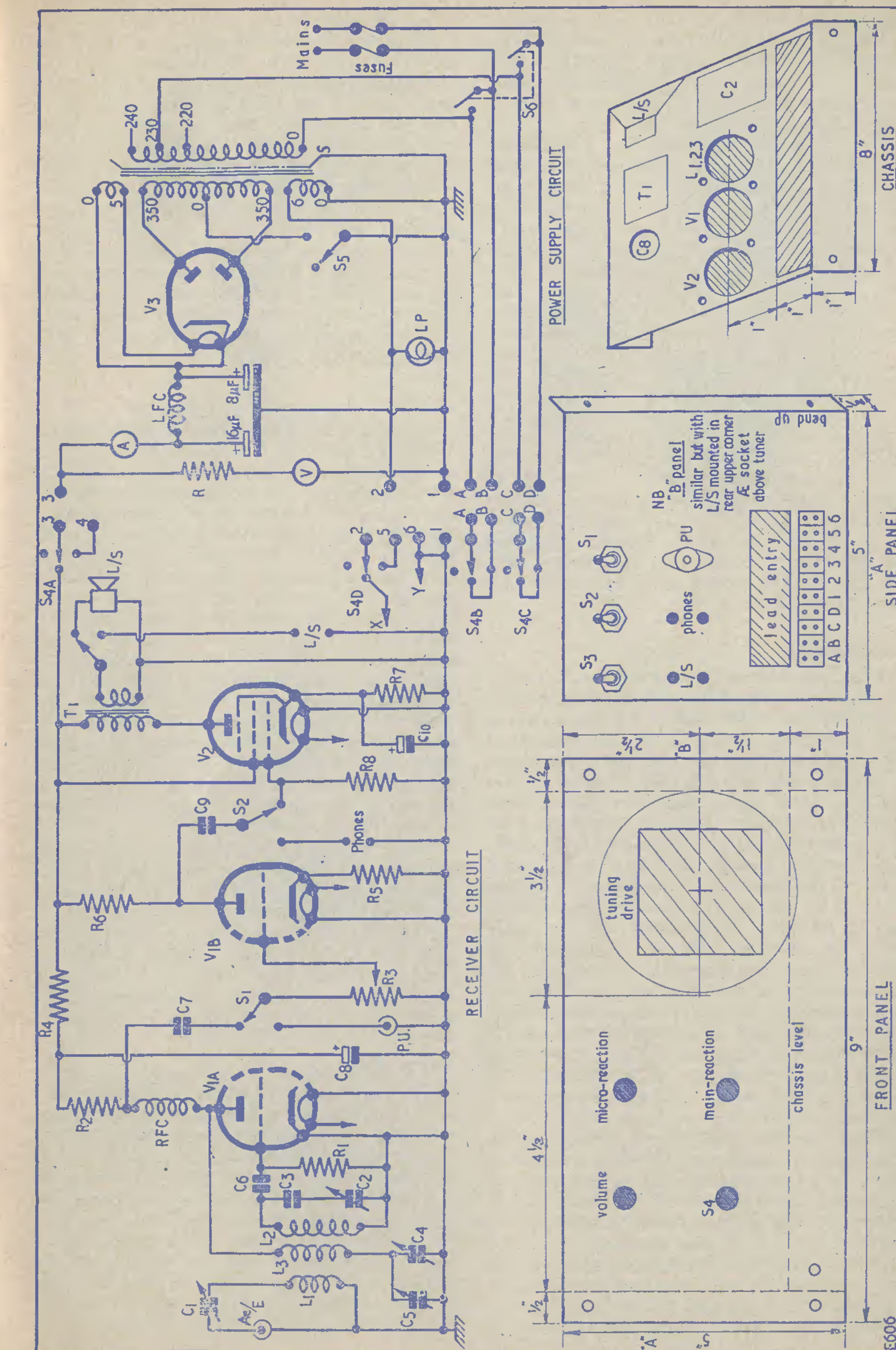
*Switches*

| | |
|---|---|
| $S_1$, $S_2$, $S_3$, $S_5$ | All single-pole change-over switches |
| $S_4$ | 4-pole 3-way rotary switch |
| $S_6$ | 2-pole on/off switch |

*Miscellaneous*

R.F. choke—short wave type
L.F. choke—20H–80 mA
Smoothing condensers—8+16µF 450V d.c. working, 550V surge
Mains transformer:
200–230V primary
350–0–350V h.t. secondary
0–6.3V heater secondary
0–5V rectifier heater secondary
Output transformer ($T_1$)—Multi-ratio or 6V6 to 3Ω type
Loudspeaker (internal) 3in Rola
Metal plugs, sockets, terminals, tags, etc.
Tuning drive—Admiralty type No. 8419 was used in prototype





anode load resistor, $R_6$, is high enough in value to provide a nice large a.f. voltage when using low-voltage output pick-ups, and plenty of audio gain is available when receiving weak signals. $C_9$ is made large to avoid attenuating the bass.

$S_2$ is the phones/l.s. switch. The phones socket is useful when listening for weak signals and also when listening in a noisy room (or one in which one is supposed to be quiet!). The rest of the output stage is quite conventional. A switch which changes between internal and external loudspeakers was fitted because L.P.s don't sound very good on a 3in speaker. For most S.W. listening the small speaker is quite adequate.

The switch $S_4$ is for control of the power circuits of the set. It is shown in the "receiver" position. $S_{4D}$ is responsible for controlling the l.t. (6.3V) circuit. Terminals are fitted for, say, a QRP transmitter (up to 10W) or a v.h.f. receiver, or a M.W./L.W. set. $S_{4A}$ switches the h.t.+ lead. When using a transmitter (and $S_4$ as send-receive switch), "5" and "x" on $S_{4D}$ may be shorted, so that there is no delay. Switches $S_{4B}$, $S_{4C}$ are for remote control of the power pack. (In my case the power pack was about 10ft away from the set.)

### Construction

First, assemble all parts roughly on a piece of paper the size of the chassis to determine how they are to be fixed. A good layout is that shown in Figs. 2, 3, 6, 7, but much, of course, will depend on what parts you have. I, for example, used a 500pF tuner, a 3in speaker, octal valves, and that tuning drive merely because they were in my spares box. It would be possible to use a 300pF tuner, a 5in or 8in speaker (but not on the same chassis), B9A valves, or a non-surplus tuning drive. Use the best output transformer that can be afforded; cheap ones can give really shocking quality, almost unnoticed on average jazz, but showing up on classical music and always noticeable on piano. In the prototype, Denco octal plug-in coils, Green ranges 3, 4, 5, were used to cover all the short waves from 1.6 to 32 Mc/s. (Ranges 1 and 2 cover L.W. and M.W. respectively.) This firm also makes similar coils with B9A bases.

Mark out the positions of holes, etc., on the metal, not forgetting the 7in x 1in slot in the front of the chassis; this helps a lot with wiring up the front panel. A glance at the left end of the set will show that the wiring is pretty tight. The best method is to make sure that the chassis fits together all right and then wire up $S_4$, with terminal block and a tag strip (not shown) on left of set. Next put all the rest of the mountable components on the chassis, with a solder tag under at least every valveholder nut, and the coil holder.

Now wire up the detector stage, $V_{1A}$. $C_1$ does not appear in the diagrams showing layout, as I had an aerial tuner at the lead-in and thus did not need it. Keep all leads in this part of the set as short as possible. There is a great temptation to leave them long "just in case the set won't work," but it is more likely not to work if the leads are left long.

$V_{1B}$ circuits are comparatively straightforward, and so are $V_2$. It may be necessary to use a separate box for l.s. and transformer circuits. If it is possible to use screened leads for a.f. wiring, do so; I did not and I found the hum level (which may have been due to bad smoothing in the power pack) a little high, though bearable.

### Testing

Although the circuit of the set is simple, working it properly is not quite so easy. Plug in the valves and aerial and connect up the power supplies. Put in coil range 4 and with the reaction condenser at minimum capacity tune over the band. About the middle, some stations ought to be heard; when they are, turn up the reaction control and retune the set, as any considerable alteration in the reaction control alters the tuning slightly. If the reaction is turned up too far, the set will oscillate and whistle. Severe distortion is usually audible first. Many people who have tried to get stations on this set for the first time have failed through not adjusting it properly; with careful adjustment an apparently empty band can be made to yield signals—all that is needed is practice and patience. The main trouble is that the tuning alters with the reaction.

When tuning over a limited (e.g. amateur) band, the micro-reaction control is set at half capacity and the tuning set to the middle of the band. Bring up the main reaction until the set just oscillates. Then reduce capacity with the micro control. There is now no need to touch the main control. Any searching can be done by adjustments to the vernier tuner and micro-reaction controls.

### Power Pack

This uses a 350–0–350V transformer ($T_2$) with 5V and 6.3V heater windings and a standard mains primary. Two fuses are fitted in case of shorts in the remote control circuit. My power pack was fitted on a 6in x 4in x 2in chassis; the 6in x 6in front panel was fitted with h.t. switch ($S_5$, in lead from middle of h.t. winding, to earth), local mains switch ($S_6$), "l.t. on" lamp, and two meters, one for voltage, one for current, to read d.c. h.t. output. A is an 0 to 80mA meter, V an 0 to 1mA meter with a 450kΩ resistor, R, in

*continued on page* 365





# THE PREMIER *Petite* BATTERY PORTABLE RADIOGRAM

**Described by JAMES S. KENT**

THE "PETITE" BATTERY PORTABLE SUPERHET was fully described in this magazine some time ago (December 1957 issue —ED.), and since that time many hundreds of these excellent little receivers have been successfully constructed by hobbyists. A recent innovation, however, has been the addition to the basic circuit—the receiver—of a battery operated gramophone reproducer. By this means, one is able not only to enjoy the radio programmes when out of doors but also to select and listen to one's own favourite recordings. To the best of the writer's knowledge, this is the very first time that such a kit has become available to the home constructor; although, of course, battery-operated turntable motors have been available to manufacturers for some time past.

The complete receiver and reproducer is relatively inexpensive and simple to construct and here may well lie one of the answers to the Christmas gift problem. The turntable, motor and pick-up are supplied ready assembled and tested—all that is required of the intending constructor is to build the receiver, or modify an existing one, connect the pick-up, fit into the case and all is complete. For those who already have the "Petite" portable radio, a new case will be required in place of the old one, additional room being required in order to accommodate the motor.

From the front cover illustration it will be noted that the whole assembly is housed in an extremely attractive two-toned carrying case; there are two choices of colour arrangements. The turntable is of cream plastic, as is the motor board, and the pick-up arm is white. The latter fits snugly into position whilst the case is being carried. The pick-up head has a clear plastic protection dome and an automatic stylus cleaning brush. The motor incorporates its own stop-start mechanisms.

### Circuit

The circuit of the portable radio and reproducer is shown in Fig. 1. From this, it will be seen that some modifications to the original design have been made in order to incorporate the gram position, etc. For those to whom the circuit is new, a short description follows.

The frame aerial assembly, fitted inside the cabinet lid, is tuned by $C_{3A}$ on the Medium wave position and by the combination $C_{3A}$, $C_1$ and $C_2$ on the Long wave position of the wavechange switch. The frequency changer is the Mullard DK96, a heptode type that performs extremely well in such an application. The numbers around the valve refer, of course, to the actual base connections. $R_1$, $R_5$ decoupled by $C_{11}$ apply the a.v.c. voltage to both the frequency changer and the first i.f. stage. This effectively prevents over-

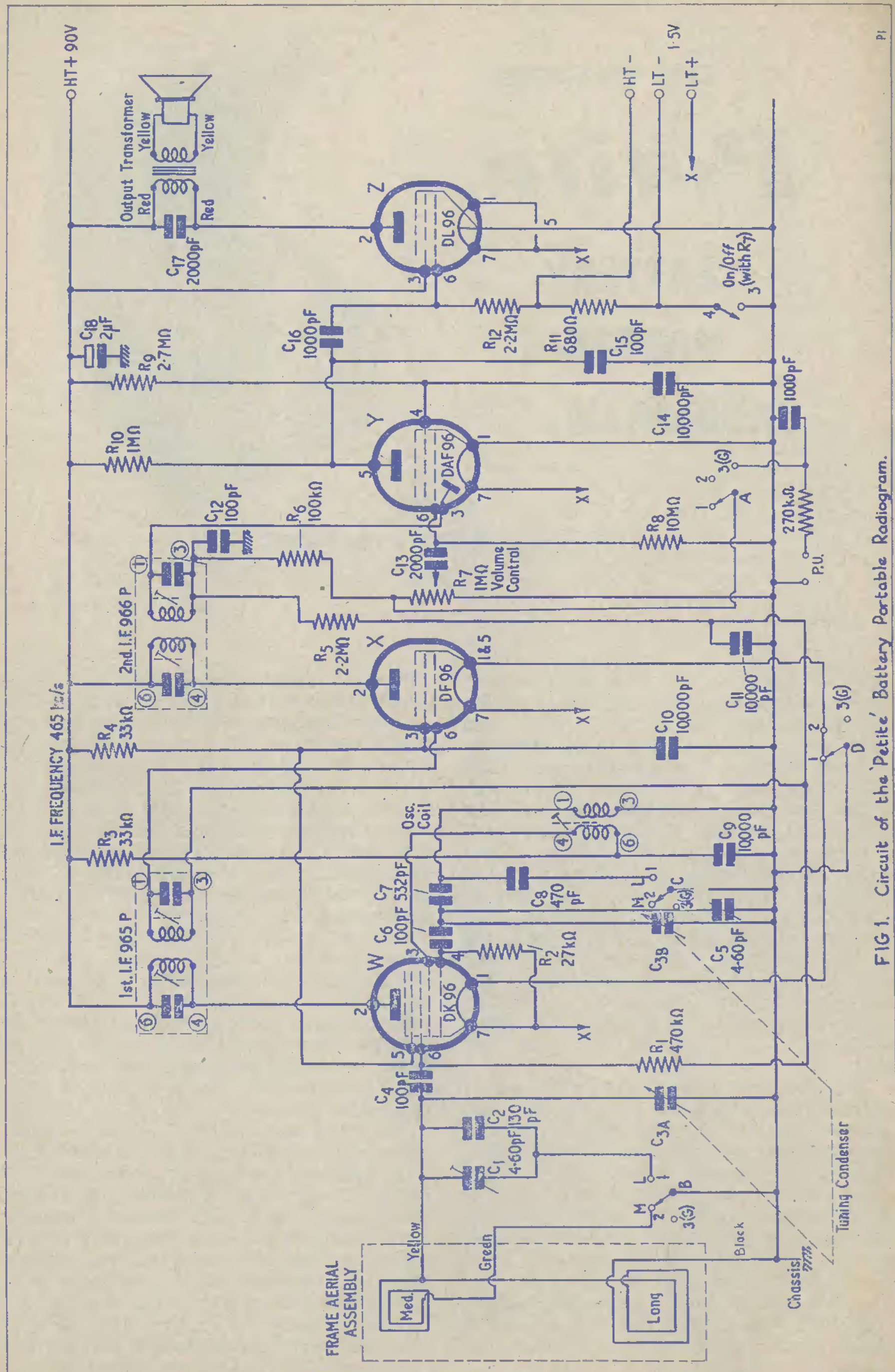
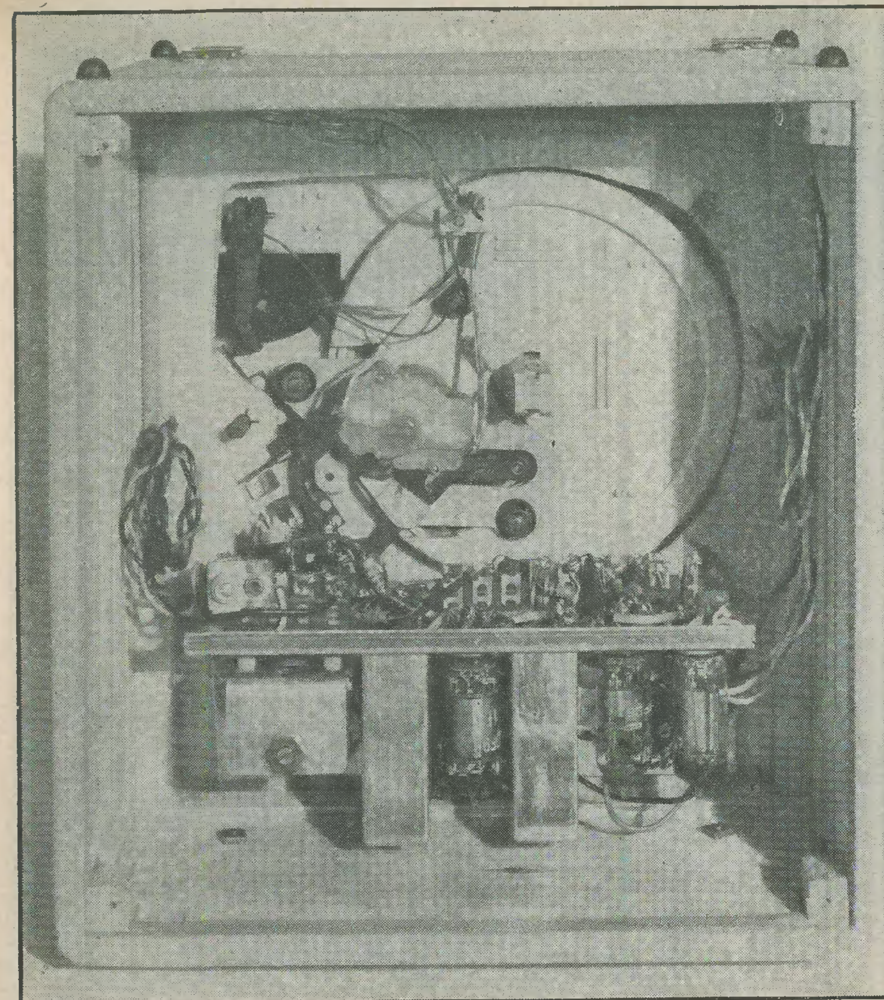


FIG 1. Circuit of the 'Petite' Battery Portable Radiogram.


*Underneath view of the motor and chassis layout*

loading when tuned to the local transmitter. The oscillator section is tuned by C3B with $C_5$ in parallel on the Medium wave and the additional $C_8$ on the Long wave position. $C_7$ is the oscillator padding condenser, and is in series with $C_6$; the latter, together with $R_2$, forms the oscillator grid components; the oscillator "anode", grid 3, is fed directly from the oscillator coil winding.

The output from this stage is applied across the first i.f. transformer, type 965P (465 kc/s) and from thence into the i.f. stage. This is a perfectly standard circuit designed around the Mullard DF96 r.f./i.f. pentode. The resultant output from this stage is rectified by the diode section of $V_3$, and the audio is fed via the slider of $R_7$ and $C_{13}$, into the pentode section of the DAF96. The potentiometer $R_7$ acts as the volume control. $R_{10}$ is the $V_3$ anode load component, while $R_9$ is the screen series resistor decoupled by $C_{14}$.

The amplified a.f. is fed into the output stage via $C_{16}$, the condenser $C_{15}$ filtering any residual r.f. to chassis. The grid leak and bias components respectively are $R_{12}$ and

$R_{11}$. The output from the DL96 a.f. pentode is fed into the speaker via the output transformer, $C_{17}$ applying a measure of tone correction. The speaker is a 5in 3Ω type.

The lid operated switch previously incorporated in the "Petite" receiver has been omitted from the reproducer design, the on/off switch being an integral part of the volume control $R_7$.

the grid of the DAF96, from which point normal amplification takes place.

The turntable motor draws its power supply from a type 996 six-volt battery contained, as are all the other batteries, within the carrying case.

Fig. 2 shows, in greater detail, the wiring connections to the wavechange/gram switch and also the volume control $R_7$. This should be studied by those already owning a

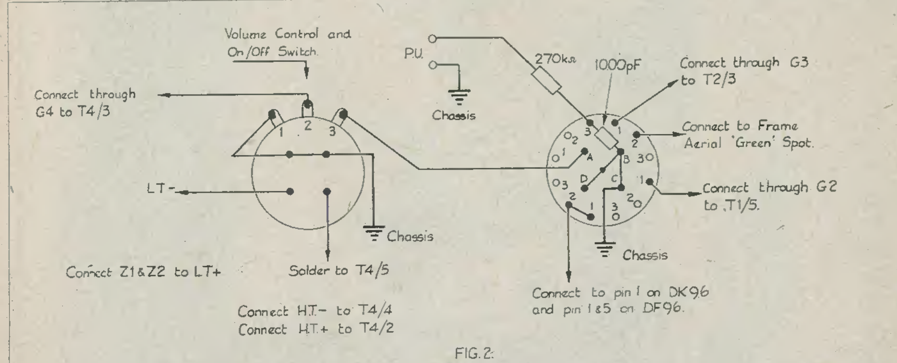



FIG. 2: Modified Circuit for Petite Battery Portable Radiogram.

Position 3 of the wavechange switch is the gram position. With the gram input in use, the frequency changer and i.f. stages are made inoperative by disconnecting the DK96 oscillator and grid tuned circuits (sections B and C) from the earthed return, and breaking the l.t. minus to both valves in the same manner (section D). Input from the gram pick-up is via $R_{13}$ $C_{19}$, $R_7$ and $C_{13}$ into "Petite" portable receiver, as the details given in this drawing represent the main modification to the original circuit in order to accommodate the record player addition. The notations, such as $G_4$ (Grommet 4) and T1/5 (Tagboard 1, tag 5), are referred to in the original article describing the "Petite" as a battery portable superhet which appeared in the December 1957 issue of this magazine.

# Book Review

**AN APPROACH TO AUDIO FREQUENCY AMPLIFIER DESIGN.** 126 pages, 66 diagrams. Published by The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2. Price 10s. 6d.

Edited by C. E. Knight-Clarke, the contents of this book represent the culmination of considerable design and development studies by research staff in the laboratories of the General Electric Co. Ltd., and its subsidiary, the Marconi-Osram Valve Co. Ltd. In consequence, the discussions are authoritative and the several designs presented for high-fidelity amplifiers are proven examples of this type of equipment.

The first chapter is devoted to major design features for output stage, input, phase inverter and driver stages, and power supplies. Discussion on output stages concerns the four main requirements of maximum power output, frequency range, maximum distortion, and output impedance. The operation of output valves in Class B, AB1, AB2, triode, pentode and ultra-linear modes, using fixed bias or auto-bias, is also dealt with. The information on input and intermediate stages is necessarily rather brief since it covers only well-tried arrangements which are incorporated in some of the designs given later in the book. Four different power supply arrangements are discussed, and necessary precautions in operating and balancing amplifiers are described.

Seven chapters, forming the major portion of the book, are devoted to circuits and full information on fifteen different amplifier designs, ranging from a simple 5-watt one for domestic use to a public address amplifier capable of delivering 1100 watts at a maximum of 7 per cent distortion. A separate chapter discusses pre-amplifiers and tone control before giving full details of two pre-amplifier circuit designs.

Appendix A concerns a multiple-pair push-pull amplifier design using ten valves in ultra-linear mode with fixed bias, giving 400 watts output. Appendices B, C and D deal with output transformers and stabilisation, valve ratings and characteristics, and abbreviations respectively. This is an excellent reference book, very well produced and presented. It is, to say the least, outstanding value at its cover price.

W. E. THOMPSON.



# Technical Forum

### Picture Tube Mounting

THE MOUNTING AND HANDLING OF TELEVISION picture tubes is a subject which we feel is worthy of a place in this series. As the size of tubes increases so the problems become more acute, partially because of their increasing weight and partly because the consequences of an accidental breakage are more costly. It goes without saying that a tube costing between £20 and £30 is worthy of very careful handling and subsequent mounting in a receiver. Any carelessness or lack of thought can have disastrous consequences in the form of a cracked tube, or in some cases an implosion may occur. Anyone who has had the misfortune of being in the vicinity of a 17in or 21in tube which has imploded would agree that it is an unforgettable experience in which there is a serious danger of flying glass. The writer has actually witnessed an implosion which resulted in a part of the face plate of the tube becoming embedded to a depth of about ½in in a plaster wall. The tube had been standing face downwards on the bench and at the time no obvious cause for the fault could be suggested; it was, however, subsequently assumed that the glass had been weakened by a knock some hours earlier, but more of this later.

### Tube Handling

During the manufacturing process the tube undergoes several heat annealing cycles which ensure that no serious glass strains exist at the time it leaves the factory. However, stresses can be introduced by mishandling or by knocking the tube. When a tube is not installed in the equipment it should be stored face downward in its original packing, with a soft pad of material placed under the face plate. It is advisable to inspect the pad to make sure that it is free from any abrasive particles which might scratch the glass. Scratches anywhere on the tube can weaken the glass and may lead to an implosion, sometimes after a considerable delay of weeks or even months.

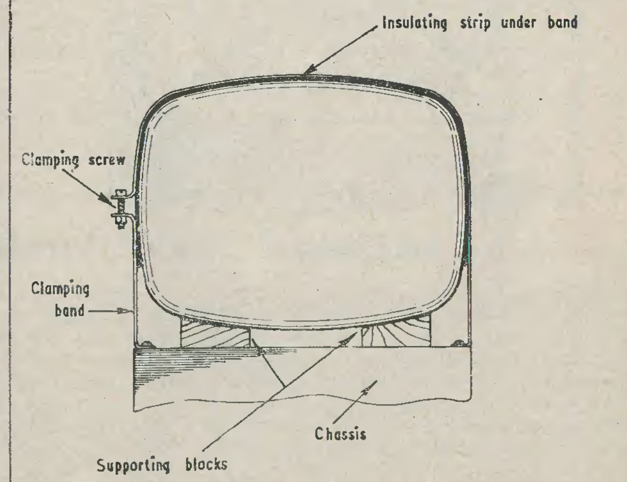



FIG. 1.

When lifting 12in or larger tubes from the carton they should be handled around the edge of the screen and preferably not extracted by lifting from the neck. If handling by the neck is essential, great care is required to keep the axis of the tube vertical, avoiding any sideways leverage and supporting the bulb where-ever possible. It is usually necessary to take the tube from the packing and place it face downward on the bench prior to installation; remember to have a pad of soft cloth handy to receive it and make very sure that the cloth is free from dirt. Small particles of coal or metal splinters can produce a very severe scratch on a tube face plate. Another possible source of glass scratches is the presence of rings on the fingers of the person handling the tubes. The tube manufacturers have experienced the trouble which such rings can cause, particularly when they are fitted with ready-made glass cutters in the form of diamonds.

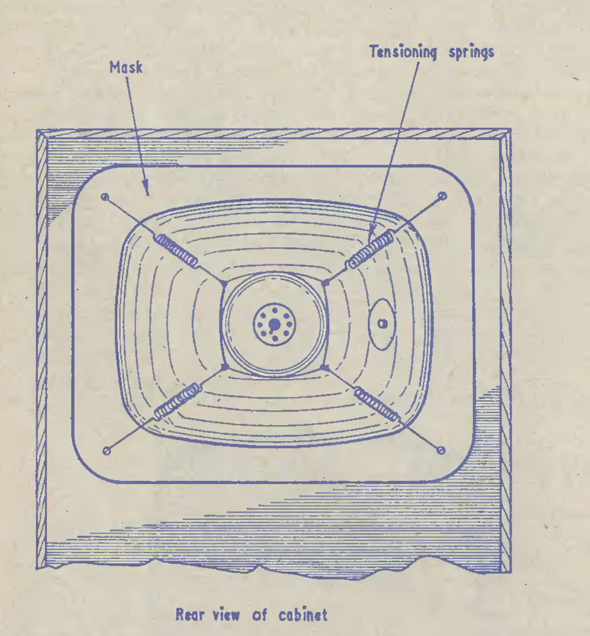



FIG.2. Showing cord harness holding tube against rubber mask

There is another possible way in which a tube may be damaged and it is one which is by no means obvious, but it has caused the loss of several tubes to the writer's knowledge. Most tubes are made from glass which had a high electrical resistivity so that it is possible to remove a tube from a set which has recently been in operation with a charge still remaining on the capacitor formed by the internal and external coatings on the cone. By placing a hand over the e.h.t. terminal of the tube whilst contact is made with the external aquadag coating, it is possible to obtain quite a nasty shock. Whilst it is very unlikely that this could be serious to the handler, it can easily cause an involuntary action resulting in the tube being dropped.

### Metal Cone Tubes

The handling of metal tubes requires the same degree of care as outlined for the glass counterpart, and two additional items are applicable to them. These tubes are vulnerable to knocks on the metal rim as damage may result to the glass-to-metal seal. Some readers will no doubt have had experience of the cracks which occur radially towards the outside of the face plate of these tubes when they are subjected to a blow on the rim. This is an expensive fault and can often be avoided by a little care.

The cones of these tubes are made from a ferrous metal which can be readily magnetised. The cone should, therefore, be kept well away from magnetic components such as speakers and focusing units. Should the cone become accidentally magnetised it will produce a non-uniform steady deflection field within the tube and will appear as very asymmetrical raster distortion. This form of distortion can be distinguished from that due to deflection coils and the other tube accessories because it will rotate as the tube is rotated.

### Tube Mounting

The mounting of television tubes has been very carefully investigated of recent years as it is recognised that some of the implosions which have occurred have been due to the tube being under mechanical stress in the receiver. Because of the vast number of different tubes and chassis layouts which are possible it is difficult to give specific mounting details, so perhaps we may commence this section by describing a system which has given quite a lot of trouble in an attempt to show what should be avoided. The receiver in mind had a 17in tube mounted on the chassis. The tube was supported in two places, the main weight being taken under the face plate where a metal strap clamped it to the chassis. The other support was by means of a rubber grommet in the back of the focus magnet which was in turn mounted towards the centre rear of the chassis. Now, as described, this set-up would appear to be satisfactory, but unfortunately the whole chassis assembly was of rather too light construction to take the weight of a relatively large tube. In fact, if the chassis was lifted at two opposite corners the back would move relative to the front where the tube was supported, and this caused the focus magnet to apply appreciable pressure to the tube neck. Steps were taken to reinforce the chassis when one day as it was being lifted from the cabinet there was a loud report which investigation subsequently revealed as due to the tube neck being removed from the cone. This proved to be a somewhat expensive way of finding out the importance of preventing relative movement between the cone and neck supports.

In general, the weight of the tube should be taken near the centre of gravity which is two or three inches behind the face plate. Also, the relatively flat surface of the glass in this area makes it suitable for taking a clamping band designed to hold the tube rigidly to the chassis. The tube should rest on two blocks whose combined length is greater than one-third of the length of the horizontal edge of the tube, and the metal clamp should be held off the glass by means of a plastic or rubber strip. This arrangement is depicted in Fig. 1.

An alternative assembly is shown in Fig. 2, which is used in receivers where the tube is fixed permanently in the cabinet and the deflection and focusing components are supported from the sides of the cabinet. Here again it is most essential to make the cabinet sufficiently rigid to prevent the focus unit being forced against the tube neck upon lifting. With this form of mounting the tube face is usually supported by the mask and is held in position by spring-loaded cords encircling the cone and attached to the front of the cabinet. A harness of this type is easily made up and can be fastened to the cabinet by means of four hooks screwed into the wood.

### Electrostatic Tubes

In the mounting of magnetically focused tubes it is impossible to allow the weight of both the deflection coils and the focus magnet to rest on the tube neck so some additional support is necessary and is usually obtained via the focusing unit. However, with the electrostatically focused tube the position is different as the neck carries only the deflection unit and a small ion trap magnet. As the deflection coils are pushed up against the cone section their weight is distributed over a reasonably large area of the glass and it is permissible to rely on the face plate clamp only with no additional support given to the neck end of the tube.

One final point is worthy of mention and is applicable to all types of picture tubes. The socket should not be rigidly mounted, but should be equipped with flying leads which are sufficiently flexible not to apply any pressure to the neck. Also when removing the chassis from the cabinet of a receiver in which the tube is clamped, don't forget to first remove the tube socket. A sudden tug on the leads can produce sufficient strain to crack the neck.

Whilst some of the precautions described may be obvious, it is quite surprising how many tubes have been lost because they have not been observed. So perhaps we may conclude with the familiar saying, "To be forewarned is to be forearmed."

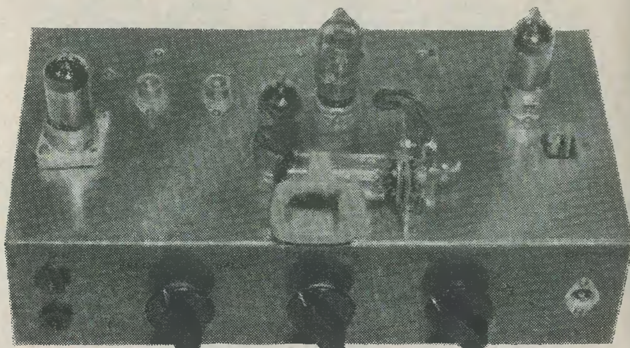
## Two-Valve Short Wave Receiver

*continued from 358*

series. F.S.D. is thus 450 volts. (This is the absolute maximum voltage that may be allowed to appear across the smoothing condenser, but it is not likely to be exceeded; the maximum will not ordinarily be more than 425V.)

The history of this set may present some points of interest. Two years ago, in April, 1956, it was planned as a two-stage T.R.F., battery-driven. In May, two articles appeared in *The Radio Constructor*, under the titles "Simple Kitchen Radio" (page 634) and "Simple All-Wave Receiver" (page 636), describing very similar sets. The original circuit borrowed many values from the former and some from the latter, and these two will be seen to bear some resemblance to the circuit I eventually used. The frills (all the switching, the micro-reaction, etc.) were added about six months later. The final product seems to me as good as many, and better than some, commercial T.R.F.s and a few superhets, especially in the tuning, which is very sharp indeed.

# *The* MULLARD TAPE AMPLIFIER "Type C"*



PART 2

Described by R. WEBB

*Component List.*—$C_{18}$, it should be noted, variable. $C_{28}$, shown in Fig. 13 (*a*) is a 2,200pF silvered mica capacitor and was omitted from the circuit diagram Fig. 2 (Part I, November issue) and also from the component list given. $C_{29}$, also omitted, but shown in Fig. 16, is rated at 0.5μF, 350V.

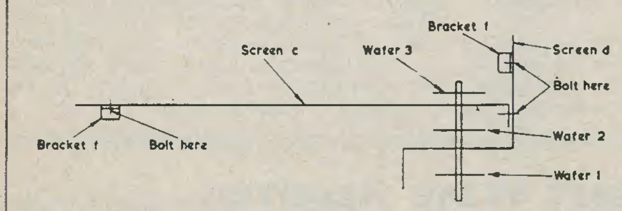


FIG. 3

## Chassis Construction

DETAILS HAVE BEEN PUBLISHED BY, AND are still obtainable from Mullard Ltd. of the layout and disposition of the various holes for components. For the purposes of this article it is assumed that a ready punched chassis will be purchased, and those which can be obtained from advertisers in this publication can be recommended as providing a professional finish to your amplifier. It does certainly help to start off with a nice piece of well shaped metal work. Somehow this seems to impress the constructor with the need for a careful and neat job with the result that an all-round high class finish is achieved. A little time spent polishing up this item before commencing assembly is well worth the trouble. Any minor blemishes incurred during assembly can usually be removed quite easily afterwards, provided a good preliminary polish is imparted to the chassis. With regard to the lettered control panel which can be obtained from the same advertisers, and which is recommended to give the finishing touches to the amplifier, there are two kinds available, one with the lettering horizontal as in the photograph of the complete amplifier, and another with the lettering vertical in case you should wish to house the unit in a console

* The prototypes of this amplifier were designed and built in the Mullard Applications Research Laboratory by D. H. W. Busby, C. Hardcastle and J. C. Latham.



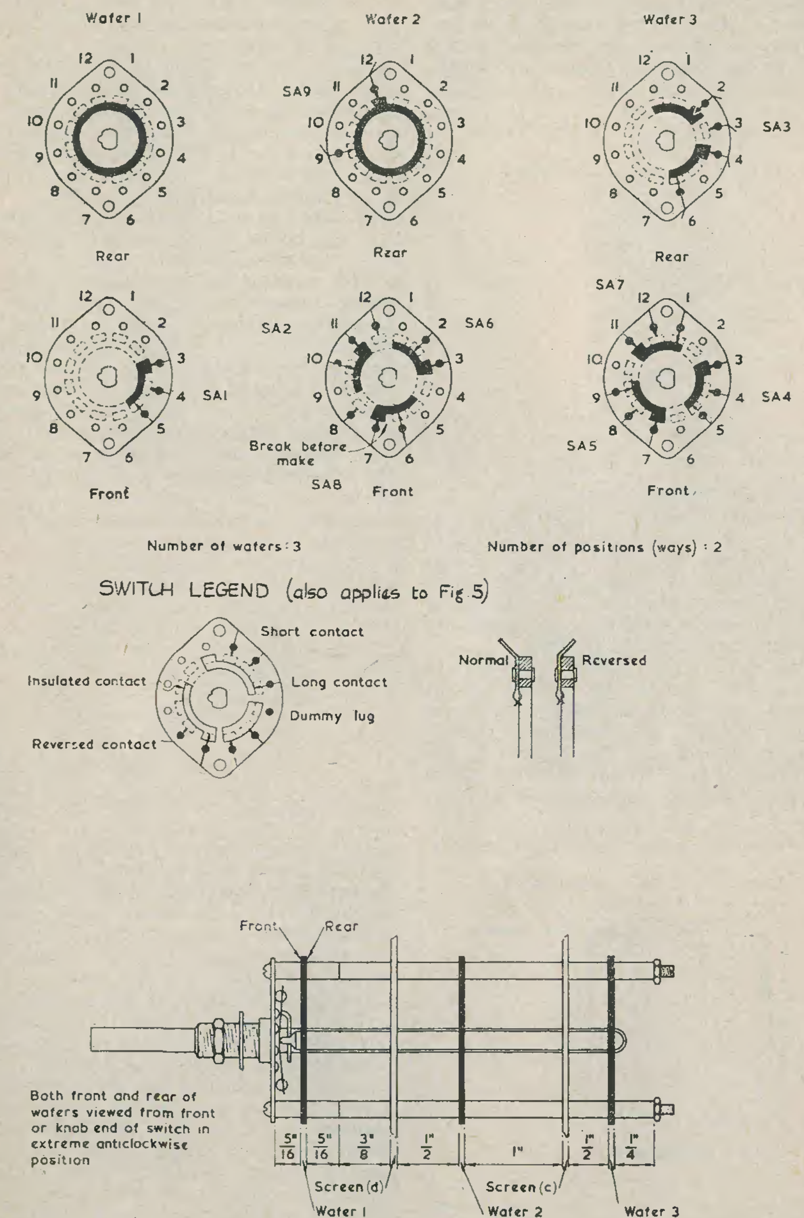


Fig. 4—RECORD/PLAYBACK SWITCH DETAILS

cabinet, for example, which might require the lettering to be read vertically. This is mentioned because the question of filing "flats" on the control spindles may arise and it is as well to do this before wiring them in permanently, seeing that the pointers of the knobs register accurately according to whichever way the lettering runs.

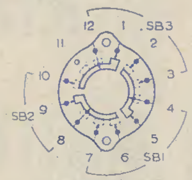



Fig. 5 Equaliser switch details

Viewed from front of knob in extreme anti-clockwise position.

M562

## Assembly and Wiring Details

For the rest of this article, extensive use is made of the Mullard Publication TP322 which describes the first "Type C", subsequent modifications being kindly supplied by Technical Service Dept. of Mullard Ltd., to whom due acknowledgment for assistance and information supplied is given.

In this section, all positional references to the amplifier should be interpreted as follows: The chassis is upside down for wiring. The top of the chassis is the surface nearer to the viewer; the bottom is the farthermost surface. The front of the chassis is the panel with the control knobs on it.

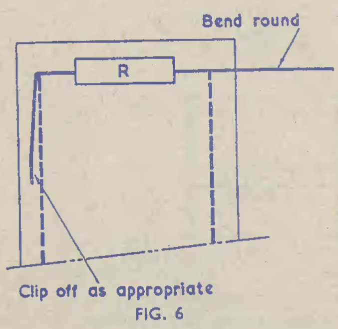



FIG. 6

M563

## Initial Assembly

Before assembling the record/playback switch SA around the screens, it will be found convenient to fix some of the components to the chassis. These components are:

(1) The erase and record/playback coaxial sockets which have to be fitted to the chassis beneath wafer 3 of the change-over switch SA.

(2) All the valveholders. Only the three EF86 valves should be skirted, and the holders for these valves should be nylon-loaded. The holder for the input valve $V_1$ (EF86) should be of an anti-microphonic type—that is, having a flexible mounting.

(3) The two small brackets f, which should be bolted to the internal screens c and d as shown in Fig. 3

The construction is continued after the above components have been fitted by assembling wafers 1 and 2 around the internal screen d. The wafers should be arranged so that positions 6 and 7 are at the bottom and the face of each wafer described as "rear" in the switch diagram (Fig. 4) is farthest from the switch plate. The internal screen c should be added to the assembly, both screens should be bolted

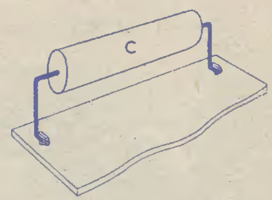



FIG. 7

M564

together, and wafer 3 should be fitted in position, again with its "rear" face (Fig. 4) farthest from the switch plate. The general arrangements of the switch wafers and internal screens, is shown in Fig. 3. Details of the spacers required for the assembly are shown in Fig. 4.

On the switch used for the prototype the wafers have a slotted edge to captivate the contacts and soldering tags. This meant that in the Mullard Technical Publication T.P.322, although the soldering tags are in position as shown on that drawing the corresponding contacts are on the other face of the wafers. This has been rearranged in Fig. 4 by reversing the "Front" and "Rear" positioning.

The switch and screens should be fitted to the main chassis, a shakeproof washer being used between the switch plate and the front panel of the chassis. It will be necessary to drill a hole in the chassis so that one of the small fixing brackets, attached to the internal screen c, can be bolted down. The other small bracket should be fixed by one of the screws holding the record/playback coaxial socket.

The assembling of the unit is best continued by referring to the diagram giving the component layout (Fig. 16). The components that should be fitted at this stage are listed below, and some remarks are made when the exact positioning of the components is perhaps doubtful.

(1) EM81 mounting bracket—The valveholder should be fastened to the bracket so that the solder tags are on the same side as the flange on the bracket. The gap between pins 1 and 9 on the holder should face the flange to ensure that the tuning eye of the EM81 faces forwards. The level indicator should appear in the centre of the front panel of the equipment, and the bracket should be bolted to the chassis in the correct position for this to be so.

A stand-off insulator should be mounted as near as is convenient to pin 6 of the EM81 valveholder.

(2) Input jacks—The soldering tags should be on the inside, and the radio jack, which has two contacts only, should be beneath the microphone jack.

(3) Recessed coaxial socket for the output.

(4) Supply input plug—Pins 1 and 3 should be on the outside.

(5) Equaliser switch—Positions 9 and 10 (Fig. 5) should be adjacent to screen "d."

(6) Ferroxcube pot core.

## Wiring Instructions

With this set of instructions, it should be possible to complete the wiring without reference to the circuit diagram. It will be of help, however, to make reference to the diagram, especially if it is intended to use different coloured wires for various sections of the circuit.

It will obviously be more convenient to solder most of the smaller components to the tagboards before they are mounted in the amplifier. Several general remarks may be of use in assembling these small components. Needless to say, all connecting wires are executed in good quality P.V.C. insulated wire.

The small carbon resistors should be laid across two tags on the board, and the lead wires bent around the tags in the manner shown in Fig. 6. If the tagboard wiring diagrams show that the neighbouring tags are to be connected together, the lead wires of the appropriate components should be cut to lengths to allow this.

Waxed capacitors, silvered-mica capacitors and high-stability resistors will require longer leads so that they will not be overheated when they are soldered into position. The leads should be bent as shown in Fig. 7, care being taken in doing so to avoid sharp bends very close to the ends of the components.

Where dotted lines indicate links between tags, the connections should be made with insulated wire.

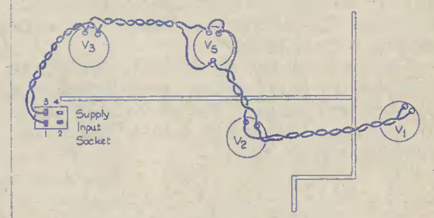



FIG. 8

M565

*Heater Supply*

This is the first stage in the wiring of the amplifier. From pins 1 and 3 of the supply input socket (Fig. 8) a pair of twisted wires should be taken to pins 4 and 5 on the valveholder for valve $V_3$. From these pins the wires should be taken to pins 4 and 9 on the valveholder for $V_5$ (the ECC82) and link 4 and 5. Two sets of heater leads should be taken from $V_5$. One set should pass through the rubber grommet to pins 4 and 5 on the holder for the EM81, and the other set should be connected to pins 4 and 5 on the holder for $V_2$.

From $V_2$, the heater leads should be taken to pins 4 and 5 on the holder for $V_1$ to complete the heater wiring of the amplifier.

*The Input Stage (Valve $V_1$, Type EF86)*

The construction of this stage should be started by wiring Tagboard No. 1. The

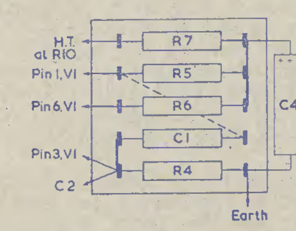



Fig. 9—TAGBOARD No. 1

M566

components: $R_7$ (33k$\Omega$), $R_5$ (1M$\Omega$), $R_6$ (220k$\Omega$), $C_1$ (0.5$\mu$F), $R_4$ (2.2k$\Omega$) and $C_4$ (8$\mu$F) should be soldered to the small tagboard as shown in Fig. 9. It is important that the polarity of the electrolytic capacitor $C_4$ should be correct. The assembled tagboard should be bolted to the chassis in the position indicated in the layout diagram (Fig. 16).

On the $V_1$ valveholder, pins 2 and 7 should be strapped to the centre spigot and a wire should be taken from the spigot to the solder tag. (This should be one of only two earth connections in the amplifier made directly to the chassis: additional connections to the chassis are likely to cause increased mains hum.)

The grid resistor $R_3$ (2.2MΩ) should be soldered directly across the valveholder between pins 2 and 9. Pin 9 should be joined to position 5 on section $SA_1$ of the record playback switch SA.

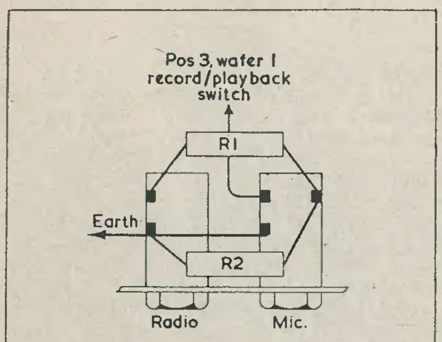



FIG. 10

The resistors $R_1$ (680kΩ) and $R_2$ (5.6kΩ) should be wired directly across the tags of the input jacks as shown in Fig. 10. The output from the jacks is taken to position 3 on the switch section $SA_1$. Earth connections from the jacks and from the junction of $C_4$ (8μF) and $R_4$ (2.2kΩ) should be made to the solder tag near the valveholder.

The positive pole of the capacitor $C_2$ (50μF) should be connected to the junction of $C_1$ (0.5μF) and $R_4$ (2.2kΩ) on Tagboard No. 1, and the negative pole of $C_2$ should be wired to the earth point near the valveholder.

The screen resistor $R_5$ (1MΩ) on the tagboard should be connected to pin 1 of the valveholder, and the anode resistor $R_6$ (220kΩ) should be joined to pin 6. Pins 3 and 8 should be joined together with insulated wire, and a connection taken to the cathode resistor $R_4$ (2.2kΩ).

The feed for the next stage is taken from the anode (pin 6) of $V_1$ to position 8 on the switch $SB_2$. The capacitor $C_3$ (0.1μF) should be wired between these two points, sleeving being used on the bare wire. This wire can pass either in front of screen d (as in Fig. 16) when $C_3$ should be clipped to the chassis, or through the grommet hole in the screen when a stand-off insulator will be required. A wire should run through a grommet in the screen from position 4 on switch $SA_1$ to the double contact in position 4 on sections $SA_3$ and $SA_4$.

*The Equaliser Stage (Valve $V_2$, Type EF86)*

The assembly of this stage should start with the wiring of Tagboard No. 2. The components: $C_7$ (8μF), $R_{10}$ (18kΩ), $C_6$ (0.1μF), $R_{11}$ (82kΩ), $C_8$ (0.1μF), $R_9$ (390kΩ), $C_5$ (0.1μF), $C_{27}$ (100pF), $R_{35}$ (470kΩ), $C_{25}$ (390pF), $R_{34}$ (150kΩ) and $C_{26}$ (2,200pF) should be fitted to a ten-way tagboard and the connections should be made as illustrated in Fig. 11. When assembled and wired, the tagboard should be bolted to the chassis in the position shown in Fig. 16.

On the holder for $V_2$, pins 2 and 7 should be joined to the spigot, and the spigot should be connected to the earth tag near the holder for $V_1$. Pin 7 should be connected to position 9 of $SA_9$. Pins 3 and 8 should be strapped together.

The junction of $R_{11}$ (82kΩ) and $C_8$ (0.1μF) on Tagboard No. 2 should be connected to pin 6 on the valveholder for $V_2$. The resistor $R_{12}$ (1.0kΩ) should be connected between pins 2 and 3 on the holder. The positive pole of the capacitor $C_9$ (50μF) should also be connected to pin 3, the negative pole being connected to the junction of $C_{26}$ (2,200pF) and $C_{27}$ (100pF) on Tagboard No. 2. This junction should be connected to pin 2 on the holder for $V_2$, and a wire should also be taken from the junction to one end of the Ferroxcube pot core inductor. The other end of the inductor should be connected to position 12 of switch $SB_3$. The resistor $R_{36}$ (27kΩ) should be joined between position 12 of switch $SB_3$ and position 11 on section $SA_2$.

The junction of $R_{34}$ (150kΩ) and $C_{26}$ (2,200pF) on Tagboard No. 2 should be joined to position 1 of switch $SB_3$. The junction of $R_{35}$ (470kΩ) and $C_{25}$ (390pF), also on Tagboard No. 2, should be connected to position 2 of $SB_3$, and the free end of capacitor $C_{27}$ (100pF), again on Tagboard No. 2, should be joined to position 3 of $SB_3$.

One end of the resistor $R_8$ (1MΩ) and ends of the capacitors $C_{23}$ (180pF) and $C_{24}$ (82pF) should all be connected to pin 9 of the holder for $V_2$. The other end of $R_8$ should be joined to pin 7 of the holder. The other ends of $C_{23}$ and $C_{24}$ should be joined to positions 9 and 10 respectively on switch $SB_2$.



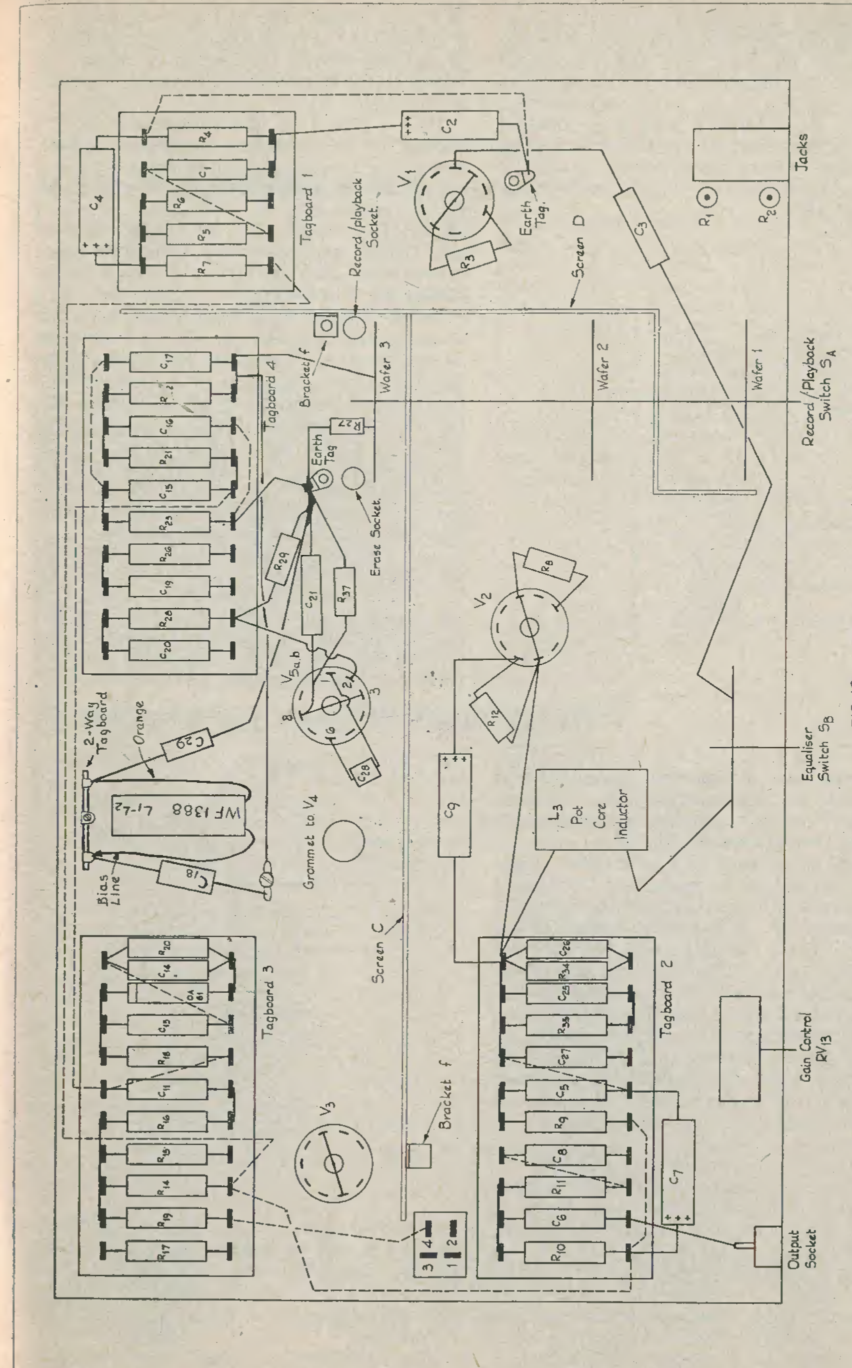



FIG. 16

MAIN COMPONENT LAYOUT DIAGRAM. (Components which would obscure parts of the layout have not been shown.)

*In view of the numerous references to this diagram in Part 2, it has been reproduced here, although out of numerical sequence*

The resistor $R_{30}$ (390kΩ) should be connected between position 8 on switch $SB_2$ and position 10 on $SA_2$, and the connection should be continued from position 10 on $SA_2$ to pin 9 on $V_2$. The resistors $R_{31}$ (2.7MΩ), $R_{32}$ (1.2MΩ) and $R_{33}$ (680kΩ) should all be joined to position 12 on $SA_2$, and the free ends of these resistors should be connected to positions 5, 6 and 7 respectively on switch $SB_1$.

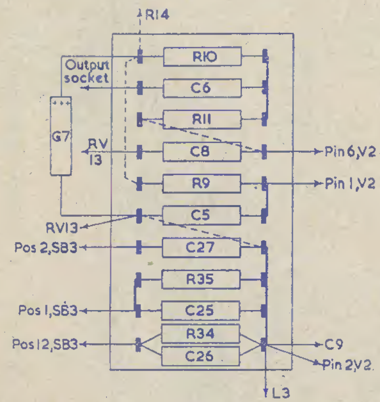



Fig. 11—TAGBOARD No. 2

M568

A connection should be made between position 12 on $SA_2$ and position 12 on $SA_9$. Position 9 on $SA_9$ should be connected to pin 7 on the valveholder for $V_1$.

The gain control $RV_{13}$ (500kΩ logarithmic) should be mounted on the chassis at this stage with the tags pointing upwards. The right-hand tag should be joined to the junction of $C_5$ (0.1μF) and $C_7$ (8μF) on Tagboard No. 2. The left-hand tag of the gain control should be connected to the near end of $C_8$ (0.1μF) on Tagboard No. 2, and the capacitor $C_{22}$ (82pF) should be joined between this tag and position 4 on switch $SB_1$. The free end of the capacitor $C_6$ (0.1μF) on Tagboard No. 2 should be connected directly to the output socket.

*Recording Output Stage* (*$V_3$, Type EF86*)

The following components should be fitted and wired to Tagboard No. 3 as shown in Fig. 12: $R_{17}$ (1kΩ), $R_{19}$ (10kΩ), $R_{14}$ (27kΩ), $R_{15}$ (220kΩ), $R_{16}$ (68kΩ), $C_{11}$ (0.1μF), $R_{18}$ (470kΩ), $C_{13}$ (18pF), OA81, $C_{14}$ (0.05μF) and $R_{20}$ (1.0MΩ). In fitting the germanium diode type OA81, plenty of wire should be left at its ends to prevent overheating when it is soldered in position. Preferably, the wires should be held with pliers, which act as a heat shunt. The end with the band on it should be connected to $R_{18}$ (470kΩ). When assembled, the tagboard should be bolted to the chassis in the position indicated in Fig. 16.

Pins 2 and 7 on the valveholder for $V_3$ should be connected to the centre spigot. From pin 2, leads should be taken to pin 2 on the supply input socket and to $R_{17}$ (1kΩ) on Tagboard No. 3. From pin 7 a lead should be connected to the nearer end of $C_{13}$ (18pF) and continued from this point through the grommet to pin 2 on the valveholder for $V_4$ (EM81).

A wire for the h.t. supply to the equaliser stage of the amplifier should be connected to the junction of resistors $R_9$ (390kΩ) and $R_{10}$ (18kΩ) on Tagboard No. 2, and should be taken to the near end of the resistor $R_{14}$ (27kΩ) on Tagboard No. 3 and continued from $R_{14}$ to the free end of $R_7$ (33kΩ) on Tagboard No. 1. Pin 4 on the supply input plug should be joined to position 6 on switch $SA_8$. From this point, the connection should be taken to position 2 on section $SA_6$.

The end of $R_{17}$ (1kΩ) farthest from the $V_3$ holder should be connected to pin 3 on the holder, and the connection should be continued to pin 8. The nearer end of $R_{15}$ (220kΩ) should be connected to pin 1 and $C_{10}$ (0.5μF) should be connected between pin 1 and the remote end of $R_{17}$.

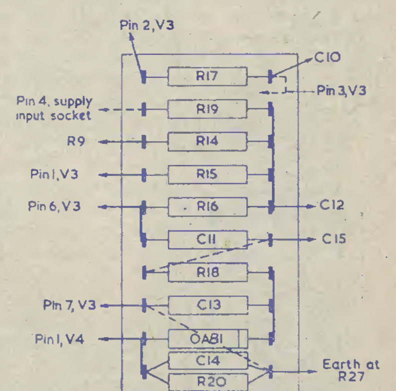



Fig. 12—TAGBOARD No. 3

M569

The junction of $R_{16}$ (68kΩ) and $C_{11}$ (0.1μF) should be joined to pin 6 of the $V_3$ holder. The end of the OA81 with the lettering on it should be connected through the rubber grommet to pin 1 of the EM81 valveholder.

The capacitor $C_{12}$ (16μF) should be connected between the junction of $R_{19}$ (10kΩ) and $R_{16}$ (68kΩ) on Tagboard No. 3 and pin 7 on the holder for $V_3$. The positive end of $C_{12}$ should be joined to the junction of the resistors. The other end of $R_{19}$ should be connected to pin 4 on the supply input socket.

To complete the assembly of this stage, pin 9 on the valveholder should be connected to the centre tag of the volume control $RV_{13}$, the wire passing under the internal screen c.

*To be concluded*

## RADIO MISCELLANY *continued from page 351*

superimposed on a very heavy background.

Unfortunately I have had no opportunity of hearing this record yet, but surely after such treatment any imperfection in the reproducing equipment should quickly be revealed.

**Junk, First-class**

On several recent occasions this column has made references to the rebuilding and modernising of old or discarded receivers. We agreed there was a lot of fun in it. So does a correspondent, but he cynically adds "and by the time you have hunted down and bought all the components of suitable dimensions to fit in the existing gaps on the old chassis, it doesn't cost you much more than about twice the amount needed to build a new set."

The question of cost, I suppose, depends on the depth of one's junk box, and talking of junk boxes reminds me of a friend who keeps two! One is marked "Junk" and the other is labelled "Bits." The bits box holds all the odds and ends likely to be needed in the early future, but the stuff in the junk box is a collection of items for which there is no foreseeable use—speaker magnets, screening cans, broken down soldering irons and burnt-out transformers. Hence, if he has a pair of i.f. transformers they are carefully taped together and gently stored in the bits box, but an odd single i.f.t. would be simply slung in the junk container.

I thought I had been systematic since my last spring-clean, but I haven't yet got round to classifying my junk into first and second class. However, in future when referring to junk I will try to remember to specify the grade just in case this sort of thing is general. (Personally, I scrap "junk," and keep "spares."—ED.)

## EXPERIMENTAL CHASSIS CONSTRUCTION *continued from page 355*

beyond the stage concerned are simply unbolted from the girders and moved an appropriate distance along the framework and bolted back again, leaving a space for the new stage to be inserted. If it is foreseen at the outset of construction what modifications will be made, gaps may be left between the chassis for the new stage to be inserted, provided instability is not likely to arise from the length of wires bridging the gap.

Clearly, these ideas may be very much modified, particularly as regards dimensions, to the readers' own applications and opinions, and this article is only intended as a pointer. The chassis may be put into several decks if desired, as shown in Fig. 3. Aluminium girders, of course, would be more suitable, but the writer has not been able to find any standard types which are reasonably available. In fact, it should be pointed out that there may well be several other firms which manufacture girders, etc., just as suitable, or more so, than the Meccano ones described here. The latter, however, may easily be obtained separately from many shops.

It might be said that this form of construction lacks aesthetic value; but since it was designed for experimental work, it seems reasonable to consider this aspect of secondary importance. The requirements of rigidity and reasonable safety are fulfilled, provided the chassis are isolated from the mains, and that no bare h.t. wires, etc., are exposed. To ensure the latter, it may be necessary to make a box of five sides into which the whole may slide.

*The Editor and Staff of*
**The RADIO CONSTRUCTOR**
*wish all their many friends and readers*
**A HAPPY CHRISTMAS**

# MODELS FOR RADIO CONTROL

# *THE* "WAVEMASTER" *KIT*

**Part 5**

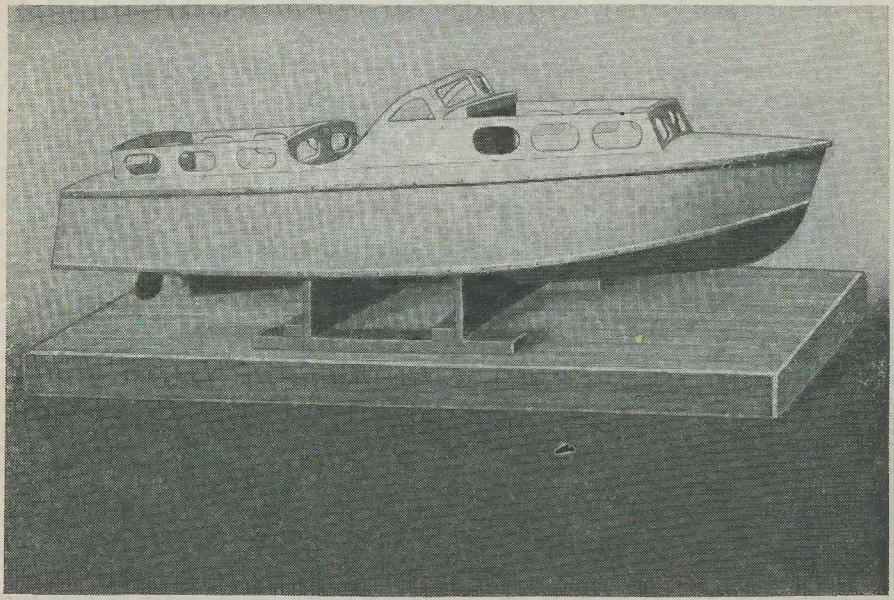
**by Raymond F. Stock**

### Construction

Having considered the various points relating to the model as a whole, and after making any necessary modifications to components, construction may be started.

In addition to the materials provided, it is necessary to have some pieces of scrap wood (about four yards of $\frac{1}{2}$in square is ideal) for supporting the bulkheads while building, and a plank of wood at least 12in by 36in by approx. $\frac{3}{4}$in as a building board. No doubt many constructors would use the top of the bench directly for this purpose, but the surface must be truly flat.

Before starting, it is desirable to clean up some of the components where the cutting process has left ragged edges. This will facilitate assembly, but care must be taken not to enlarge slots and so spoil the fit.



*The hull nearly complete*



The "Wavemaster" is a simple design and the instructions are clear enough to enable even a beginner to produce an excellent model. The following notes, however, may be useful to intending constructors who are less familiar with glue than with solder.

For the sake of authenticity, a complete model was made up by a constructor having no previous experience of modelling. The kit was supplied by the manufacturers in standard form, and no additional information or supervision was applied. Total construction time proved to be thirty hours.

The constructor made up a building board by pinning a sheet of 5-ply wood to a rectangular frame (36in x 15in x 2in) having two transverse supports across it, spaced 12in apart.

The following tools were to hand, and found useful, though were not all essential: half-round smooth file; 8in smooth flat file; $\frac{1}{2}$in chisel; sharp penknife; $\frac{1}{4}$in round file; small hammer; small frame saw; hand vice; $\frac{1}{8}$in and $\frac{1}{4}$in drills; one sheet each of numbers 0 and 2 sandpaper; and an old compass used as a scriber.

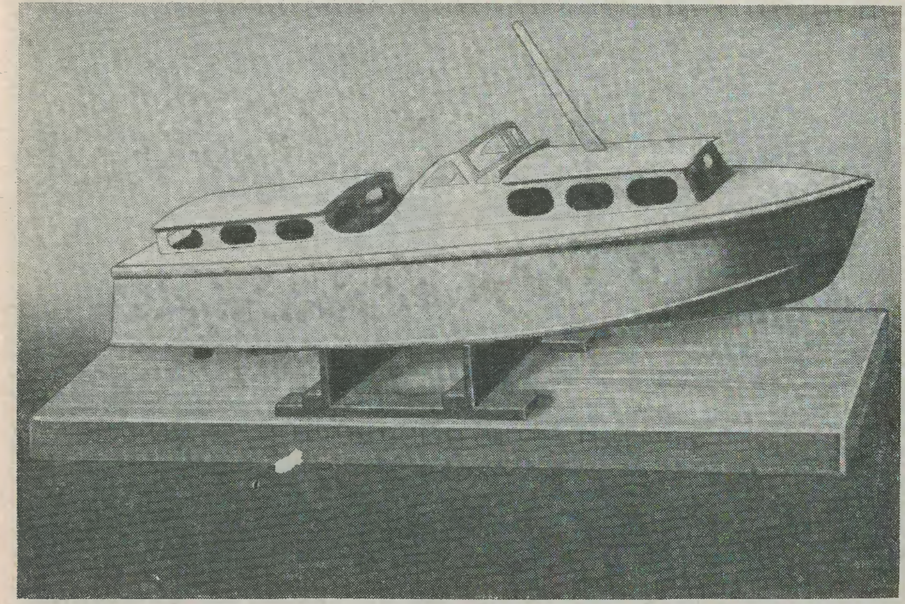
It was decided to use Durofix as an adhesive (though several other types of glue would have sufficed); about 7 or 8 ozs of this cement were used in all.

The sequence of operations described with the kit was followed closely, and in general no difficulty was experienced in making good joints.

Fitting the keel and keel blocks to the bulkheads was a simple matter of careful fitting, but the next stage, fitting the stringers, was thought to be potentially tricky. Consequently, the constructor felt it wise to preset the sharper curves by soaking the strips and teasing to shape over a low gas flame. The curve was maintained and fixed by allowing the strips to dry out in a curved jig made by hammering small nails into a board, thus trapping the strip in the required curve. The instructions note that the use of two pieces $\frac{1}{8}$in x $\frac{1}{4}$in obviates this process, but the additional trouble expended was thought to be worth while. It is essential to allow any dampness to dry thoroughly before glueing, particularly when a cement is used.

The stringers were shaped to the hull, by cautious use of a sharp knife and of sandpaper wrapped around a curved block, before the framework was sanded overall.

When the framework was tacked down again to the building board, it was thought to be a good policy to pack up the deck surfaces with thin card; the side skins, when fitted, could then be butted hard against the



*The completed model ready for painting* building board and finally sanded off flush with the deck structure. The thin card ensured that the skins would not lie below the top of the deck stringers, and would, if anything, be slightly proud of them.

After the side skins were firmly attached and the cement dry, great care was taken to trim off the excess (at the forward end particularly), level with the face of the chine stringer *and at the correct angle* to ensure a good surface for attachment of the bottom skins.

Fitting the bottom skin panels was the only difficult part. In general, the method described in the instructions was adopted, but the initial approximate curve was formed by soaking, heating and drying to shape rather than simply heating as described.

Forward, the bottom panels were overlapped (as shown on the plans) on top of the side skins, but the overlap was cut away at an angle in the vicinity of B.2 as soon as the greater angle through which the ply needed to be bent began to cause it to wrinkle and to crack.

After the cement was thoroughly dry the hull was well sandpapered, and replaced on the building board while the chine rubbing strakes were applied. These were pre-bent by soaking and heating, as for the stringers.

The stern tube was fitted as described in the instructions, a large amount of cement being used around all junctions between the tube and the surrounding structure.

The cabin produced no problems and was made up entirely according to the instructions. After the deck structure was added the deck rubbing strakes were bent by soaking, as before, then glued into position. After the deck and wash strakes were fixed, the deck surface inside the latter was scribed with indented lines to represent planking.

Two coats of clear dope were given inside and outside to waterproof the hull. Several coats of paint were then applied, using a $\frac{1}{2}$in flat and a $\frac{1}{4}$in round camel hair brush.

After completion of the painting, the celluloid was cut and cemented inside the window areas. The handrails were sanded, varnished and fixed last of all.

The main lessons learned from construction were the need for care when cutting parts to fit accurately together, and the desirability of doing this by filing and sanding rather than by indiscriminate cutting. Surfaces to be glued should be carefully prepared to lie close together—the cement should not be used to fill large cracks between components. Nevertheless, plenty of cement should be applied to both parts of a joint, and the excess squeezed out as the parts come together.

The finished hull has a good appearance, considerable strength, and plenty of room for equipment. It is, in fact, a thoroughly practical model and one which we have no doubt could be made up successfully by any radio amateur.

## TRADE REVIEW

**A. F. Bulgin & Co. Ltd.,** Bye-Pass Road, Barking, Essex, have sent us samples of their type J.30 Miniature Jack and the P.519 Miniature Jack-Plug. This is a new 2-pole concentric jack and jack plug, for miniature uses. The plug has axial cable exit, screw-on phenolic cover, plated members and internal solder tags for the connections. The jack also has phenolic insulation, nickel-silver contacts and tags. One pole is live to the fixing bush and a third contact mates with the tip-contact when the plug is removed. Technical specification—for 1A max, 50V max, 10W max, loaded and connected. Maximum test voltage 250V.

These small precision made and highly finished components would find many ready uses, e.g. for 2-pole audio, in or out; for telephones; portable bells; or test points, etc. They would be absolutely ideal for modern miniature equipment.

**R. Fagelston,** 46 Hardwicke Road, London, N.13, are currently offering, among their many other ranges, a Bulgin "little brother" version of the above jack-plug and jack. Somewhat less robust than the above, the plug has no provision for axial outlet but is designed for two-wire exit only. The plug cap is of phenolic insulation, the inner plated contacts being mounted on paxolin. The jack is likewise mounted on paxolin, this having two sturdy eyeletted holes for fixing purposes. The Bulgin type numbers for these are: plug P523 and jack J33. They are available to readers at 1s. 3d. and 9d. respectively.

**Kendall & Mousley Ltd.,** 18 Melville Road, Edgbaston, Birmingham 16, have now commenced a new ceramic switch service. A wide variety of both paxolin and ceramic Yaxley type switches are now being produced to readers' requirements. The maximum length of switch which is at present being produced is $8\frac{1}{2}$in from clicker plate to the end of the flatter shaft.

Constructors often find that the stock pattern of switch has either too many or too few contacts, poles, or contacts that cannot be earthed when not required in circuit. Kendall & Mousley Ltd. now issue a leaflet setting out specimen charges and details of the service. The samples submitted to us were of first-class workmanship, sturdy and robust. All contacts were of the double type with heavy plated tag connections.

Readers requiring that special Yaxley-type switch are advised to get in touch with the above firm.





# A WIDE RANGE Audio Oscillator

By W. E. WOODHEAD

In the course of design and experimental work, the need for a signal generator covering the audio frequencies must be considered sooner or later. Several designs have been produced in the past, and described in a number of technical and practical publications.

The instrument to be described in this article is a compact piece of apparatus and will not take up too much space on the average experimenter's work bench. It will be noticed that the generator does not carry its own mains supply, but is fed from an outside source. It has been found in the writer's experience that one power pack can supply a number of pieces of equipment; and where this can be done, represents an overall economy in the setting up of a small laboratory.

Many people stress the necessity of instruments incorporating their own power supply, and in some cases stabilisation of that supply is essential for the maintenance of accuracy in calibration.

In the majority of cases, however, small variations in supply are not important and one power pack will serve a number of pieces of test gear. The essential features of the present design are as follows:—

1. Purity of sine wave.
2. Stability and constant output amplitude.
3. Wide range.
4. Facilities for square waves.
5. Reasonable cost.

The first consideration was the type of oscillator to use. The B.F.O., or Beat Frequency Oscillator, was rejected as a great deal of careful design is necessary to get the apparatus to work well. The two oscillatory circuits are working at radio frequency, and any stray coupling between the two would lead to "pulling" in, particularly as they have similar characteristics. Greater freedom from this pulling in or locking together can be achieved by a push-pull detector system, but this adds to the complexity and cost of the equipment.

The phase shift oscillator works well on certain conditions but operation is confined, in the writer's experience, to the use of particular valves of high slope and certain other characteristics.

The final choice was a Wien Bridge controlled R.C. Oscillator which fulfilled most of the conditions required. Another point which had to be settled was whether the variable frequency control should be capacitive or resistive. Variable capacity has the required smoothness of control, but to keep the resistive part of the bridge arms within reasonable limits the condenser has to be large in value. The usual method is to use a four-gang 500pF unit, and to parallel the sections to make two capacitors of 1,000pF each. This makes a bulky item, and even this value requires a resistive component of 10 megohms on the lowest frequency range.

In addition to using excessive space, the whole R.C. combination requires careful screening to avoid hum pickup.

Finally, variable resistance was adopted, a two-gang component being compact and having the advantage of giving a dial rotation of 300° against the 180° of the capacitor.

Large wirewound two-gang potentiometers with log characteristics can be obtained at a price, but the writer has used a carbon element component supplied by the Reliance Manufacturing Co., which after a long period of use continues to give complete satisfaction.

Although most textbooks explain the Wien Bridge in principle, it would not be out of place to analyse, for the benefit of beginners, the theory of the circuit as applied to this instrument.

With reference to Fig. 1 it will be seen that at the resonant frequency determined by component values, the impedance of the variable arms is purely resistive, and that the output across $C_1$ $R_1$ is in phase with the input across $C_1$ $R_1$ $C_2$ $R_2$.

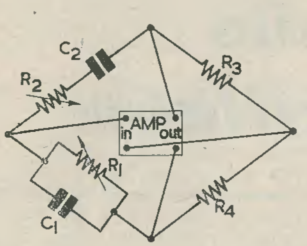



FIG. 1.
Bridge controlled R.C. Oscillator.
M552

Due to these conditions it will be apparent that the output is only one-third of the input, or that the attenuation of the output is approximately 10dB.

If this output is fed back through an amplifier with negligible phase shift and 10dB gain the frequency of oscillation will be maintained. To stabilise frequency and reduce phase shift in the amplifier to a minimum a proportion of the amplifier output is introduced into the fixed arms of the bridge as negative feedback. The amplifier gain must, of course, be increased accordingly.

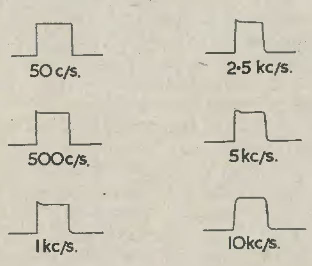



FIG. 2.
Square Wave Shapes at various frequencies.
M553

Reference to Fig. 1, again, will show that $R_3$ $R_4$ are the other arms of the bridge and the feedback is determined by the junction position of this network. In the bridge as a whole, if $R_3 = 2 \times R_4$ the junction point is at the same potential as the junction of $C_1$ $R_1$ with $C_2$ $R_2$ in the variable arms and the attenuation is infinite; or in other words, there is no input into the amplifier with consequent cessation of oscillation. If, however, the feedback point in the fixed arms is carried towards the earthy end of the network, attenuation will be reduced until the loop gain of the amplifier will cause the commencement of oscillation.

It will be appreciated from the above examination of the circuitry that the junction of $R_3$ $R_4$ is of vital importance to the operation of the oscillator. If there is no control at this point circuit values may be such that either there is no oscillation or there is excessive amplitude with consequent distortion of waveform.

It is found that if $R_3$ is chosen as the control element and the gain of the amplifier is made high enough, the shift of the junction point of $R_3$ $R_4$ is made small enough to give an extremely effective $R_3$ $R_4$ control ratio.

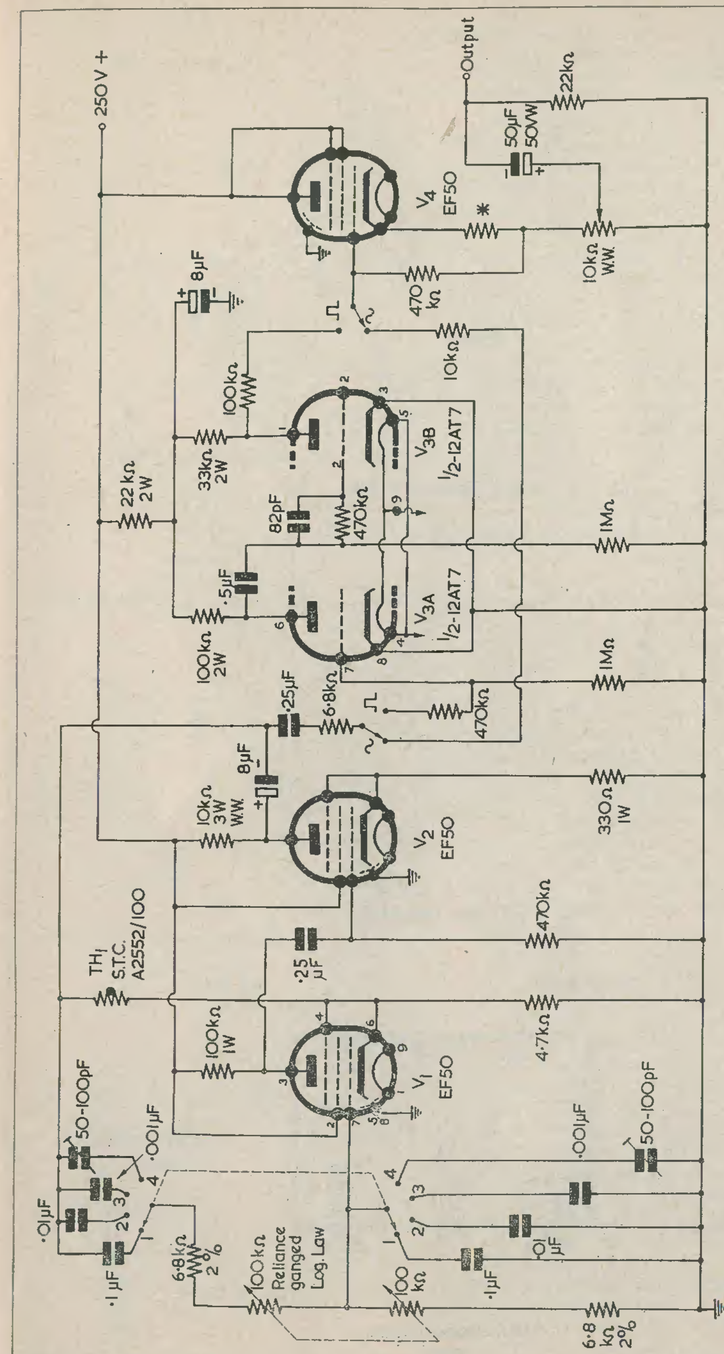
A component having the necessary control characteristics is the Brimistor, a product of Standard Telephones and Cables Ltd., and it is a device many times more effective than special feedback circuits, lamps and ballast resistances used in the past. Its physical size is small, its action practically instantaneous and it gives perfect amplitude and feedback control.

Replacing $R_3$ in the diagram, it will be seen that as amplitude tends to rise, the resistance of the thermistor decreases, raising the junction point of $R_3$ $R_4$ and thereby increasing feedback and reducing loop gain.

The thermistor is appreciably sensitive to ambient temperature changes, but as long term amplitude stability is not important, the location of the component is not critical. It will be noticed, however, that in the layout the fixing position is on top of the chassis where temperature is reasonably constant.

Square wave facilities have been included in the instrument and may be switched in when desired by a front panel control. Square waves as low as 50 cycles, providing they have flat top and short rise times, are much more searching than sine waves, and are most useful for investigating transient response in all types of amplifiers. For serious work on wide band circuits they are almost a necessity. They are obtained by feeding the full output of the sine wave oscillator into a squaring circuit. This comprises a double triode functioning as an overdriven two-stage amplifier. A measure of frequency compensation is incorporated in the interstage coupling and sharpens up the corners of the pulses. The range over which good wave shape may be expected is

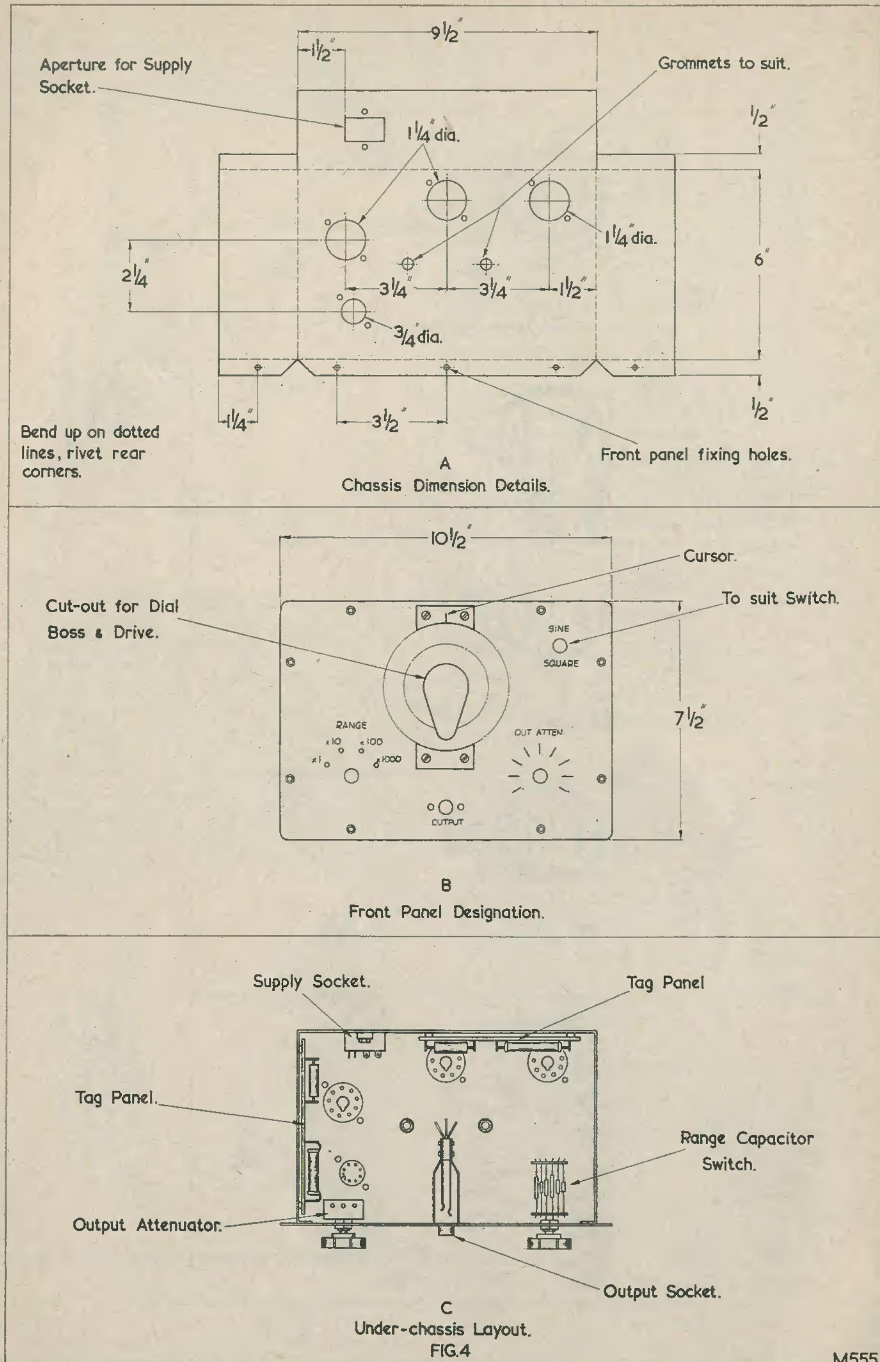





All Resistors to be 1/2 Watt unless otherwise stated.
* To be adjusted on test.

Range 1. 14-200 cycles
2. 140-2000 cycles
3. 1·4 kc/s - 20kc/s
4. 14 kc/s - 200kc/s

FIG. 3.
Circuit Diagram of Wien Bridge Oscillator.



A
Chassis Dimension Details.

B
Front Panel Designation.

C
Under-chassis Layout.
FIG.4



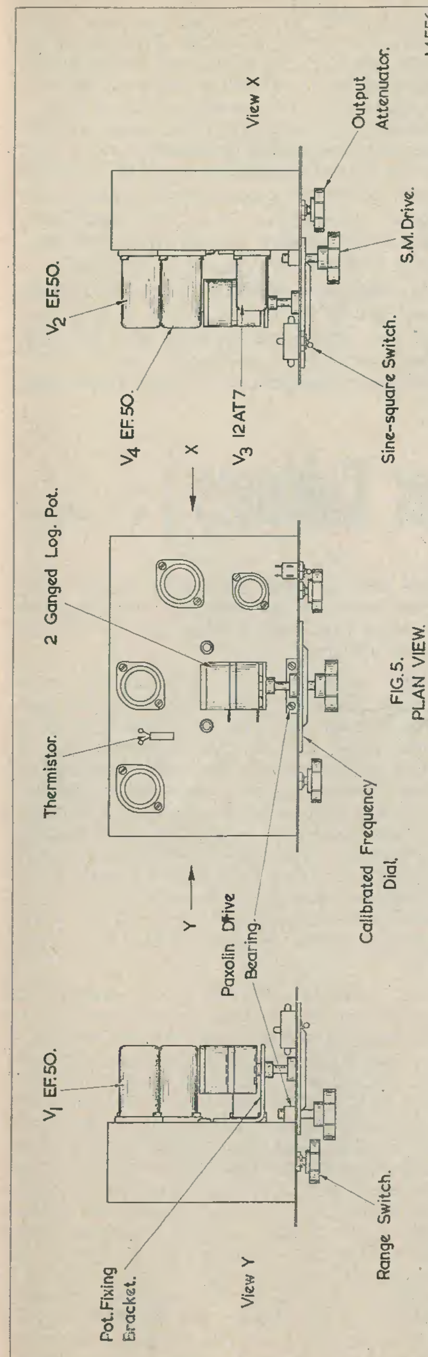


FIG. 5.
PLAN VIEW.

14–2,000 c/s. Any higher frequency than this is undesirable, and is unnecessary in any case for audio work. Reference to Fig. 2 will show waveforms for various frequencies.

Sine wave coverage is 14 c/s to 200 kc/s, this being obtained by four overlapping ranges. The coarse range switch is marked in multiples of 10 and is used in conjunction with a single frequency scale.

To provide an output of low impedance a cathode follower buffer stage was inserted between the oscillator and output terminal. In addition, to block d.c. from the output a large capacitor was fitted between $R_k$ of $V_4$ and a load resistance of 22kΩ. This load resistor can be replaced by a calibrated attenuator if so desired. It should be mentioned that valves 1, 2 and 4 used in the generator are the familiar and easily obtained EF50. These give good results in the present circuit and it would be difficult to find a more suitable component. The other valve concerned is that which provides the square waves, and satisfactory results were obtained by the use of a miniature 12AT7.

Reference to Figs. 3, 4 and 5 will give the necessary information regarding the construction of mechanical details. As most constructors have their own particular preference as to the final finish and site of an item of test gear, only the main points of interest will be considered.

The chassis is the conventional box type which is screwed to the front panel. This forms an integral unit which may be fitted into almost any type of casing.

The case and slow motion dial used in the writer's instrument was salvaged from surplus war material. These items fitted nicely into the constructional plan, although it meant that the dial would have to be re-calibrated.

It is well worth while paying a visit to the local war surplus dealer to see what he has to offer in hardware before being committed to unnecessary work and expense. The wiring and general layout follows no particular plan, and anyone who wishes to make alterations may do so providing component values are not altered.

The oscillator circuit wiring should be rigid and as short as possible. Failure to observe this point will possibly result in stray capacitances altering calibration, especially on the higher frequency ranges.

It must be admitted that frequency calibration was carried out with the aid of an accurate decade oscillator. While being most convenient it is by no means essential, and was in any case double checked by the oscilloscope method.

The 50 cycle mains are a very good standard of accuracy and if the timebase of the oscilloscope is locked to this frequency it is possible, with care, to obtain a number of calibration points on scale 2 (140–2,000 c/s).

If the timebase speed is increased by a known multiple of 50 cycles, while keeping the scan locked to the mains, it will be found that if the switched capacitors are exact multiples of 10 the same marks on the scale for Range 2 should coincide with 10 times the frequency of Range 3. If this does not occur, then the capacitors for Range 3 should be trimmed until the variable scale suits both Ranges 2 and 3.

Plots on log paper can be made of these two ranges and with the aid of these and the oscilloscope, Range 1 capacitors can be adjusted to fit the frequency scale. Range 4 (14 kc/s–200 kc/s) capacitors will need setting for every individual instrument, as strays will alter the calibration considerably. They can be set to suit a point on the low frequency end of the scale and left at that.

Frequency accuracy on this range was not considered absolutely necessary, and if one point was fairly accurate the rest of the range would be within a reasonable tolerance. It should be pointed out that amplitude stability falls away slightly after 100 kc/s, and is 2dB down at the end of the scale.

In conclusion, it is felt that this instrument is well worth the time spent on its construction and is an asset to those who take full interest in their experimental work.

**MISCELLANEOUS**

# Inexpensive Loudspeaker Cabinets

By E. G. WILSON

It is often possible to obtain old wireless cabinets at very small cost, and many experimenters will have collected some over the years. For a small outlay these can be modified to house an extension speaker or one of the speakers of a multi-speaker system (Fig. 2 is especially suited to this purpose and looks well standing on the top of the main cabinet).

Before commencing any work, select a cabinet which is strongly made, with the veneer in good condition and not peeling. It is advantageous if the speaker aperture is at the top. Cut the cabinet as suggested in the diagrams, using a sharp tenon saw for the external cuts and a keyhole saw for the speaker aperture. The actual size of the aperture will, of course, depend on the size of the cabinet and the personal taste of the constructor but, as a general guide, dimension "B" should be about 2in or 1/5th of the aperture width, dimension "C" about 1½in and "D" about 2½in. Dimension "A" will depend on the depth of the speaker to be housed, but 4in is normally adequate. These dimensions retain sufficient strength in the cabinet and also give a result that is pleasing to the eye.

Construct a base and fit this to the new cabinet using wood blocks glued inside (the old base can usually be modified for use quite simply). A couple of strips of foamed plastic can be glued to the base to avoid scratching any polished surface on which the cabinet may stand.

Finish off by rubbing the whole cabinet down with fine sandpaper and varnishing with "Valspar" stain. This latter should be done with a good quality brush in a dry atmosphere, and extreme care must be taken to avoid any dust getting on the varnish before it is dry.

The speaker should be mounted on a suitable sized baffle, covered with silk and fitted behind the aperture. Alternatively, a metal grille can be used although this is rather more expensive than silk. If a sloping front cabinet has been constructed, the use of a metal grille is not recommended as many of these consist of a series of holes sloping downwards. The slope at the front of the cabinet means that these holes are seen in the wrong perspective and the brilliant metallic colour expected appears drab. In the worst cases the speaker is often visible through the grille.

An effective alternative to cutting an aperture for the speaker is shown in Fig. 3. This consists of a piece of ¼in thick wood cut to a size equivalent to the aperture required and covered with silk. Before fitting the silk, four 2BA countersunk screws and nuts are fitted at the corners and several 1in holes cut in the wood. The whole assembly is fitted to the cabinet by the four 2BA screws. Clearance holes for the 2BA nuts are required in the cabinet and oversize washers are necessary to clamp the assembly to the cabinet. Full details are shown in Fig. 3. When this method is used it will not normally be necessary to alter the original speaker aperture in the cabinet, and in many cases it will be possible to fit the speaker directly to the cabinet without the need for providing a separate baffle.



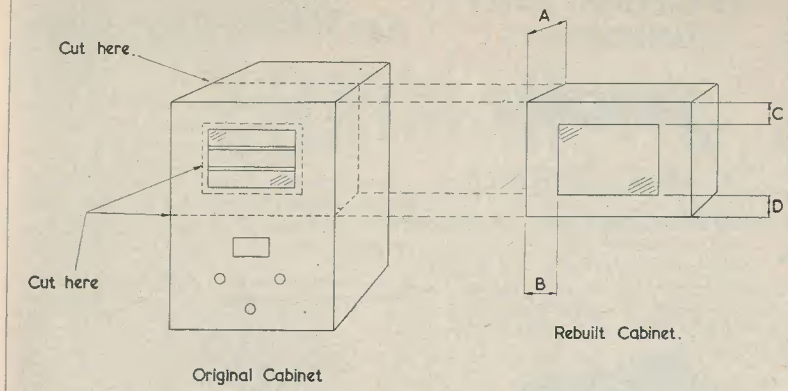



FIG.1.

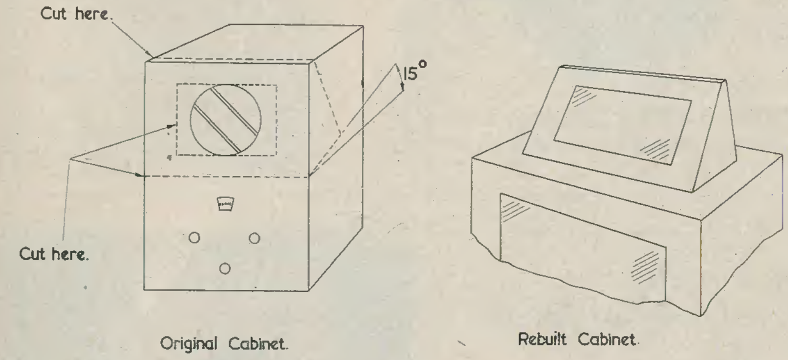



FIG.2.

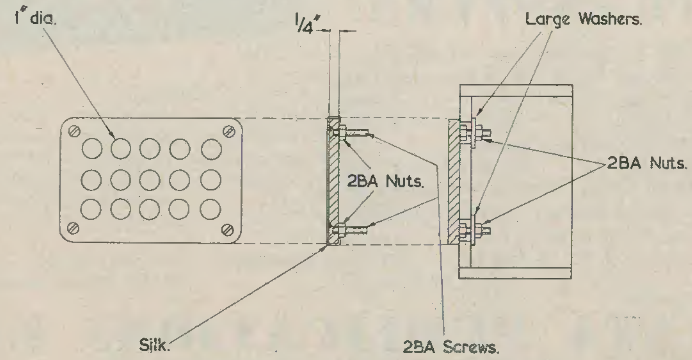
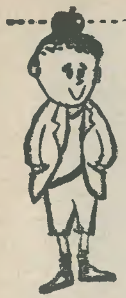



FIG.3

M558

## PRECISION-BUILT COMPONENTS

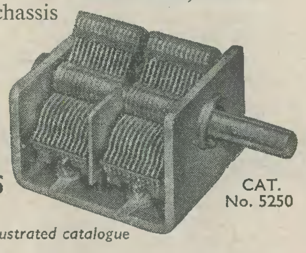


# JACKSON

## 'O' GANG CONDENSER

Miniature model in 1 or 2 gang, capacities up to 365pF swing, front area 1⅜″ x 1$\frac{17}{32}$″ including sweep of vanes, length: 1 gang 1″, 2 gang 1¾″, spindle ¼″ dia. x ¾″ long. Aluminium vanes, cadmium plated steel chassis

**1 gang 7/6**
**2 gang 11/6**



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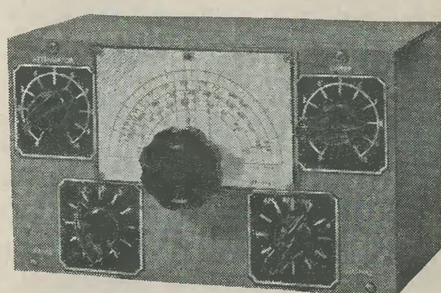

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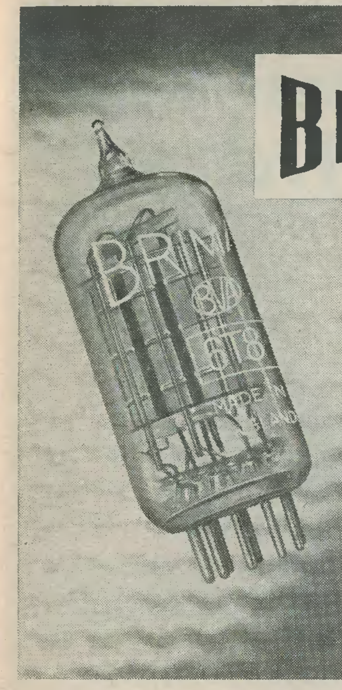
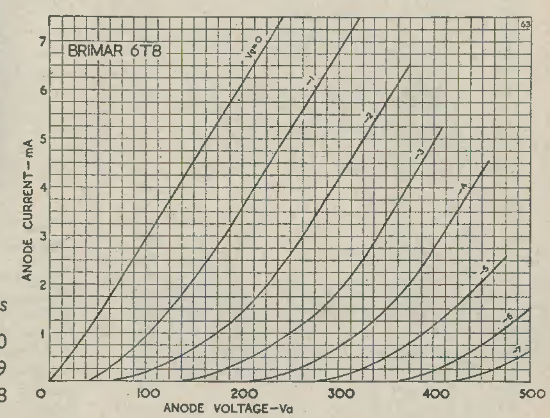


# BRIMAR 6T8

## TRIPLE DIODE TRIODE

The Brimar 6T8 is a triple-diode-triode in which one diode has a separate cathode. The triode section has a high amplification factor making the valve suitable for use in AM/FM receivers in the demodulation and first stage audio circuits. The diodes may be used in series shunt limiter circuits, for example in the audio sections of television and communications receivers, followed again by the triode section for AF amplification.




*Near Equivalents*
EABC80
DH719
6AK8

**Typical Triode Operating Characteristics as an R.C. coupled amplifier**

| | | |
|---|---|---|
| Heater Voltage 6.3 volts | Heater Current 0.45 amp | |
| Anode Supply Voltage | 250 | 250 volts |
| Anode Load Resistor | 0.25 | 0.25 megohms |
| Grid Resistor | 1.0 | 10 megohms |
| Cathode Bias Resistor | 3 | 0 kilohms |
| Peak Output Voltage | 43 | 40 volts |
| Stage Gain (for 24V peak to peak output) | 42 | 42 |
| Distortion (for 24V peak to peak output) | 1 | 5% |

*Cut this out for further reference or write to the Publicity Department at Footscray for a data sheet*

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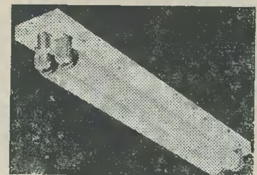
**FOOTSCRAY SIDCUP KENT** *Telephone* 3333

## FLUORESCENT LIGHTS



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**Single 40.** 4' 3" long, uses a 40 watt tube. **Twin 20.** Uses two 20 watt standard tubes.
Price for either type **39/6**, with tubes.
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Carr. and ins. up to 150 miles 5/6, up to 250 miles 7/6.

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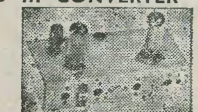

Suitable Wales, London, Midlands, North, Scotland, etc. All the parts including 2 EF80 valves, coils, fine tuner, contrast control, condensers and resistors. (Metal case available as an extra.) Price only **19/6**, plus 2/6 post and ins. Data free with parts or available separately 1/6

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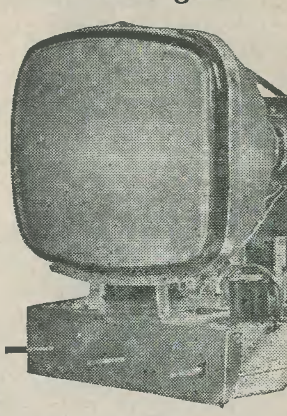

This is a very modern circuit and when you have completed it, it will be equal to any factory-made model. Note these special features:

★ Miniature valves and metal rectifier
★ 12 Channel turret tuner
★ Ferrox E.H.T. and scan coils
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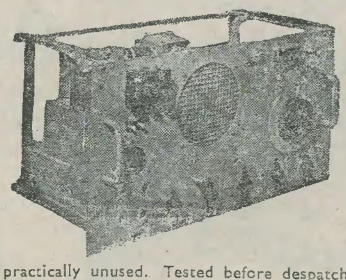

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| 1T4 | 6/– | 12AH8 | 9/6 | DK96 | 9/– | EL84 | 9/– |
| 3S4 | 7/6 | 12AT7 | 7/6 | DL92 | 7/6 | EL91 | 7/6 |
| 3V4 | 8/– | 12AU7 | 7/6 | DL94 | 8/– | EY51 | 10/6 |
| 5U4G | 6/– | 12AX7 | 9/– | DL96 | 9/– | EZ35 | 8/– |
| 5Z4G | 9/– | 12K8GT | 13/6 | EB91 | 5/6 | EZ40 | 8/– |
| 6AM6 | 6/9 | 12K7GT | 8/6 | EBC41 | 8/– | EZ80 | 8/– |
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| 6AT6 | 7/6 | 25A6G | 10/6 | ECC81 | 7/6 | KT33C | 9/6 |
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| 6BW6 | 8/6 | 53KU | 11/6 | ECF82 | 11/– | PCC84 | 9/– |
| 6J5G | 5/6 | 807 | 6/9 | ECH81 | 10/6 | PCF80 | 9/6 |
| 6J7GT | 8/6 | 5763 | 10/6 | ECH42 | 10/– | U76 | 8/6 |
| 6K7G | 2/6 | DAF91 | 7/6 | ECL80 | 12/6 | UBC41 | 10/– |
| 6K8G | 7/6 | DAF96 | 9/– | EF36 | 7/6 | UCH42 | 9/– |
| 6Q7GT | 8/6 | DF91 | 7/6 | EF39 | 5/6 | UF41 | 10/– |
| 6SL7GT | 8/– | DF96 | 9/– | EF41 | 9/– | UL41 | 9/6 |
| 6SN7GT | 8/6 | DH76 | 8/6 | EF80 | 8/– | UY41 | 8/– |
| 6V6G | 7/6 | DH77 | 7/6 | EF91 | 6/9 | W76 | 8/6 |

**Matched Pairs.** EL84, **23**/–; 6V6G, **17**/–; 6BW6, **18**/–; KT33C, **19/6**; KT66, **27/6**; 807 **14/6** pair

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**P.M. Speakers.** 3 ohm. 5″ **16/6**, 6½″ **17/6**, 8″ **21**/–, 10″ **25**/–, 12″ **30**/–, Bakers 12″ 15 ohm 15W, **90**/–

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3. **CONTEMPORARY STYLED LIGHT-WEIGHT CASE** in maroon and grey, size 14½″ x 11½″ x 6″, **£1.7.6,** carriage 2/6

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**ALL 3 UNITS ONLY £9, Carriage 4/6**

### RECORED PLAYER BARGAINS

**New Reduced Prices!**

**SINGLE PLAYERS.** 4-speed **BSR** (TU9) **92/6**; 4-speed **GARRARD** (4 S.P.), **£7.15.0**, carr. and ins. 3/6

**AUTO-CHANGERS.** 4-sp. **BSR** (UA8), **£6.19.6** 4-speed **COLLARO, £7.19.6**; 4-speed **GARRARD** (RC120/4H/2), **£9.15.0**, carr. and ins. 4/6. All above units are latest 4-speed models, fitted lightweight crystal p.u. and twin sapphire styli. Complete and ready to use.

4-sp. **COLLARO JUNIOR, £4.10.0**

4-sp. **GARRARD** RC121/4D/Mk. II, **10 gns.**

**FINEST SELECTION AVAILABLE—ALL BRAND NEW AND GUARANTEED**

### 80 OHM COAX CABLE

NOW ONLY **8d.** YARD!

Highest Quality Cable, low-loss Polythene Aeraxial, semi-air spaced, feeder losses cut 50%. Standard ¼″ dia. Stranded core. Famous make.

20 yds **12/6**, carr. 1/6 40 yds **20**/–, carr. 2/–

**Coax Plugs 1**/–, **Coax Sockets 1**/–, **Couplers 1/3, Outlet Boxes 4/6, B1-B3 Xover Unit 7/6**

### C.R.T. HEATER ISOLATION TRANS.

New improved types—mains prim. 200/250V tapped. All isolation transformers now supplied with alternative *no boost, plus* 25%, *and plus* 50% *boost taps* **at no extra cost, all in one transformer.** 2V 2A type, **12/6**; 6.3V 0.6A type, **12/6**; 10.5V 0.3A type, **12/6**; 13V 0.3A type, **12/6**. P. and p. 1/6. Other voltages in course of production. Small size and tag terminated for easy fitting. P. and p. 1/6

### EMITAPE RECORDING TAPE

ALL NEW AND BOXED

| | Type 88 (Stand.) | | Type 99 (Long Play) | |
|---|---|---|---|---|
| 3″ | 175ft | **7**/– | 250ft | **9**/– |
| 5″ | 600ft | **19**/– | 850ft | **24**/– |
| 5¾″ | 850ft | **24/6** | 1,200ft | **31/6** |
| 7″ | 1,200ft | **30**/– | 1,800ft | **45**/– |

Spare Reels (unboxed). 7″ metal **1/6**, 7″ plastic (EMI) **3/6**

**RE-GUNNED TV TUBES—GENUINE OFFER** New heater, cathode and gun assembly can now be fitted to your old tube, revacuumed and reconditioned virtually as new. Fully guaranteed to highest standards —as used by our own Service Department. 12″ **£8**; 14″ **£8.10.0**; 17″ **£10.** We regret only Mullard and Mazda types at present. Delivery approximately 7 days. Carriage and insurance 12/6

**MIDGET TRANSISTOR TYPE ELECTROLYTICS.** T.C.C. 2μF, 4μF, 8μF 6V, **3/6**; 6μF, 10μF, 16μF 3V, **3/6**; 32μF 1½V, **3/6**, etc.

**VALVES—NEW BOXED—ALL GUARANTEED** 1R5, 1T4, **7/6**; 1S5, 1S4, **7/6**; 3S4, 3V4, **8**/–; 5Z4, **9/6**; 6AT6, **8/6**; 6K7, **6/6**; 6K8, **8/6**; 6Q7, **8/6**; 6SN7, **8/6**; 6V6, **7/6**; 6X4, **7/6**; 6X5, **7/6**; 7C5, **9**/–; 7Y4, **8/6**; DAF96, **9**/–; DF96, **9**/–; DK96, **9**/–; DL96, **9**/–; 35L6, **10/6**; EABC80, **9/6**; EB91, **6/6**; EBC41, **10/6**; EBC33, **8/6**; ECC84, **12/6**; ECH42, **10/6**; ECH81, **10/6**; ECL80, **12/6**; EF41, **10/6**; EF80, **10/6**; EF86, **14/6**; EF91, **8/6**; EY51, **12/6**; EZ40, **8/6**; EZ80, **8/6**; MU14, **9/6**; PCC84, **10/6**; PCF80, **10/6**; PCF82, **10/6**; PCL83, **12/6**; PL81, **14/6**; PL82, **10**/–; PL83, **11/6**; PY80, **9/6**; PY81, **9/6**; PY82, **8/6**; U25, **14/6**; UY41, **8/6**

**SPECIAL**—1R5, 1T4, 1S5, 1S4 or 3S4 or 3V4 per set **27/6**

*We can only show a small selection from our vast stocks in this advert. Write now for full Bargain Lists, 3d.*

*Hours 9 a.m.–6 p.m., 1 p.m. Wed.*

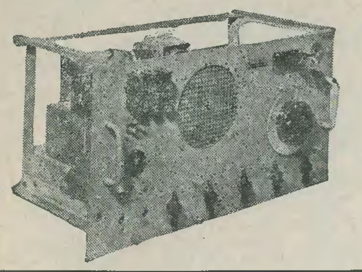
TRS Est. 1946

**RADIO COMPONENT SPECIALISTS**

**70 Brigstock Road Thornton Heath Surrey** *Telephone* THO 2188

*Terms: C.W.O. or C.O.D. Post and packing up to ½lb 7d., 1lb 1/1, 3lb 1/6, 5lb 2/–, 10lb 2/9*

# *SPUTNIK-SPECIAL* — THE WORLD IN YOUR HOME



**SHORT-WAVE RECEIVER 10-60 MC/S (5-30 Metres) RECEPTION SET TYPE 208**

Complete with 6 valves, 2 6K8G, 2 EF39, 6Q7G and 6V6G. Internal mains power pack and 6V vibrator pack. Built-in 6½" speaker. Muirhead slow-motion drive. B.F.O. and R.F. stage. I.F. freq. 2 Mc/s. Provision for phones and muting and 600 ohms **input 110/250V** a.c. 6V vibrator pack included for battery operation. All sets in new condition and air tested **£6.19.6** carr. 15/6

6½" Extension Speaker **27/6** in cabinet

**NO WORK REQUIRED : JUST PLUG IN AND SWITCH ON!**

## AC/DC PORTABLE RADIO

- ★ 5 valve superhet
- ★ Built-in frame aerial
- ★ Size 10" x 10" x 4" deep
- ★ All Marconi valves
- ★ Med., long and short waveband OR Med. and two short wavebands
- ★ Gram. sockets (for crystal or magnetic pick-ups)
- ★ 7" x 4" elliptical speaker
- ★ Slow motion tuning
- ★ Ideal for a radio-gram

**ONLY £7.12.6** post 7/6

Portable polished cabinet ... ... ... 27/6
Super portable rexine cabinet ... ... ... 37/6

ABSOLUTELY GUARANTEED BRAND NEW AND IN PERFECT WORKING ORDER

### CRYSTAL CALIBRATOR For No. 19 Set

10 kc/s; 100 kc/s; 1 Mc/s; spot frequencies; crystal controlled oscillators; includes 5 12SC7 valves, neon modulator handbook, etc.
BRAND NEW **£4.19.6** Post free

### TRANSMITTER/RECEIVER Army Type 17 Mk. II

Complete with valves, high resistance headphones, handmike and instruction book and circuit. Frequency range 44.0 to 61 Mc/s. Range approximately 3 to 8 miles. Power requirements: Standard 120V h.t. and 2V l.t. Ideal for Civil Defence and communications. BRAND NEW **45/–**
44-61 Mc/s calibrated Wavemeter for same, 10/– extra

### RADAR UNIT TYPE 1683

Complete with the following valves: 2 6C4, 832A, 829B, 2 5R4G, 3 6AC7, 6V6GT, 931A photo multiplier with associated network. Also 2-blower motors. Input 30-115V 400 to 2,600 c/s cd 26V d.c. BRAND NEW AND boxed **£6.10.0** Post free

**VIBRATOR PACKS.** Input 6V d.c. Output approx. 100V d.c. at 30mA, fully smoothed and r.f. filtered. Size 6½" x 5" x 2". Fitted with Mallory 629C vibrator. BRAND NEW. Boxed. 12/6

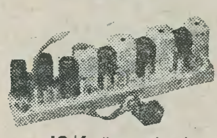
### TRANSISTOR SQUARE GENERATOR

Complete kit with 2 Transistors, Components, Circuit and plastic case **20/-**

### TRANSISTOR SIGNAL TRACER

Complete kit with 2 Transistors, Components, Phones and Circuit and plastic case **37/6**

## 373 MINIATURE I.F. STRIPS 9.72 MC/S



The ideal f.m. conversion unit as described in P.W., April/May 1957. Complete with 6 valves, three EF91's, two EF92's and one EB91. I.F.T's etc., in absolutely new condition. With circuit and conversion data.

**12/6** (less valves) **42/6** (with valves)
*Postage and packing 2/6 (either type)*
FM AT ITS CHEAPEST!

**RCA 6½" P.M. SPEAKER IN CABINET**
With vol. control and 600V line trans. **27/6**, P.P. 2/6

### MIXER UNIT TYPE 79

Frequency range 172 to 190 Mc/s. Comprising: VCR139A cath. ray tube; 7 EF50's; EF55; 4 EA50's; 2 EB91's; 5U4; VU120 and EC52. Standard main input 200-250 volts 50 c/s. Ideal Scope basis.
**£5.10.0** carriage 5/–

### A.C./D.C. 200/250V Portable-Gram AMPLIFIER

Completely assembled on baffle board size 12¼" x 4¾", depth 3". Containing two Mullard valves type UL84 and UY85, Elac 7" x 4" elliptical speaker, volume control, tone control. Nothing else to buy, just plug in to mains and connect your pick-up to amplifier.
**Absolute bargain 67/6** Carr. 2/6

### DYNAMOTORS

12 volt d.c. input, 220 volt 165mA output, **32/6**. Post free

### BATTERY CHARGER

Input 200/250V a.c. Output for 12V batteries at 2½A trickle charge.
BRAND NEW in metal case **27/6** P.P 2/6

### RF UNITS

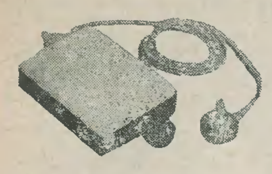
**TYPE 25 Switched.** Tuning 30 to 40 Mc/s. Includes 3 SP61's Carriage 2/6 **10/–**
**TYPE 26.** Variable tuning, 50 to 65 Mc/s, Including 2 EF54's and 1 EC52. Carr. 2/6 **25/–**
(Circuits in stock for both types 9d.)

**Send 3d. stamp for new transistor components list: new quartz crystal list; valve list; transistor receiver circuits, etc. Complete Catalogues 6d.**

**HENRY'S RADIO LTD · 5 HARROW ROAD · LONDON W2**
*Opposite Edgware Road Tube Station* (DEPT. RCD) *Telephone* **PADdington 1008/9**



# MINOR (Ideal Xmas Presents) MAJOR



**MINOR**

- ★ Variable tuning over medium waves
- ★ 3-stage reflex circuit
- ★ Highly sensitive
- ★ Internal ferrite aerial
- ★ Drilled chassis
- ★ Long-life battery
- ★ Complete constructional details
- ★ Weight less than 2 oz.
- ★ Size only 3" x 2" x ¾"

Total cost, including transistor, personal miniature phone, case, battery and complete circuit and layout diagrams, **52/6** post free. All components sold separately. Circuit and shopping list FREE. **Call and Hear Demonstration Model.**

**MAJOR**

- ★ 4-stage reflex circuit
- ★ Variable tuning over medium waves
- ★ Highly sensitive
- ★ No aerial or earth
- ★ Home, Light and Third
- ★ Economical
- ★ Drilled and mounted chassis
- ★ Size 4½" x 3" x 1¼"
- ★ Internal ferrite aerial
- ★ Weight less than 4 oz
- ★ Complete layout diagram
- ★ May be built in 1 hr.

All items can be supplied, including **EDISWAN** transistors, battery, case and personal phone, etc., for **72/6**, post free. All components sold separately. Circuit and shopping list FREE. **Call and Hear Demonstration Model.**

As described in October issue of *The Radio Constructor*

## "THE TRANSISTOR — 8" Push-Pull Portable Superhet

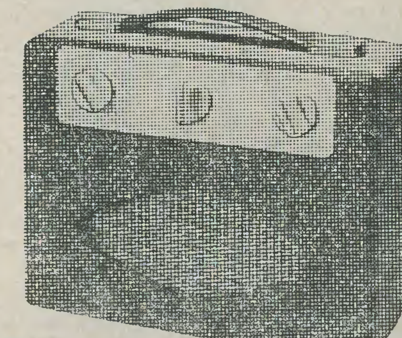
This Portable 8-Transistor Superhet is tunable for both Medium and Long Waves and is comparable in performance to any equivalent Commercial Transistor Set. **Call and Hear Demonstration Model.**

- ★ 8 **EDISWAN** Transistors
- ★ 250 Milliwatts output Push-pull
- ★ Medium and long waves
- ★ Internal ferrite rod aerial
- ★ Elliptical speaker
- ★ Drilled chassis 8½" x 2½"
- ★ Point-to-point wiring and practical layout
- ★ Economical. Powered by 7½V battery
- ★ Highly sensitive
- ★ Attractive lightweight contemporary case. In various colours

**COMBINED PORTABLE/CAR RADIO**
Two sets for the price of one

We can supply all these items including cabinet for **£11.10.0** P.P 2/6. All parts sold separately
Circuit diagrams and shopping list free

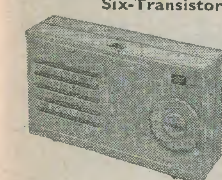
Car Radio Conversion Components, **8/–**. A.V.C. **5/9**
325mW version, **40/–** extra



Size: 8" x 7" x 3½"
Weight: 4lb.

## TELETRON "TRANSIDYNE" RECEIVER

**Six-Transistor Pocket Superhet**



- ★ TCC printed circuit
- ★ Medium and long waves
- ★ Powered by two No. 8 batteries
- ★ Push-pull output 150mW
- ★ Moulded plastic case
- ★ Rola 2½" p.m. speaker
- ★ Internal ferrite aerial
- ★ Weight 20 oz
- ★ Complete layout instructions
- ★ Easy to assemble (All components identified)

Size: 6¼" x 3¾" x 1¾"
★ THE BEST YET!

All components, including **NEW EDISWAN TRANSISTORS**, cabinet, batteries, etc., can be supplied for **£11.19.6**, P.P. 2/6
All parts sold separately. Circuit and shopping list **9d.**

### CRYSTAL MIC. INSERTS

¾" square ... ... **3/6** 1½" round (Acos) ... **7/6**
¾" round (Acos) ... **5/–** 2½" round (Acos) ... **12/6**
Moulded plastic hand mic. case suitable for any of above, only **2/6**

## NEW TYPE TRANSISTORS—PRICE REDUCTIONS

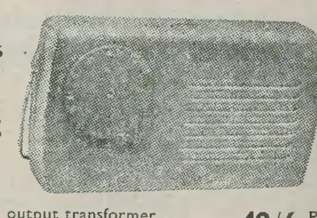
**JUNCTION TYPE P.N.P.—ALL EDISWAN**

XA104 6 Mc/s osc./mixer or r.f. amplifier ... **18/–**
XA103 4 Mc/s r.f. and i.f. amplifier ... ... **15/–**
XB104 audio output ... ... ... ... ... **10/–**
(A pair in push-pull will give up to 250mW audio output)
**RED SPOT** 800 kc/s audio amplifier ... **7/6**
**WHITE SPOT** 2 to 5 Mc/s r.f. and i.f. amplifier **12/6**

*CONSTRUCTORS PARCEL FOR*

### TRANSISTOR POCKET RADIO

Perdio attractive moulded cabinet, **12/6**
J.B. screened twin gang 208+176pF, **10/–**. Perdio 2½" min. 3 ohm speaker, **21/–**



Single ended output transformer to match, **10/–**. ALL FOR ONLY **49/6** P.P. 2/6

**HENRY'S RADIO LTD · 5 HARROW ROAD · LONDON W2**
*At junction of Edgware Road and Harrow Road* (DEPT. RCD) *Telephone* **PADdington 1008/9**

## The TRANSIDYNE RECEIVER

*(Page 119 Sept. issue)*

*We guarantee all components to be exactly as* **specified by designer & approved by Messrs. Teletron**

| | |
|---|---|
| Drilled case, printed circuit, battery holder, dial, nuts, screws | **£1.5.0** |
| Complete coil and aerial kit | **£2.2.0** |
| Resistor kit (with circuit refs.) | **6/-** |
| Cond. kit (with circuit refs.) | **£1.5.0** |
| Rola speaker (tax paid) | **£1.8.2** |
| J.B. tuning condenser with centre screen | **10/6** |
| Ardente D131 & D132 per pr. | **£1.5.6** |
| Ardente volume control (R15) | **12/6** |
| Slider wavechange switch | **3/6** |
| GEX34 diode | **4/-** |

COMPLETE KIT AS ABOVE AT THE SPECIAL PRICE OF **£8.15.6**

Transistors—
Red/Yellow (r.f.) **15/-** each
Green/Yellow (audio) **9/6** each

**COMPLETE KIT WITH TRANSISTORS AT THE SPECIAL REDUCED PRICE OF £11.19.6**

*FREE—Special 'printed circuit' solder with each kit*

Full constructional details, **9d.** S.A.E. Price List

TRANSISTOR KITS. **Companion £5.9.0.** Leaflet 6d. **'Mini-7', £12.** Envelope 1/6. **Radiosette £2.3.0** (with phones)
*Price Lists—S.A.E.*

We recommend the 'LITESOLD' soldering iron for all work and especially printed circuits. Mains or battery. **21/6** complete *(state mains voltage)*

CONNECTING WIRE. p.v.c. 50ft coil, 5 colours, **1/9. Sleeving,** 15ft, asstd. colours and thicknesses, **8d. Tinned Copper Wire** 24 s.w.g., 15ft **8d. Combined pack** (3 above items) **2/9**

TRANSISTOR ITEMS. **Electrolytics** 8µF 6V, 16µF 12.5V, 32µF 3V, 5µF 12.5V, 5µF 40V, 2.5µF 40V, 1.6µF 6V, 25µF 6V. **All 3/3 each;** 100µF 6V **3/-**; Paper 0.01, 0.001, 0.002, 0.005µF, **all 8d. each. Transistor Holders 1/-** each, 6 for **5/9, 11/-** doz. **Ardente T.1065** transformers (page 911—July), **12/-. Subminiature Speakers** $1\frac{3}{4}''$ round, **27/-**; 2" x 3" elliptical, **33/- Sub-miniature Output Transformers,** single-ended or p/p, **12/6. Volume Controls,** button type (totally enclosed), 47k and 1MΩ, **2/6**; preset skeleton type 5k, **2/6**; spindle type, ½M, 1M, 2M, **4/3** (page 705—'R.C.' May). **Ardente Deaf Aid Earpieces** E.R.100, with cord and plug. Limited number at **13/9. Ardente Catalogue 6d.**

**TRANSISTORS**—*CHEAPER STILL*

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|---|---|
| Yellow/Red R.F. | 15/- |
| White Spot R.F. | 14/- |
| Yellow/Green A.F. | 9/6 |
| Red Spot A.F. | 9/- |

GENERAL ITEMS. **Miniature neons** (as used in mains testers), **1/10. Resistors,** carbon from **3d.,** wire-wound from **1/3,** hi stabs from **6d. Mixed Carbon** 50 for **7/-. Capacitors,** paper from **10d.,** s/mica from **8d. 'Ajax' Crystal Kit** complete, **14/6** (L.W. **15/-**). **Phones 14/-** and **16/-. 'Ajax' Case** with chassis, **5/9. Multicore Solder 4d.** yd, 19 ft reel **2/6,** 1lb reel **14/9. Fine gauge** for printed circuits, 40 ft reel **2/6. Switches,** s/p from **2/3,** d/p from **3/6. Ferrite Rods** 8" x ¼" diam., **2/-. Mains neon indicators** with built-in resistor. Domed top, chrome bezel, 1" long ½" diam. Opal, red, amber, **3/10**; green **4/7. Assorted nuts, bolts, washers.** 25, **1/-**; 72, **2/9**; 144, **5/-**

### JACK PLUGS AND SOCKETS

**(by Bulgin)** See p. 376

**Miniature type** ¾" diameter panel space. ⅞" behind panel. With optional closed circuit leaf.
*Plug* **3/-** *Socket* **2/6** See p. 376

**Sub-miniature type** ¾" x ½" panel space. ½" behind panel, ⅝" projection.
*Plug* **1/3** *Socket* **9d.**

### GIFT IDEAS

AJAX CRYSTAL RECEIVER. Complete kit to make this well-known receiver. Easy to assemble—superb reception. M.W. set **14/6,** L.W. **15/-**

**Headphones 14/-, Superior Type 16/6, Crystal Headphones 21/-**

REP. 1 VALVE RECEIVER. For excellent headphone reception. With battery but less phones, **£2/10/0**

**File Set.** 6 wood handled files in smart wallet ... ... ... **12/6**

**Screwdriver Set.** 6 blades (including 2 Philips type) with amber handle. In compact wallet **7/6**

**Pliers Set.** 1 pair large pliers, 1 pair slender nosed, 1 pair side cutters. In wallet ... ... ... **12/6**

**Drill Set.** 7 sizes $\frac{1}{16}''$ to ¼". In wallet ... ... ... **6/10**

**Side Cutter Pliers.** 5" insulated handles ... ... ... **5/8**

**Long Slender Side Cutters.** For compact work. Lap jointed 4½" long ... ... ... ... **8/9**

**Box Jointed Side Cutters.** Superior make, polished steel, 4½" ... ... ... ... **12/9**

**Screwdriver Mains Testers 3/9**

### HI GAIN BAND 3 PRE-AMPLIFIER

*(See page 568 March)*

**Resistor Set, 1/6; Capacitor Set** (with clip), **8/9; Valve ECC84, 17/-; Rectifier** (50mA), **7/6; Transformer, 13/-; Coil Set** ($L_1$–$L_5$) **9/-; Chassis** (punched for coils, space for Power Pack), **3/9; Coax Sockets, V/holder, Tag Strip, Nuts, Bolts, 5/6.**

**COMPLETE KIT AS ABOVE £3.3.0**

*QUOTATIONS gladly given (S.A.E. please)*

# R. FAGELSTON (MAIL ORDER)

*Please add Postage to above prices*

**46 HARDWICKE ROAD · LONDON N13**

# Res/Cap Bridge

FOR

## 35/- ONLY

P. & P. 2/-

For checking all types of resistors and condensers

**BUILT IN 1 HOUR! DIRECT READING!! READY CALIBRATED!!!**

Stamp for details of this and other instruments

**RADIO MAIL** Dept CD Raleigh Mews Raleigh Street Nottingham

# HIGH FIDELITY

*Quality components of all types always in stock for the*

**MULLARD 2-VALVE PRE-AMPLIFIER**
**MULLARD 3-VALVE 3-WATT AMPLIFIER**
**MULLARD TAPE AMPLIFIER TYPE C**

*Circuits free on request*

| | |
|---|---|
| 510 AMPLIFIER FM TUNER | circuits 3/6 |
| 912 PLUS AMPLIFIER | „ 4/- |
| JUPITER STEREO UNIT | „ 2/6 |
| RADIO CONSTRUCTOR FM | „ 2/- |
| MERCURY SWITCHED FM | „ 2/- |
| DENCO FM TUNER | „ 1/6 |

*Price list available on request*

**J. T. FILMER** 82 DARTFORD ROAD DARTFORD KENT
Telephone Dartford 4057



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### PRIVATE

FOR SALE. PCR2 receiver, mint condition, fitted internal power pack, £7.—W. Oakley, "Pearl Dene," Craig Walk, Bowness-on-Windermere, Westmorland.

SALE. *The Radio Constructor*, 5 years back issues, perfect, 55s. Hallicrafters S27, needs attention, 55s. 25 valves, new and boxed, B7G and B9A, 50s.—Booker, 77 Goldsmith Avenue, London, E.12.

SALE. Metal rectifiers 14A86 and 14A100 (200mA 250V). Used but good, 5s. each or 5 for 20s. Please add postage.—Box No. E.192.

COLLARO TAPE DECK Mk. II, perfect, £13. AR88 Manual, £1. Valves 35T, unused, boxed, 15s.—Anderson, 16 Warrender Way, Ruislip, Middx.

FOR SALE. Wearite tape deck, unused, 7 x 1,200 feet reels Emitape, m/c microphone, £25 o.n.o.—Yallop, Standard Road, Downe, Kent.

SALE. TV engineer's entire private stock, valves, components, etc. Value £150, accept £35 but no reasonable offer refused.—HATch End 5162 after 7 p.m.

BAIRD "SOUNDMASTER" tape recorder in working order, 110/230V a.c. Less microphone. Compact carrying case, snip, £23 15s. 0d., carriage paid. C.W.O.—L. Starling, 11 Benson Road, Croydon, Surrey.

WHAT OFFERS? 23 Bound Volumes *Wireless World* plus many single issues. Sheffield or Hertford. Box E.191.

FOR SALE. Newnes *Radio and TV Servicing*, 6 volumes, new, £8.—Martin, 4 Beech Road, Princes Risborough, Bucks.

FOR SALE.—Cossor 399 Double Beam Oscilloscope, £15, also Taylor Multimeter type 71, 1000 ohms per volt, overhauled recently by manufacturer, guaranteed with circuit diagrams.—Phone for appointment to view, CLI 6335 or, after 6 p.m., 20 Brooke Road, London, N.16.

FOR SALE. Taylor model 55A Wobbulator, Taylor model 30A Oscillograph, Taylor model 65C Signal Generator. All complete with Instruction Manuals, £25 for the three instruments.—Snell, Central Garage, Stairfoot, Barnsley.

FOR SALE. TSL Concert Soundcorner, Hi-Fi corner hanging speaker system, as new, £8 10s. 0d., Wednesday/Thursday evenings.—Thomas, 8 Lysia Street, London, S.W.6.

WANTED. Partridge Williamson output transformer, first class condition only, reasonable—Cooke, 35 Victoria Grove, Bridport, Dorset.

WANTED. Quad II main amplifier, also Ferrograph, Vortexion, or similar tape recorder.—Terry, 39 Ronaldstone Road, Sidcup, Kent.

*continued on page 399*

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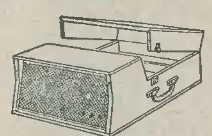

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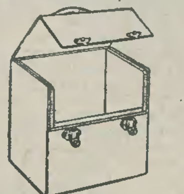

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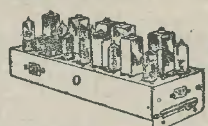

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*continued from page 397*

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*continued on page 400*

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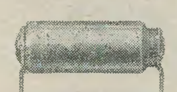

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*continued from page 399*

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