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FOR THE RADIO AND TELEVISION ENTHUSIAST

VOLUME 9 NUMBER 10 MAY 1956

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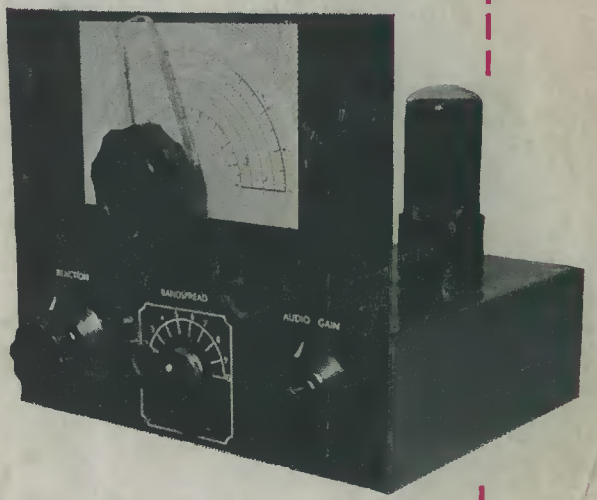

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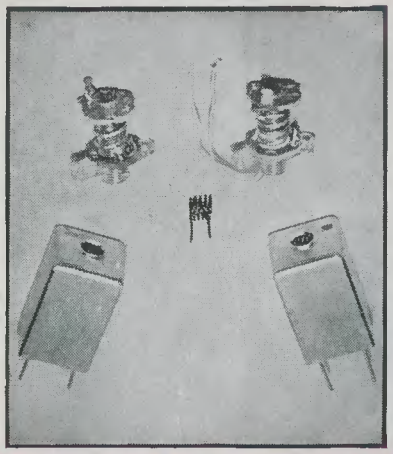

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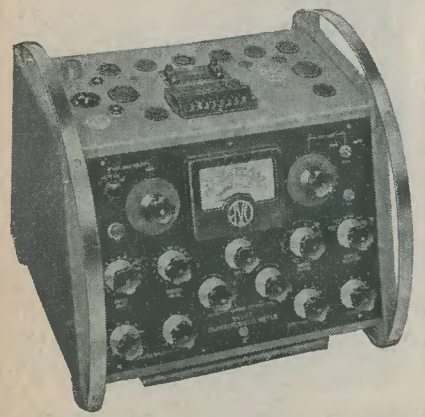

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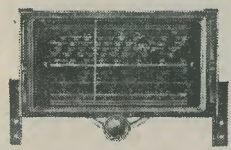

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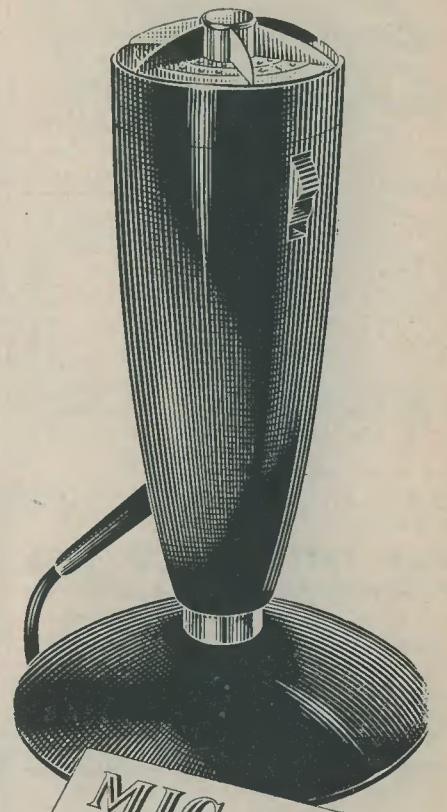

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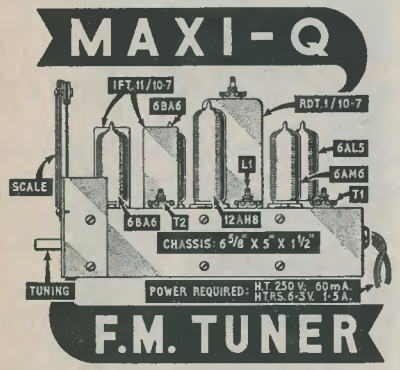

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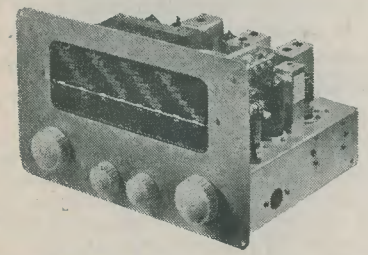

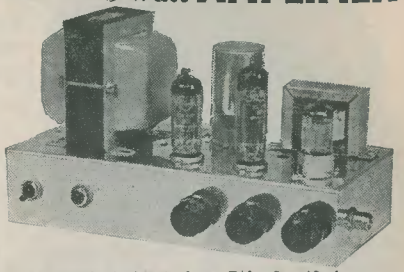

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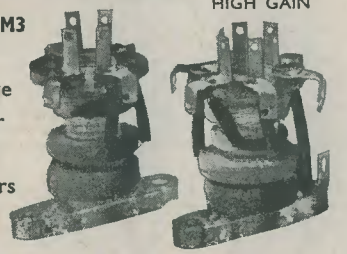

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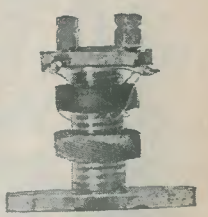

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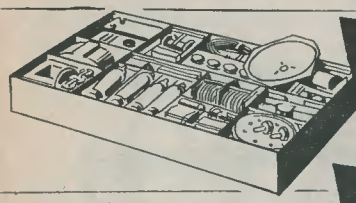

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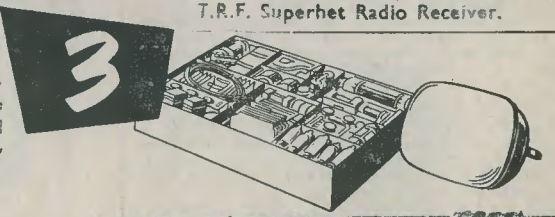

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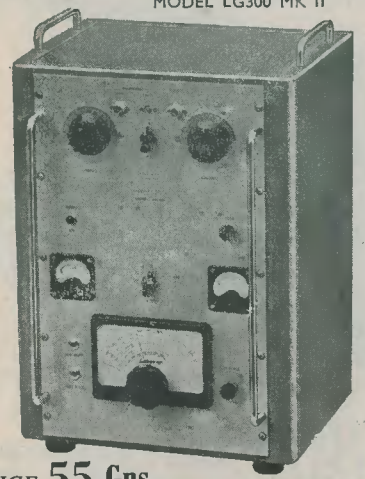

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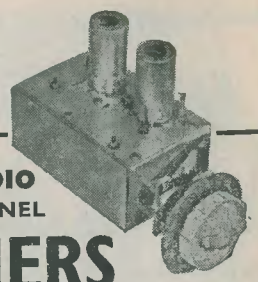

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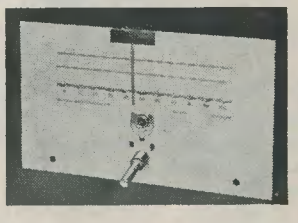

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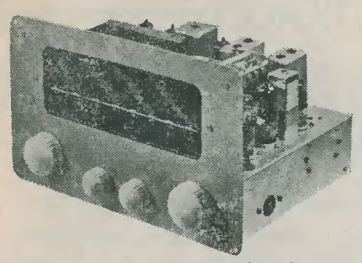

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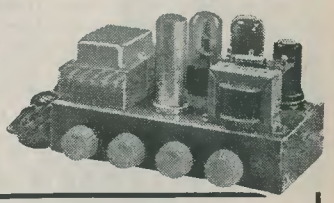

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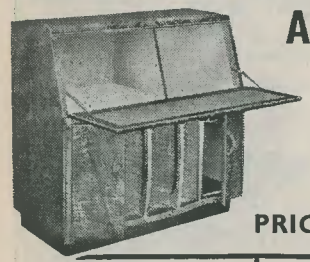

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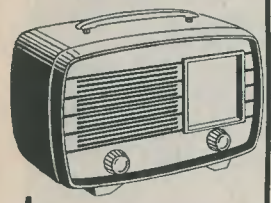

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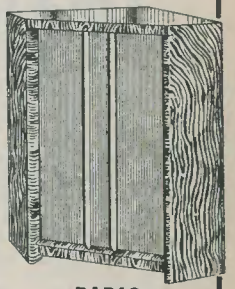

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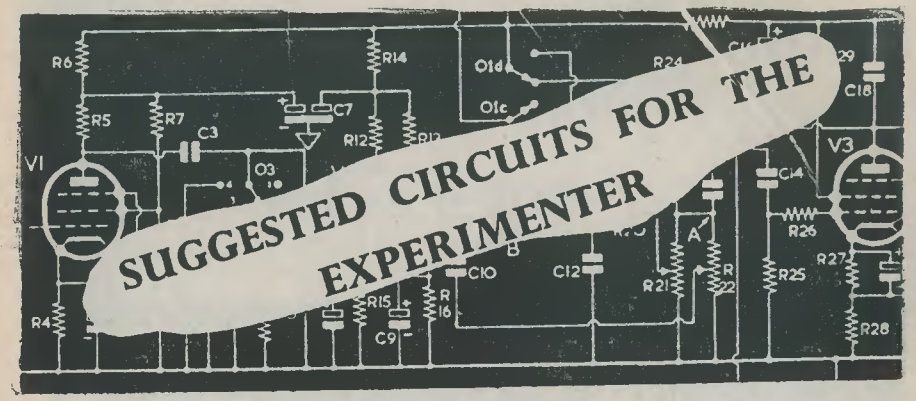


The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data*

No. 66. A VOLTAGE REGULATED POWER PACK

DURING EXPERIMENTAL WORK THE NEED often arises for a power pack capable of supplying a well-regulated source of h.t. voltage. This power pack should be such that its output has a constant potential despite differing h.t. current consumptions or variations in the mains supply voltage. The power pack should, in addition, be capable of maintaining its steady voltage during very quick changes in load current.

Conventional rectifier h.t power units employ either condenser or choke input filtering. Condenser input filtering is more economic than choke input filtering because it enables a higher h.t. voltage to be obtained from the same mains transformer. However, the regulation of a condenser input power pack is poor. Choke input filtering provides better regulation but necessitates the use of an expensive mains transformer if a reasonably high h.t. voltage is to be obtained. Even with choke input filtering, h.t. regulation for slow changes in current consumption can be no better than that permitted by the resistive elements of the circuit. In other words, the equivalent circuit of a power pack employing choke input filtering may consist of a source of steady potential in series with a resistance; this resistance representing the sum of the resistances of the transformer and choke windings, plus transformer losses and the internal resistance in the rectifier. Neither a condenser input or choke input power pack will, of course, be able to prevent alterations in h.t. output voltage caused by variations in the mains supply.

The Circuit

This month's circuit illustrates a power pack which works on an entirely different principle. It employs a conventional condenser input filter arrangement which is followed by a valve whose effective resistance can be altered by varying its grid-cathode potential. This potential is varied by a second valve whose function is that of comparing the h.t. voltage output of the power unit with that appearing across a voltage regulator valve.

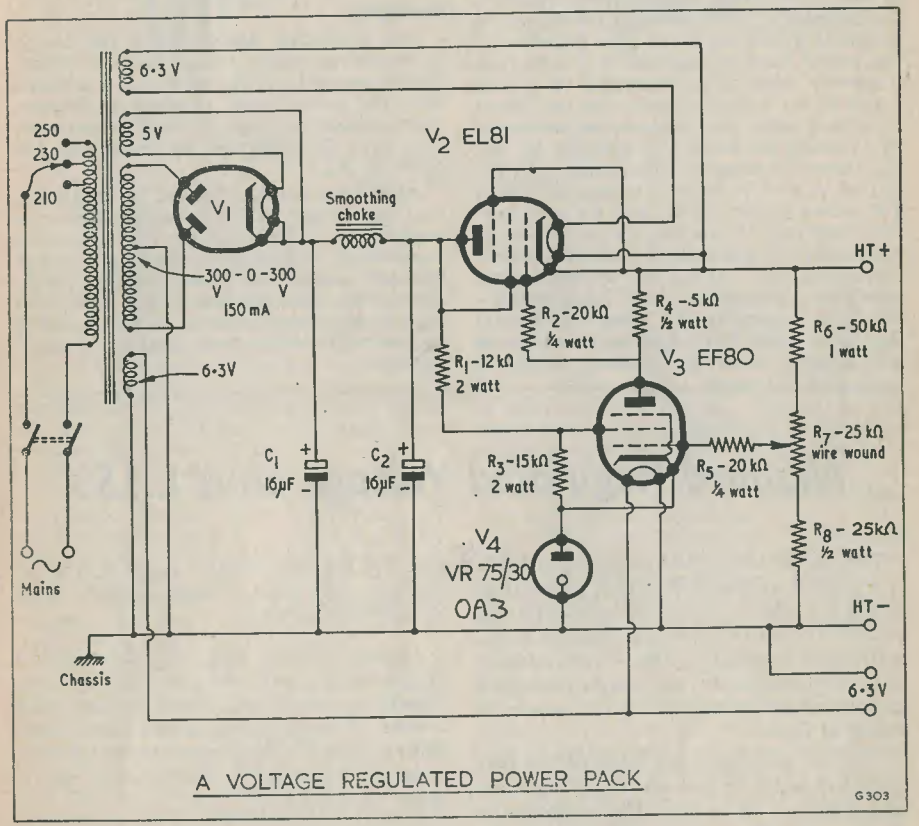
The h.t. output of the power unit shown in the circuit should be capable of adjustment from some 150 to 250 volts, its maximum output current being approximately 150mA. The 6.3 volt l.t. supply also provided by the power pack is not regulated. The resistor values shown in the diagram have been calculated from the curves of the particular valves employed, and should give rise to no trouble in practice. However, this point is discussed in more detail later. A type number for the rectifier, V_1, is not given, since this may consist of any full-wave valve capable of passing the maximum h.t. current required.

Operation

The operation of the circuit is fairly simple. It works on the principle that the regulation of the h.t. voltage applied to the anode of V_2 is poor, and that, to ensure a constant voltage at the output terminals, the effective resistance of this valve is varied to compensate for the poorly regulated voltage.

It would be advisable to commence a more detailed explanation of the operation of the power unit by assuming that it is supplying an h.t. voltage at a particular current via its output terminals. For some reason, such as would be given by increased load current or by a drop in mains input voltage, the h.t. voltage at the output terminals commences to drop. This drop in voltage is then passed, via the tap into the potentiometer formed by R_6, R_7, and R_8 in series, to the grid of V_3.

The cathode of V_3 is held at a constant potential by V_4 and is relatively undisturbed by the fall in h.t. voltage. On the other hand, the grid voltage of V_3 is proportional to the output voltage of the power pack and, in consequence, goes negative. The anode current of V_3 therefore falls. The drop in anode current of V_3 results in a lower voltage appearing across R_4. The voltage across R_4 is that which biases V_2 with the result that, when it decreases, so also does the effective series resistance provided by V_2. The ultimate effect is that the h.t. voltage appearing at the output terminals of the power pack then rises, reaching, or very closely approaching, its previous value.



Practical Points

It will be seen from the above that the output h.t. voltage always tends to revert to its original state, its reference voltage being provided by the regulator valve V_4. The purpose of the potentiometer R_7 is to apply the desired fraction of the total output h.t. voltage to the grid of V_3. Adjusting R_7

EL81: P_a max. 8W
P_s max. 4·5W

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will, in practice, alter the stabilised voltage available from the power unit. The component values shown in the circuit should enable this control to provide regulated outputs between 150 and 250 volts. It should be pointed out, however, that regulation over a wide range of currents may be slightly lower when the output voltage approaches 150 or 250 volts than it is at the design centre of 200 volts.

If it is to be of practical use, a regulated power supply should be capable of accommodating changes in load current which occur at relatively high frequencies. This infers that the regulating circuit should function effectively during a small fraction of one cycle of the load current frequency. Unfortunately, if the action of the regulating circuit is made too quick it is possible for the power pack to oscillate at a very high frequency when it is connected to a load which is not purely resistive. In the circuit illustrated here this tendency is prevented by inserting the series grid resistors R_2 and R_5, these operating in conjunction with the C_{gk} of V_2 and V_3 to form integrating filters. The values shown for R_2 and R_5 are somewhat high but, despite this, the circuit should still cope quite satisfactorily for load current frequencies up to 20 kc/s and above. Higher regulating frequencies could be accommodated by decreasing the values of R_2 and R_5; these being reduced, if necessary, to as low a value as several hundred ohms. If such a course is followed the wiring between V_2 and V_3 should be kept short.

Due to the current passing through V_4, a voltage regulator, and not a reference valve, has been chosen for this position. In consequence, the power pack reference voltage is liable to alter slightly as the current flowing through V_4 varies. The valve type given for V_4 has a shift of approximately 5 volts for a variation of current of 5 to 40mA. In this circuit V_4 should pass a current lying between the approximate limits of 10 to 22mA and should, in consequence, not cause any serious shift in reference voltage.

Sensitivity

The regulation sensitivity of the circuit is dependent mainly upon the value chosen for the anode load, R_4, of V_3. If it is found that the power pack provides inadequate regulation at very high or low load currents, this may be improved by increasing the value of R_4.

As a final point, it should be mentioned that the heater of V_2 is supplied from a separate 6.3 volt winding on the mains transformer. The separate winding is recommended because the heater-cathode insulation of the valve specified is not sufficiently high to allow the heater to be connected to chassis whilst the cathode is at h.t. positive potential.

Mullard Regulated Voltage Unit L.153

The Mullard regulated voltage unit L.153 is a general purpose laboratory power unit, which provides a stable low impedance d.c. supply continuously variable between 0 and 300V at up to 300mA. Two 4A a.c. supplies of 6.3V, tapped at 4V, are also incorporated, as well as an unregulated e.h.t. supply of 1.2kV at 2mA.

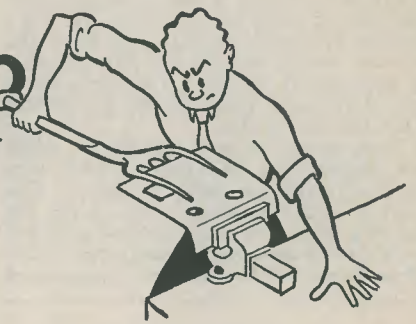
The d.c. outputs of two units can be connected in series to give up to 600V positive and negative to earth. The variation in output voltage is less than 100mV for mains variations of +10% to −15%. Ripple voltage is less than 3mV, and output resistance is about 0.2 ohms.

The 1.2kV output can be either positive or negative with respect to the negative terminal of the 300V supply. It can be used for cathode ray tubes, Geiger Muller tubes, photomultipliers, etc.

Output voltage and current meters are incorporated, and the unit is protected against overloads by a circuit breaker which breaks the supply connections and lights a warning lamp. This circuit breaker may be reset by operating a push-button on the front of the unit.

A new form of construction is used which enables the bench mounting case, in which the unit is supplied, to be very quickly removed for servicing and maintenance. The front panel and chassis are designed to fit any standard 19in rack.

IN YOUR WORKSHOP



Once more, in these two experimental articles, J.R.D. hands over his space to old Smithy, the Serviceman.

WHEN DICK WANDERED INTO OLD Smithy's workshop just after nine o'clock one morning, the serviceman was in a very disgruntled mood. He had a television chassis lying on the bench but his customary array of test gear was absent.

"You can't rely on anyone these days," grumbled Smithy, seeing Dick enter. "People just don't seem to be able to keep their promises like they used to."

"What's up?" asked Dick.

"I've got a faulty set on the bench," complained Smithy, "and I haven't even got a testmeter to help me find the fault. I was working late at a friend's house last night and, rather than take all my gear home, he promised to bring it in for me this morning. He hasn't turned up yet, so I'm stuck with a repair job I can't fix."

"Well, you've done repair jobs before now without gear," commented Dick, "perhaps you had better use your 'desert island technique' again this time!"

Smithy brightened a little. "Yes, I suppose I should," he said, "although I'm never very keen on using dodges or tricks in the workshop. That's because many supposed short-cuts often take longer than finding a fault in the text-book way. Nevertheless, I might be able to do something in this instance."

He reached into a drawer and pulled out a small home-made device. It had a short body covered with sleeving, from either end of which protruded two flexible insulated leads about nine inches long. One lead was terminated in a crocodile clip, the other in a test prod.

"Now this," he said proudly, "is an extremely clever little device, designed especially for checking television receivers. With this I can locate faults anywhere in the a.f. stages, in the frame timebase, and in the decoupling circuits. The set on the bench has no frame deflection so this little gadget should prove ideal for the job."

Dick was suitably impressed.

"What is it?" he asked, "a midget transistor oscillator or something?"

"Nothing so complicated," chuckled Smithy. "All it consists of is a common-or-garden 0.01μF paper condenser! The sleeving just helps to insulate and anchor its leads. See?" And he gave the simple arrangement to Dick to examine. (Fig. 1).

"Now for a demonstration," continued Smithy. "I start off by clipping the croc clip on to the grid of the a.f. output valve. Then, when I touch the test prod with my finger I get a slight hum from the speaker of the set, which is just what you'd expect. Now let's see if we can chase the missing frame timebase waveform. The frame oscillator is a blocking oscillator, so let's see what happens when I touch the test prod on its anode."

As he applied the test prod to the anode a 50-cycle buzz became audible from the speaker of the televisor.

"That's fair enough, then," said Smithy. "The blocking oscillator seems to be O.K. Now, let's try the anode of the frame output

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valve. A quick touch of the prod is all we want here, because, if it's working properly, there will be a fairly high amplitude at this point. Ah, silence. That shows there is no frame waveform there. The next step is to check the frame output grid. There's a coupling condenser to this grid from the oscillator anode and it's just possible that it's gone o/c. It has, too! There's no frame buzz at the grid, even though it's present at the previous anode.

"Now, before we start making too many rash assumptions, let's make doubly sure that that condenser really *is* faulty. This I can do with the device again. I put the croc clip on to the frame output grid and touch the test prod on the oscillator anode. Before I started I'd set the brilliance control

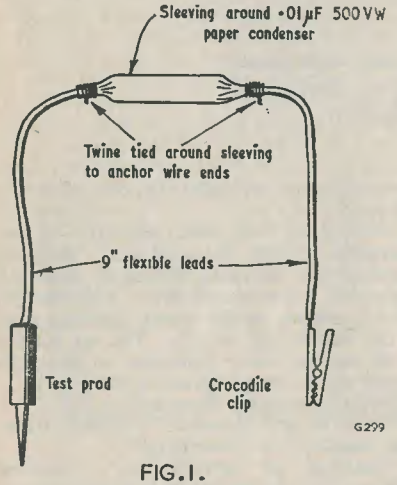

FIG.1.

right back to avoid damaging the tube, so we'll turn it up again. And, as you can see, we get a picture!

"What's happening now is that the 0.01μF condenser is bridging the open-circuit condenser in the set. The frame linearity is incorrect but that's only because the temporary condenser has the wrong value. When I put in a new condenser with the correct value everything should be as right as rain again."

"That's certainly a useful dodge," said Dick. "How else can you use the condenser?"

"It's always useful for checking a.f. stages," replied Smithy, "because you can use it in the reverse direction. This time you put the clip on the frame output grid, whereupon you have a 50 cycle buzz on the test prod. You then trace back along the a.f. chain until you find the place where the buzz disappears. Apart from the frame oscillator there is another source of a.f. in the set which you can use if you like as well, this being given by putting the clip on to one of the heater pins of a valve which is very near the earthy end of the heater chain. This time you get a 50 cycle note. Pure 50 cycles—as reproduced through a high fidelity amplifier—is practically inaudible, but most t.v. a.f. systems are so 'low-fi' that you can hear its harmonics.

"If you get instability in a set you can fix the croc clip to chassis and prod all the decoupling points to see if any decoupling circuit has gone o/c. It's rather 'naughty', expecting nine-inch leads to provide a suitably short decoupling path when checking an i.f. strip working at 30-odd Mc/s, but even at these frequencies the idea seems to work quite well. And, of course, the gadget has its uses with a radio chassis, too."

"Well," said Dick, "when I get home I am going to augment my test equipment with one 'Smithy Patent Test Probe'! It'll be the cheapest piece of gear I've got."

In the meantime Smithy had commenced to solder in a replacement condenser. He handed Dick a book whilst he concentrated on his work.

"Have a look at that," hesaid. "It concerns what we discussed the last time you called in."

"Oh, yes, I remember," said Dick. "We were talking about wires and the wave-winding of coils. I was just about to ask you how the wire on wave-wound coils was actually placed on the former."

"That's right," said Smithy, putting the iron back on its rest and pulling up a stool. "Now, this booklet will help you to understand how it is done. In my factory days, before I set up for myself, I used to have quite a lot to do with coil-winding. Anyway, let's return to the book. Now, this is a manual for a 'Douglas' wave-winding machine. 'Douglas' wave-winders are used more commonly than any other machine in British radio factories, so we're on good ground here. Have you heard the name of the manufacturers before: The Automatic Coil Winder and Electrical Equipment Co.?"

"Why, yes. They're the people who make the 'Avo' test equipment, aren't they?"

"Correct! Now, let's have a look in this manual. Here's a layout of the complete machine, and this should enable us to split it down into its various parts. Now, the main purpose of the machine is to lay the coil wire on the former such that it travels from side to side. This particular job is carried out by means of the wire guide. The wire guide consists of the wire guide arm, the pulley, and the button. (Fig. 2).

"First of all, therefore, let's examine the

wire guide arm. This is fitted to a horizontal spindle in such a manner that the wire guide arm is free to move on the spindle as axis. However, the arm cannot move in a lateral direction. I think this sketch I'm drawing makes that fairly clear. At the top of the wire guide arm there are the pulley and button. The pulley guides the wire on to the button, which rests flat against the surface of the coil. The groove in the surface of the button then guides the wire on to the exact point on the former it is intended to go. (Fig. 3). Now you can see why the wire guide arm is pivoted on the spindle. Since the diameter of the coil will be increasing all the time that it is builds up. This is done by making the wire guide spindle move from side to side laterally whilst the coil is being wound. (Fig. 4). The lateral oscillation of the spindle is then transmitted directly to the guide arm and its button, with the result that the wire falls into the correct position on the former as the latter rotates."

"How do you move the spindle, and how do you know that it will travel over the right distance?"

"That brings in another piece of mechanism. To begin with, the lateral oscillation of the spindle is obtained by coupling it up to a special cam. This cam (Fig. 5) has a groove in its surface in which a roller

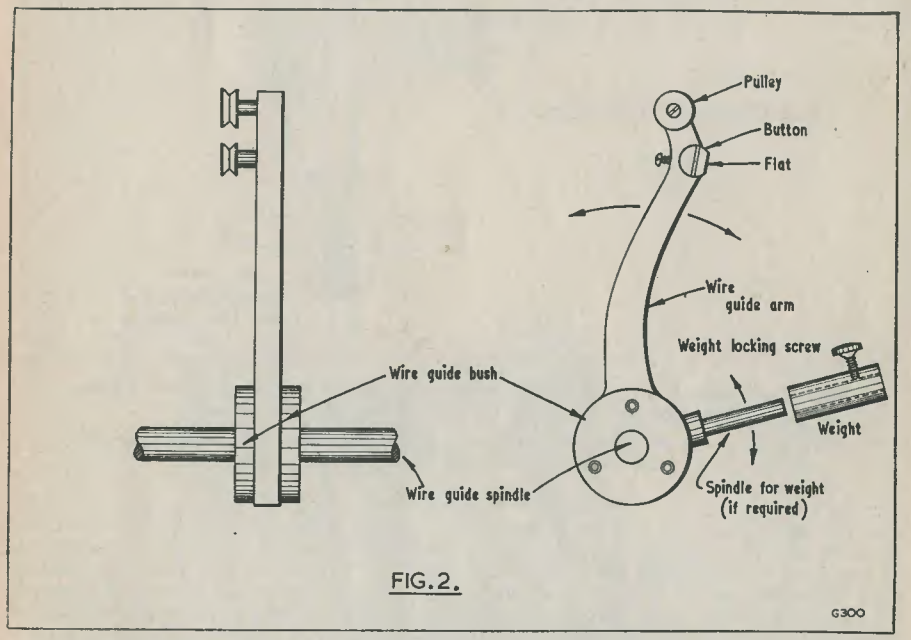

FIG.2.

Fig. 2. Simplified view of the wire guide arm of a "Douglas" wave-winder. (This and subsequent diagrams are simplified and are not necessarily to scale, and may omit many of the various adjustments available on the "Douglas" wave-winder)

being wound the button must be free to move away from the former. To keep the button pressed firmly against the coil, provision is made for mounting a weight on the wire guide arm. (Fig. 2). The position of this weight then regulates the pressure of the button on the surface of the coil. Sometimes the weight is not needed, as the weight of the guide arm itself is quite sufficient.

"Whilst the button is guiding the wire on to the coil, it is necessary to ensure that the wire forms the right pattern as the coil engages tightly. When the cam revolves, the roller is forced to follow the contour of the groove. The sideways motion of the roller is then transmitted to the wire guide spindle via the actuating spindle and a pivot. (Fig. 6). An interesting point in this particular assembly is that, by moving the pivot towards the cam roller, you can increase the distance over which the wire guide spindle oscillates; and vice versa. The net result of this is that, whilst the cam movement is transmitted to the wire guide spindle via the pivot, the position of the latter also provides an adjust-

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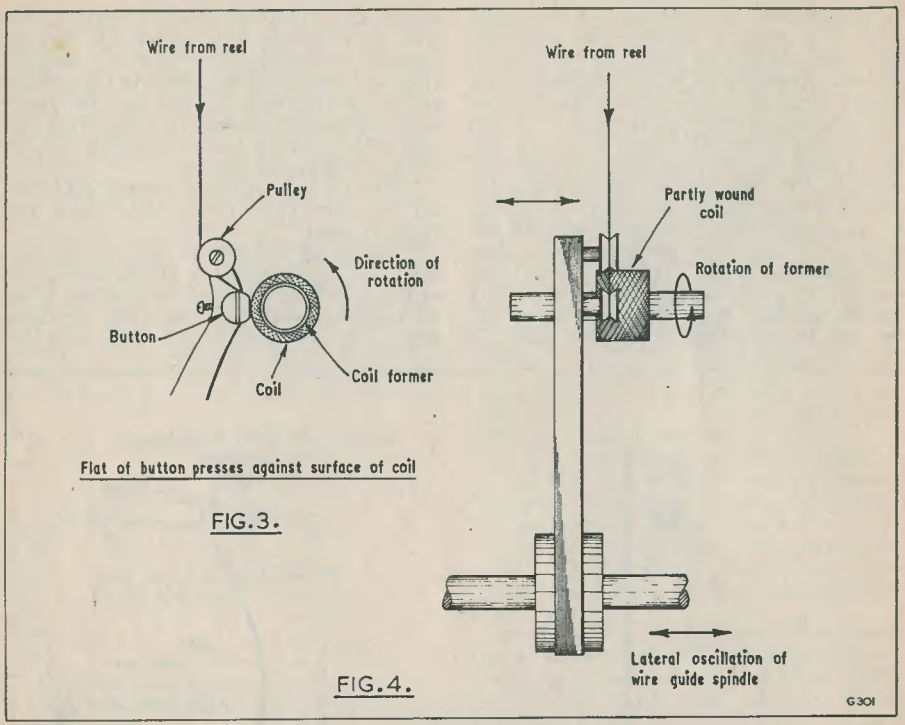


Fig. 3. *Showing how the flat of the button rests against the surface of a coil being wound, thereby laying the wire in the position required*

Fig. 4. *To cause the wire to move from side to side as the coil is wound the wire guide spindle oscillates laterally, as shown here*

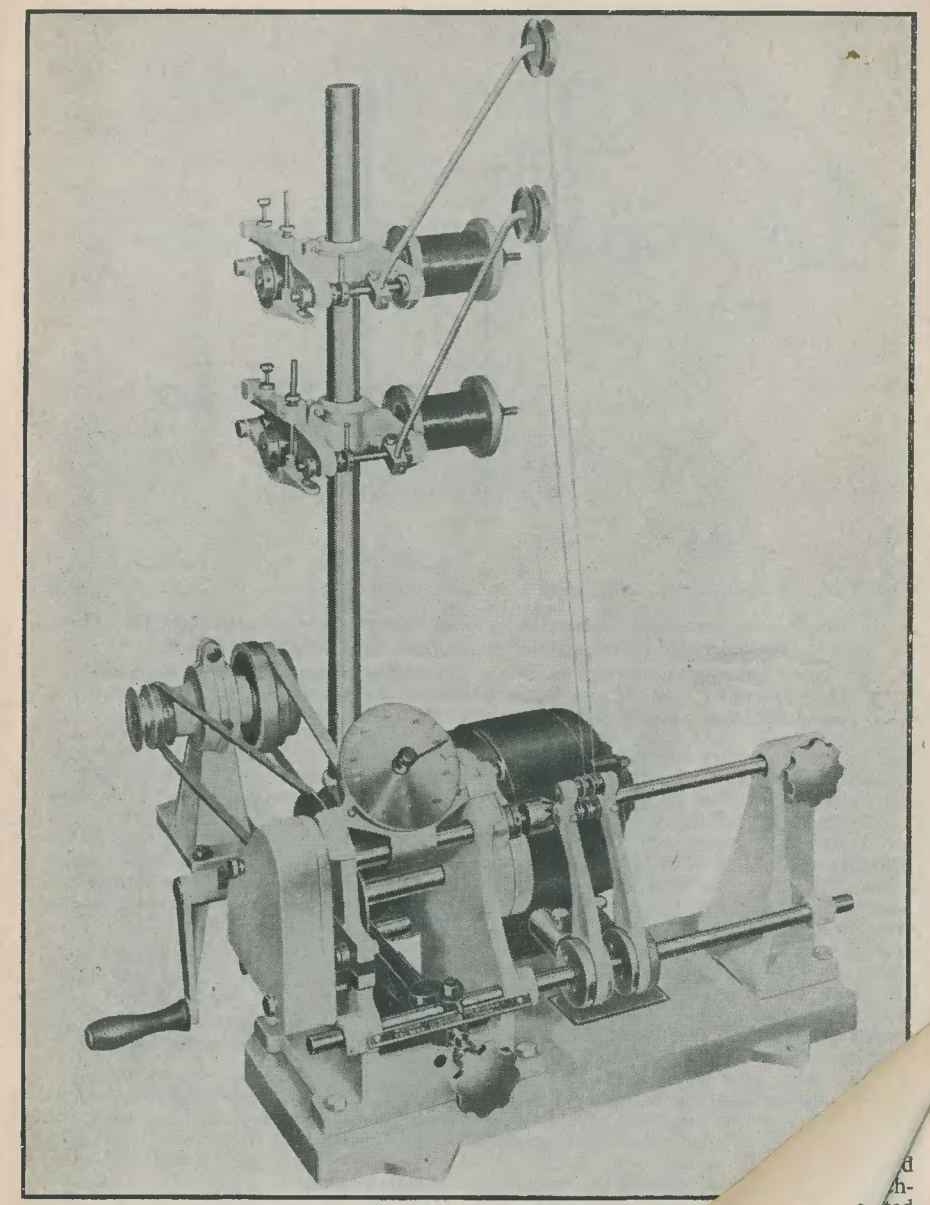
ment of the width of the coil being wound. Thus, to obtain a coil of a certain width, all you have to do is to set the pivot to the right position. In the 'Douglas' machine the pivot is mounted on a 'throw adjusting block' and a screw thread adjustment enables you to set this block just exactly where you want it."

"Well, that's the basic mechanics of the cam and wire guide system. However, although the cam system may look quite simple in its bare bones, a lot of hard work has to be put into making it a really practicable proposition. Probably the most important thing to ensure is that no lateral 'play' exists in the whole system from the cam to the wire guide button. It takes good engineering to make certain of that."

"Well, I think that seems pretty clear," said Dick. "What I can't understand yet, though, is how the machine can wind different gauges of wire. Is there some ratio between the revolutions of the cam and the coil former?"

"There is, indeed," replied Smithy. "The two are coupled up by means of an adjustable gear train rather like the gear train used on a lathe for screw thread cutting. Adjustment of the gear ratio is given by fitting different gear wheels, as required. To wind a particular coil you work out the gear train from the diameter of the wire you intend using and the width of the coil. The wire diameter enables you to substitute in a special formula, after which you find the particular gear train you require with the aid of a table. The width of the coil is a factor in determining whether a complete wire guide cycle—from side to side and back again—occurs for approximately one, or a multiple or fraction of approximately one, complete revolution of the former. There is an adjustable train of gears to satisfy this second requirement as well."

"Phew!" said Dick, after a few thoughtful moments. "As I said last time, with radio you always find something new whenever you begin to examine any part of it in real



The complete "Douglas" wave-winding machine. The "clo machine counts the number of turns wound on the coil bottom adjusts the position of the throw adjusting bloc are shown here) are clearly visible on the wire guide sp view, is to the rear of the machine, beneath the clo

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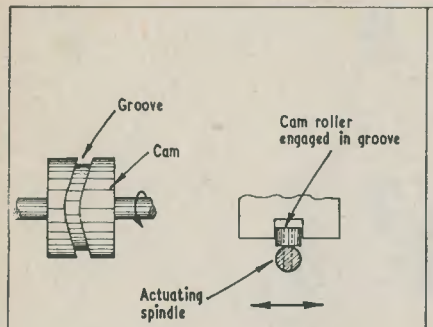

FIG.5.

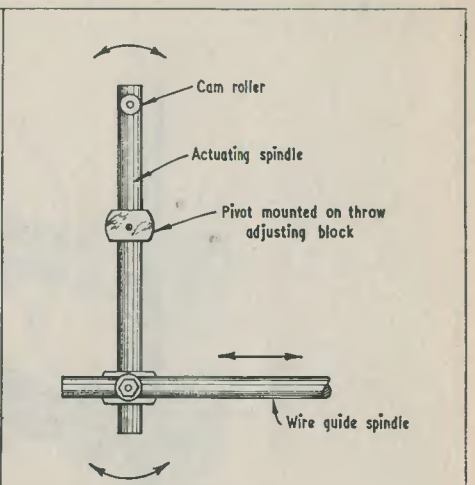

FIG.6.

G302

Fig. 5. The cam which causes the oscillatory motion of the wire guide spindle. The cam is coupled via a gear train to the head stock holding the coil former

Fig. 6. Showing how the cam roller is coupled to the wire guide spindle. The oscillation, or "throw," of the wire guide spindle can be adjusted by moving the throw adjusting block nearer to, or further away from, the cam roller

detail. Sometimes I wonder if it is possible to know even half of all there is in radio."

Smithy sighed a little.

"That's truer than you think," he said quietly. "There is so much to electronics these days that you are almost forced to specialise in a particular branch if you really want to keep abreast of things. I'm one of the old school, I suppose, and am liable to get rather nostalgic about the old times. In those days everybody in radio was an enthusiast. To a lot of people nowadays, radio is just a job. I suppose I've got old-fashioned ideas, Dick, but my advice to anyone who, like yourself, is considering making electronics his career is to tackle it always from the viewpoint of the enthusiast. You'll get a lot more fun from your work that way."

A car horn tooted outside the workshop.

"Anyway," said Smithy, brightening up, "that's enough of senile philosophy for to-day! Unless I'm mistaken my missing test gear has turned up; and I've got my living to earn. So, after we've put this set back in its box we'll tackle that other one on the shelf there. The brilliance is uncontrollable, and I'm keeping my fingers crossed for my customer's sake that the tube doesn't have a cathode-heater short . . ."

Grateful acknowledgments are made to The Automatic Coil Winder and Electrical Equipment Co Ltd. for assistance rendered with regard to drawings and mechanical details of wave-winder operation used in this article.

The "progressive" wave-wind operation described in last month's article should not be confused with progressive wave-winding wherein the wire-guide arm travels progressively laterally in addition to its oscillatory motion, and for which a separate "Douglas" machine is available.

Change of Address

As a result of a serious fire at their Feltham Works, Valradio Limited have acquired new premises, which are considerably larger in Browells Lane, Feltham, Middlesex. The telephone numbers will remain as Feltham 4242 and 4837.

BAND III TELEVISION for the HOME CONSTRUCTOR

PART 11

by S. WELBURN

This month S. Welburn continues his popular Band III series by reviewing the possibilities of channel selection. He discusses various techniques, looking at these from the point of view of the amateur constructor.

SINCE THE CHANCELLOR OF THE EXCHEQUER seems to have the impression that it is far more sinful for a retailer to sell a television set than it is for a Ministry to re-sell £26,000 worth of goods it didn't want for £13,000, the prospects of having a third Band III service do not appear to be particularly bright at the time being.

However, the situation is not too dismal, because there is the possibility that quite a few viewers already have a choice of three programmes. These programmes are given by existing B.B.C. transmissions, plus the two I.T.A. stations operating on Channels 8 and 9. Whilst the two I.T.A. transmitters sometimes carry the same programme there are frequent differences, and viewers in certain localities could, in consequence, take advantage of whatever of the three programmes they care to choose. A similar choice of programmes may be available to other viewers when Channel 10 comes on the air.

Because of this state of affairs it might be of value to examine the possibilities of channel selection in home-constructed Band III equipment.

Channel Selection

For the constructor who is prepared to experiment, the provision of Band III channel selection to a converter is a fairly simple operation. A certain amount of mechanical ingenuity is needed, but amateurs have not in the past shown themselves to be lacking in this respect.

There are four main ways in which channel selection can be carried out in Band III converters. These are by variations in tuning capacity; by variations in tuning inductance due to the physical movement of slugs in and out of coils; by variations in tuning inductance provided by switching in incremental inductance; and, finally, by taking advantage of turret tuners. Let us now consider these different methods of channel selection in more detail.

The first method of channel selection mentioned in the last paragraph is by variations in tuning capacity, these being possibly provided with the aid of a switch. As most readers will be aware, this scheme is not very attractive on technical grounds owing to the fact that, at Band III frequencies, it is necessary to keep the L/C ratio of all tuned circuits as high as is feasible. Indeed, normal Band III practice tries to ensure that, wherever possible, all resonant circuits are tuned by little more than the stray capacities appearing across each coil, plus the inevitable valve capacities which must exist in the circuit to which each coil is connected.

Despite this, tuning by variations in capacity is still *fairly* attractive if the channels being selected are not too far apart in frequency. To take an example, tuning by variable capacity between Channels 10 and 8 would not constitute too heinous a technical offence so long as it was appreciated that the converter gain on Channel 8 (where the extra tuning capacity would have to be introduced) could be noticeably lower than on Channel 10. The shift from Channel 10 to Channel 8 constitutes a change in operating frequency of 10 Mc/s, and this would probably be the largest shift which should be attempted by capacity variation alone.

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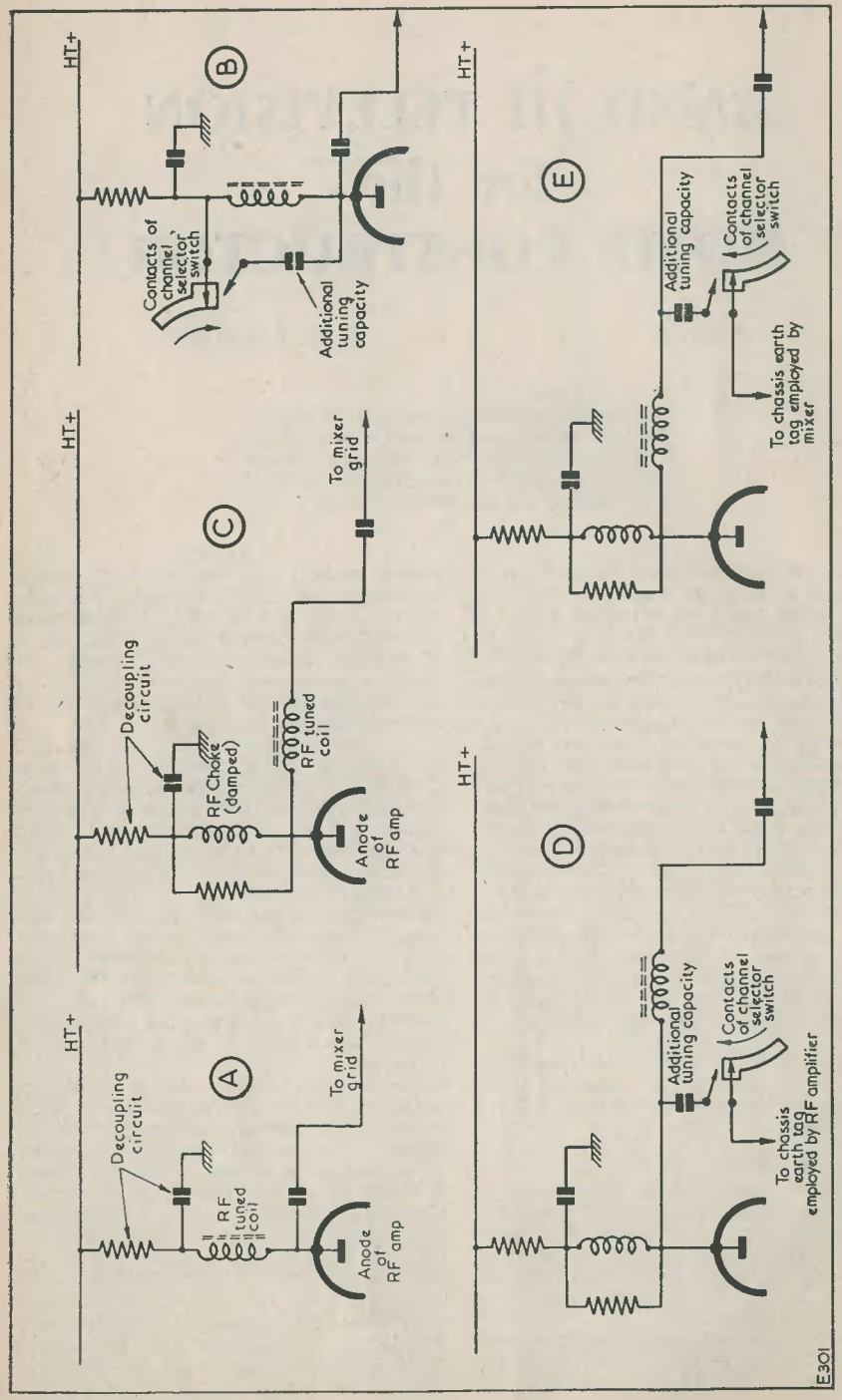

Fig. 1(a). A typical shunt-tuned circuit Band III coupling circuit. (b) For low frequency changes the channel selection arrangement shown here would be simple and effective. (c) A series-tuned coupling circuit. (d) and (e) Two methods, discussed in the text, of providing incremental tuning of the circuit of (c). Note the chassis returns recommended

The situation where the two required channels are adjacent to each other should normally be capable of solution with the aid of a "fine tuner" in the oscillator circuit alone. This fine tuner would need to have a capacity swing adequate enough to cover the two adjacent channels; whereupon the aerial and r.f. coupling coils could be peaked to a point midway between the two channels, or to the channel which provides the weaker signal. This process may result in a slightly lopsided converter frequency response curve on one (or both) of the channels. However, the normally low Q given by most Band III coils results in such a flat response that it is doubtful if any very deleterious effect would be noticeable in the picture itself.

To revert to the case where it is intended to capacity-tune the converter over 10 Mc/s, or so, a slightly more complicated situation arises. This is due to the necessity of tuning not only the oscillator but the aerial and r.f. circuits as well.

So far as the oscillator is concerned it would definitely be advisable to retain a variable fine tuning condenser, this being given a capacity swing sufficient to cover the larger range now required. The reason for this choice is that, if additional capacity were introduced into the oscillator tuned circuit by means of a switch, the reset accuracy of the latter would not be sufficiently high to ensure correct oscillator frequency each time it was operated. A fine tuning condenser would still be required; whereupon the fitting of a switch as well becomes pointless.

A high switch reset accuracy is not required at the r.f. coupling coil. If this employs a shunt tuned circuit, as shown in Fig. 1 (*a*), the switching circuit used could be that illustrated in Fig. 1 (*b*). It should be noted that the additional tuning capacity is returned via the switch to the "dead" end of the *coil* and not to chassis. If a series-fed coupling circuit (or pi-network), of the type shown in Fig. 1 (*c*) is used in the converter, the additional capacity may be switched in between either end of the coil and the applicable chassis point, as illustrated in Fig. 1 (*d*) or (*e*). The end of the coil which causes greater frequency shift for similar capacity change is that to which the switch circuit should be connected. It is probable that this will normally be at the anode end of the coil. It should be noted that, in Fig. 1, the actual switch contacts have been shown. This has been done to emphasise the necessity of keeping the capacity to chassis as low as possible.

The aerial coil may be treated similarly to the r.f. coil of Figs. 1 (*a*) and (*b*). In some converters, however, the aerial coil may have such a flat response that little advantage would be given by using capacity variation at all, the coil being set to the best compromise position between the two channels.

In Fig. 1, the additional tuning condensers switched in for the shift in channel frequency are shown as fixed components. The value of these condensers could normally be found empirically, checking tuning by means of the coil slug after fitting each particular experimental value. Ceramic condensers would be essential. Air-spaced or ceramic trimmers could, of course, be employed instead of fixed condensers, but they are liable to be bulky and may not have a sufficiently low minimum capacity. Normally, the additional tuning condensers would have a value of a few pF only.

The switch employed for adding the additional capacity need not necessarily have ceramic insulation, but it must be of reliable construction and should have silver-plated contacts. The switch contacts must be positioned *very* close to the appropriate coil, and the circuit through the metal-work of the switch itself must be kept as short as possible.

Variable Inductance Tuning

Variable inductance tuning is, from the technical point of view, much better than variable capacity tuning. The reason for this is that it maintains a high L/C ratio. The second method of channel selection for the home constructor mentioned earlier referred to tuning by means of the physical movement of slugs in and out of coils. As some constructors may be aware, this system is used in at least two commercial converters, and is also employed in a standard "front-end" by a television receiver manufacturer. In some of the commercial units the insertion of slugs into the aerial, r.f., and oscillator coils is carried out by means of a ganged mechanical assembly. An assembly of this type requires a great deal of design skill and development time if it is required to track accurately over a large number of channels, and would probably prove to be an unprofitable venture for the amateur whose equipment is limited. However, a ganged assembly which is intended to track accurately over two or three channels only should not be too difficult.

Some care has to be exercised in the choice of slug material which would be employed for a channel selection arrangement of this type. Normal iron-dust cores, as used in such things as 465 kc/s i.f. transformers, etc., are liable to cause severe losses at Band III frequencies. At such frequencies manufacturers employ iron-dust cores made especially for v.h.f. work. In these cores the particles of iron are very widely separated in the plastic insulating material which forms the body of the core, with the result that

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losses at Band III frequencies are considerably reduced. The reduced iron content of the v.h.f.-type iron-dust core results, incidentally, in a lower permeability in the material, and reduced inductance change. For the amateur who still wishes to use normal broadcast-frequency iron-dust cores, probably the best solution would consist of allowing these to enter the coil no more than, say, quarter-way. This would give a fairly useful frequency range without introducing too many losses.

At v.h.f. the losses introduced by brass slugs are normally lower than those given

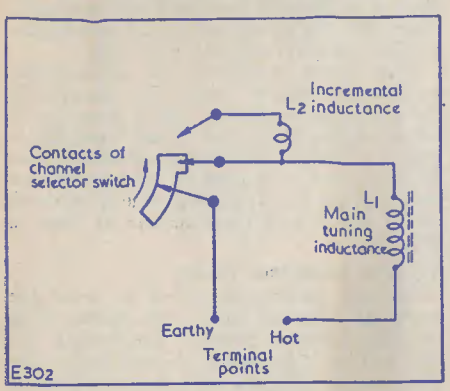

Fig. 2. The basic incremental inductance switching circuit

by broadcast-frequency iron-dust cores. The effect of a brass slug as it enters a coil is that of reducing inductance. Unfortunately, the tuning range given by a brass slug is usually noticeably lower than that given even by a low-permeability v.h.f.-type iron-dust core of the same size. However, a relatively large brass core should give a tuning range of some 20 Mc/s or so at Band III frequencies if its outside diameter is permitted to closely approach the internal diameter of the coil it tunes.

Incremental Inductance

Probably the most attractive method of channel selection available to the amateur is provided by the switching of incremental inductance. This is fairly simple to accomplish technically, and the only mechanical design considerations involved are those of ensuring that the switch contacts employed are positioned *very* close to the circuits concerned. Once again a reliable switch (not necessarily with ceramic insulation) is required, and silver-plated contacts are essential.

The basic switching circuit required for incremental inductance channel selection is illustrated in Fig. 2. In this diagram the main tuning inductance is provided by the coil L_1. Since we are speaking in terms of Band III frequencies it would be more realistic to state that the real tuning inductance is that provided by the coil plus the inductance of the metal path, including the switch contacts and wiring, between the terminal points. (The terminal points would be those which connect to the appropriate valve electrodes or chassis decoupling circuits). When the switch of Fig. 2 is turned in the anti-clockwise direction an extra coil, L_2, is connected in circuit; this causing the total inductance to increase. It is important to remember once again that the real inductance of the arrangement is given by the total metal path between the terminal points with the result that, when the switch is turned to the anti-clockwise position the length of this path is increased in the switch itself as well as in the external inductance. The necessity for keeping this point continually in mind will be appreciated when it is realised that the coil L_2 may, in practice, consist of a straight piece of wire, or even two straight pieces of wire in parallel!

The attraction of the incremental inductance method of channel selection for amateur use is given by its extreme simplicity, its cheapness, and its reasonably high efficiency. It is also fairly easy to set up and align.

An example, in which the arrangement is used with a converter oscillator, is illustrated in Fig. 3. In this case, the incremental inductance is added at the grid end of the coil, it being assumed that this has the lower impedance to chassis. As may be seen, a fine tuning condenser is still retained, this being necessary to finally trim the oscillator tuned circuit. The reset accuracy of the switch could not normally be relied upon to give sufficient accuracy of inductance at the oscillator position. If the arrangement of Fig. 3 were used in the oscillator circuit of a converter, the arrangement shown in Fig. 2 could be employed for the r.f. and aerial tuned circuits. The total switching facilities would then be given by a 3-wafer switch traversing the length of the converter chassis, each wafer being positioned close to the tuned circuit it switches.

Practical examples of the incremental inductance "coils" brought into circuit by the switch are illustrated in Fig. 4. Fig. 4 (*a*) shows a coil having a single turn, this being probably sufficient to cause a frequency shift of 4 or more channels at Band III frequencies. The "coil" shown in Fig. 4 (*b*) would cause a possible shift of some 2 to 3 channels, and that illustrated in Fig. 4 (*c*) a shift of approximately 1 channel. In

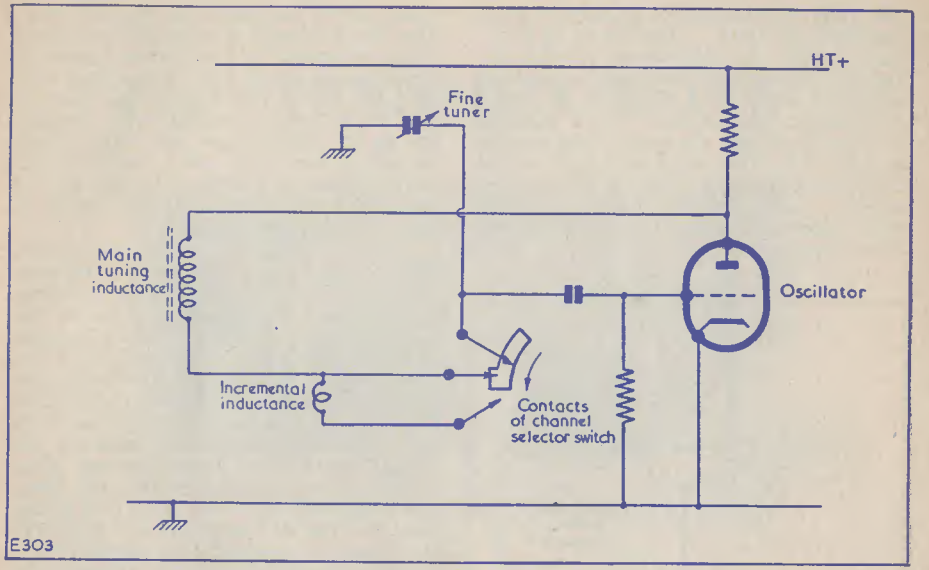

Fig. 3. Applying incremental inductance switching to the oscillator of a converter

Fig. 4 (*b*) inductance can be increased by increasing the length of the wire between the two switch contacts; whilst, in Fig. 4 (*c*), inductance can be adjusted by altering the length of either one or both of the wires. cope quite adequately for the additional inductors. It is worth pointing out, also, that the inductance of the incremental coils will decrease slightly as wire diameter increases, and vice versa.

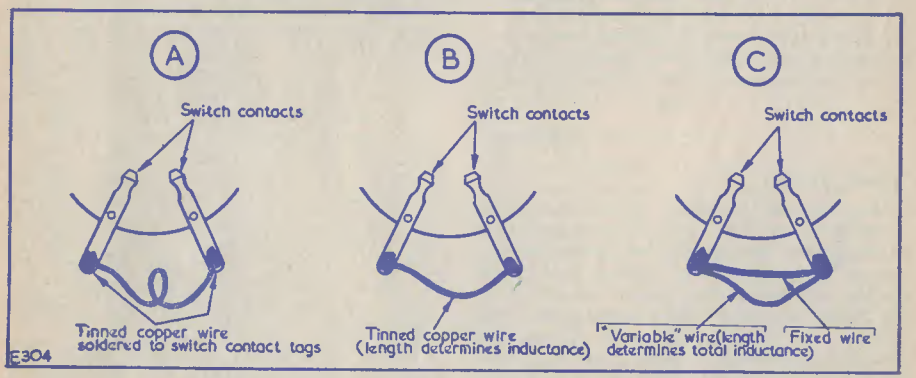

Fig. 4. Some practical incremental inductance "coils." The possible frequency shift given by these "coils" is discussed in the text

The preparation of the incremental inductances required is entirely empirical, experimental "coils" being soldered across the switch contacts and the resultant total inductance checked by adjusting the slug of the main coil. Bare tinned copper wire of any gauge thicker than 24 s.w.g. should

For those who wish to try something a little more ambitious, the circuit ahown in Fig 5 may be of interest. This shows an incremental inductance arrangement capable of switching to two Band III frequencies and one Band I frequency. The Band I frequency is selected when the switch is in

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the fully anti-clockwise position, thereby switching in coil L_3. The circuit of Fig. 5 is, in reality, a scaled-down version of a normal commercial incremental inductance switching circuit, and is not at all outside the range of the amateur who is prepared to experiment with the simple coils required at Band III. The circuit of Fig. 5 should, of course, be employed with the conventional cascode, triode-pentode line-up which has now become established practice in television front-ends.

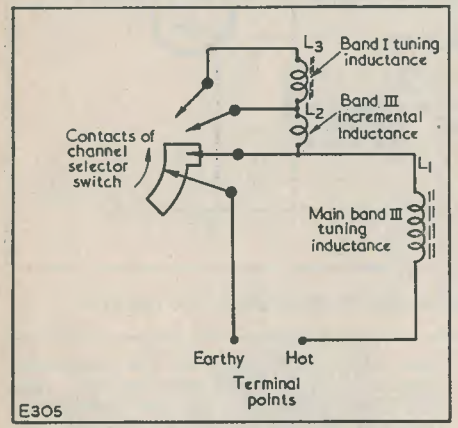


Fig. 5. A more ambitious arrangement, providing selection of one Band I *and two Band* III *channels. The Band* I *coil will need to have slightly less inductance than it would normally have if employed on its own*

Turret Tuners

For several reasons, turret tuners may present rather more difficulty to the amateur than is given by the simpler type of converter which employs fixed coils. This is due to the fact that turret tuners are not quite so readily available on the home constructor market as are other types of tuners, and because technical information on some units may be difficult to obtain. There is the further point that many turret tuners employ band-pass coupling between the r.f. stage and the mixer grid, and are consequently rather difficult to align without the aid of a wobbulator and oscilloscope. However, despite these points, the presence of turret tuners on the home constructor market cannot be ignored, and the following notes may consequently be of interest and value.

Practically all turret tuners consist of a self-contained chassis holding the r.f. and mixer stages, together with the coil turret. The turret chassis is normally capable of being connected into a receiver merely by the coupling up of h.t., heater, and a.v.c. lines, etc. The turret tuner will have its own aerial input terminals, with provision for an i.f. output from the mixer anode. Usually, a tuned i.f. coil is fitted into the turret chassis, a coupling winding on this coil supplying a low-impedance output to the i.f. strip of the receiver.

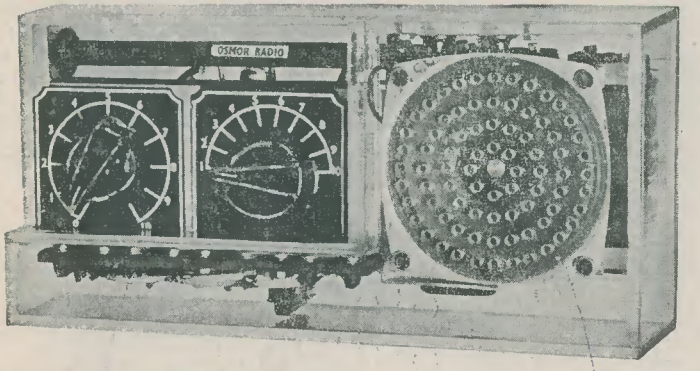
From the point of view of the amateur who is considering employing a turret tuner as the front-end of a receiver, the first thing to ascertain is the frequency of its i.f. coil. If the frequency of this coil differs from that of the set with which it will be used, a new coil will have to be wound. Unfortunately, changing the turret i.f will upset the oscillator tuning of the individual turret coils. If the new oscillator frequencies required are outside the range of slug adjustment of the appropriate oscillator coils, the coils themselves will have to be adjusted. Coil adjustment at Band III frequencies may frequently be effected by squeezing the turns together (to increase inductance) or opening them out, as required, but it should be pointed out that this process is only recommended to those who feel competent to tackle it.

Winding new coils for a turret tuner is a fairly skilled business, but is not outside the scope of the reasonably experienced amateur. If spare coil formers and "biscuits" are not available for a new channel, those for an existing channel which is not in use could have their windings removed and new coils fitted to their formers. The new coils should be wound primarily to resemble any existing coils in the turret which are close to the desired frequency. Thus, a Channel 8 coil would provide a good "model" for an experimental Channel 7 coil. After winding, a little adjustment in turn spacing and dressing may then yield quite satisfactory results. So far as band-pass coils are concerned, the best plan would consist of trying to make the spacing between the new coils equal to that of any existing coils which are close in frequency to the channel concerned.

Before concluding, the writer would like to stress once more that it would be unwise for the amateur to experiment too widely with turret coil assemblies unless he is confident of success. In the case of turret tuners fitted to commercial receivers, new coils should be obtained from the manufacturers of the receiver.

If the writer is able to obtain sufficient practical information in time, he hopes to deal with Band III alignment using a wobbulator and oscilloscope in next month's contribution.

The "TRANSISTORETTE"



PART 4. *by* G. A. FRENCH

In this article, the fourth in the series describing the Transistorette, G. A. French gives details of the Perspex cabinet in which this transistor receiver was presented in the 1955 Radio Show at Earl's Court. Our contributor also discusses one or two small points concerned with operation.

IN THE LAST THREE ISSUES OF *The Radio Constructor* full details of the chassis of this modern transistor receiver were given. In this concluding article we pass on to the construction of a suitable cabinet.

When the Transistorette was exhibited at the 1955 Radio Show it was housed in a cabinet made of Perspex. As may be imagined, the effect given by this method of presentation was most striking, since the cabinet was very attractive and it also enabled the public to obtain an excellent idea of the internal construction of the receiver. It is possible that many constructors may wish to employ this type of cabinet in their own versions.

Alternatively, it might be found preferable to build the cabinet with an opaque material. In such a case the dimensions given in this article will still apply, so long as provision is made for any differences given by varying thicknesses of material. The Perspex employed for the Exhibition cabinet had a thickness of $\frac{1}{4}$-inch, and joints were made with the aid of an adhesive, it being sufficient to have all corners butt-jointed. A similar technique is, of course, quite possible with other materials. A typical choice for such a material would be plywood. An attractive finish could be given also by covering the completed cabinet with rexine, skyver, or a similar type of cloth.

Dimensions

The appearance and general layout of the completed cabinet will already have been learned from the photographs accompanying these articles. As will have been seen, a particularly compact assembly is given by means of sinking the two control knobs. The tops of these knobs then lie slightly above the surface of the remainder of the cabinet.

Apart from their being applicable to materials of $\frac{1}{4}$-inch thickness, it should be pointed out also that the dimensions given in this article apply to the receiver when it is used with the Ever Ready B.122 hearing-aid battery. If a B.110 battery, which is slightly larger, is used it will be necessary to extend the dimensions of the top, bottom and two sides by $\frac{1}{8}$-inch at the loudspeaker end.

As we mentioned above, butt jointing is used for the corners of the cabinet. The adhesive employed for the prototype was

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Durafix, and this enabled a cabinet of more than adequate mechanical strength to be constructed.

The dimensions of the top piece of the cabinet are illustrated in Fig. 22. It will be noted that a centre is shown in this diagram for the loudspeaker cut-out. The cut-out may be obtained either by making a clean hole of 1¼ inch radius on this centre (the hole being later covered on the underside by loudspeaker fabric), or by drilling a series of holes in the material. If the latter device is adopted, a suitable drilling layout is given in Fig. 21.

Fig. 26 (*a*) and (*b*) show the two side pieces. That illustrated in Fig. 26 (*a*) is purely rectangular in form and requires no further discussion. The side piece shown in Fig. 26 (*b*) will butt against the control panel, and it has four holes drilled in it for the aerial-earth panel. This latter should be a standard item available from an advertiser, but the reader is advised to check the dimensions of the particular panel obtained before finally drilling the holes for it. The aerial-earth panel will be mounted behind the cabinet material, the aerial and earth plugs passing through the two ¼-inch holes

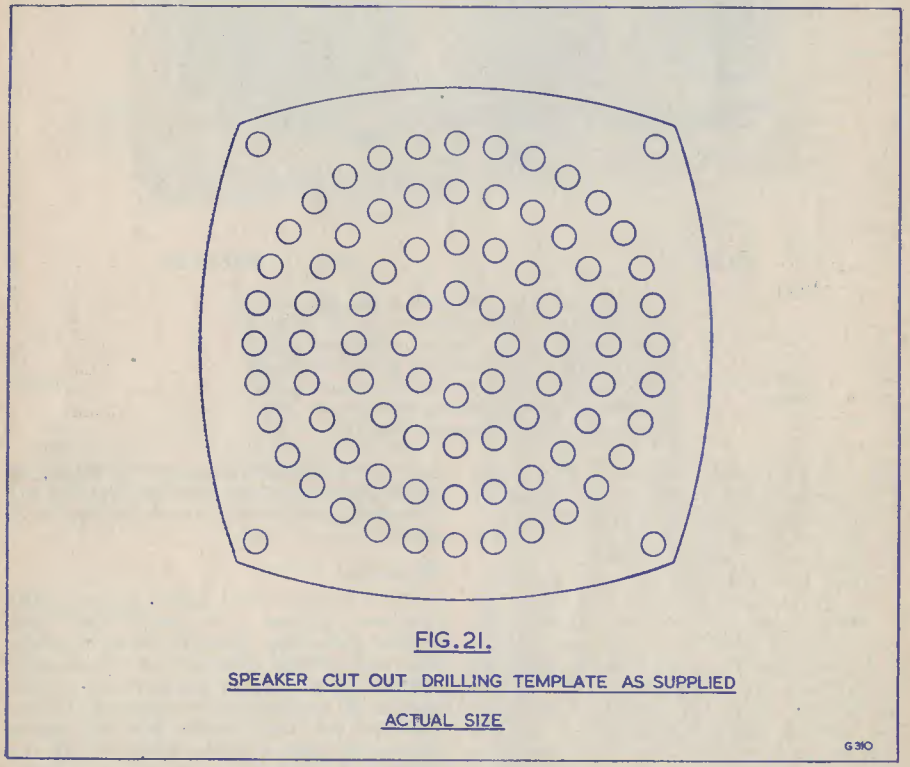

FIG. 21.

SPEAKER CUT OUT DRILLING TEMPLATE AS SUPPLIED

ACTUAL SIZE

G310

The two ends of the cabinet come next. These are illustrated in Fig. 23 (*a*) and (*b*). Fig 24 (*a*) and (*b*) illustrate the two pieces which form the recess for the sunken control panel.

The panel itself is illustrated in Fig. 25. There is little that requires comment here, apart from emphasising the necessity of marking out and drilling the two ⅜-inch diameter holes accurately. The chassis will later be mounted by fitting the bushes of the volume control and tuning condenser through these holes.

illustrated in Fig. 26 (*b*) before making contact with the appropriate sockets.

The bottom of the cabinet is shown in Fig. 27. This diagram, together with those showing the side end dimensions, does not include any details for fixing the bottom to the remainder of the cabinet. This omission is due to the difficulty of specifying standard parts for such a fixture, in addition to the fact that readers' individual ideas may vary on this point according to their tastes and the workability of the material employed. In the prototype, the cabinet bottom was

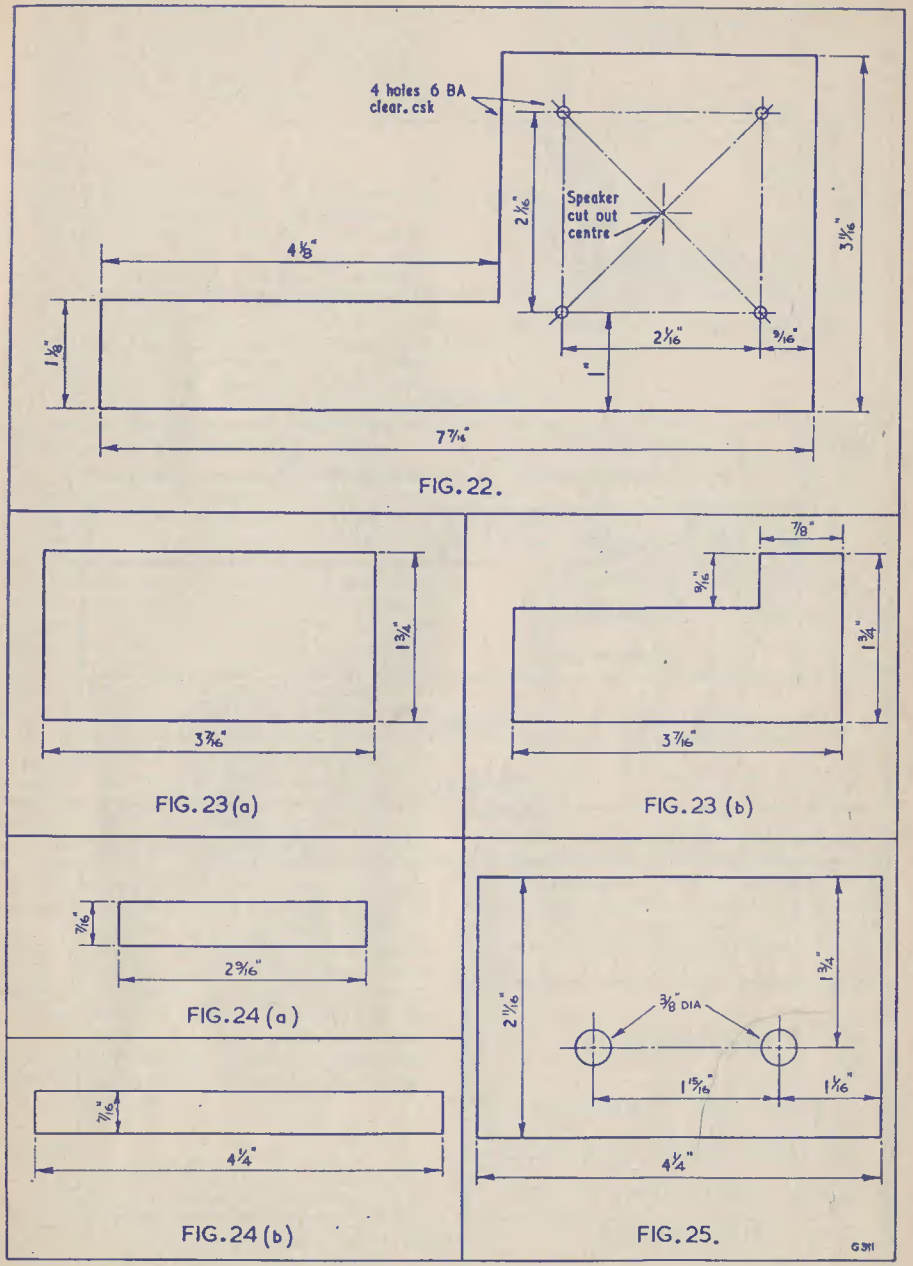

Fig. 22. The top section of the Transistorette cabinet. Fig. 23 (a) and (b). The end sections of the cabinet. Fig. 24 (a) and (b). The two pieces which form the sides of the sunken control panel. Fig. 25. The control panel.

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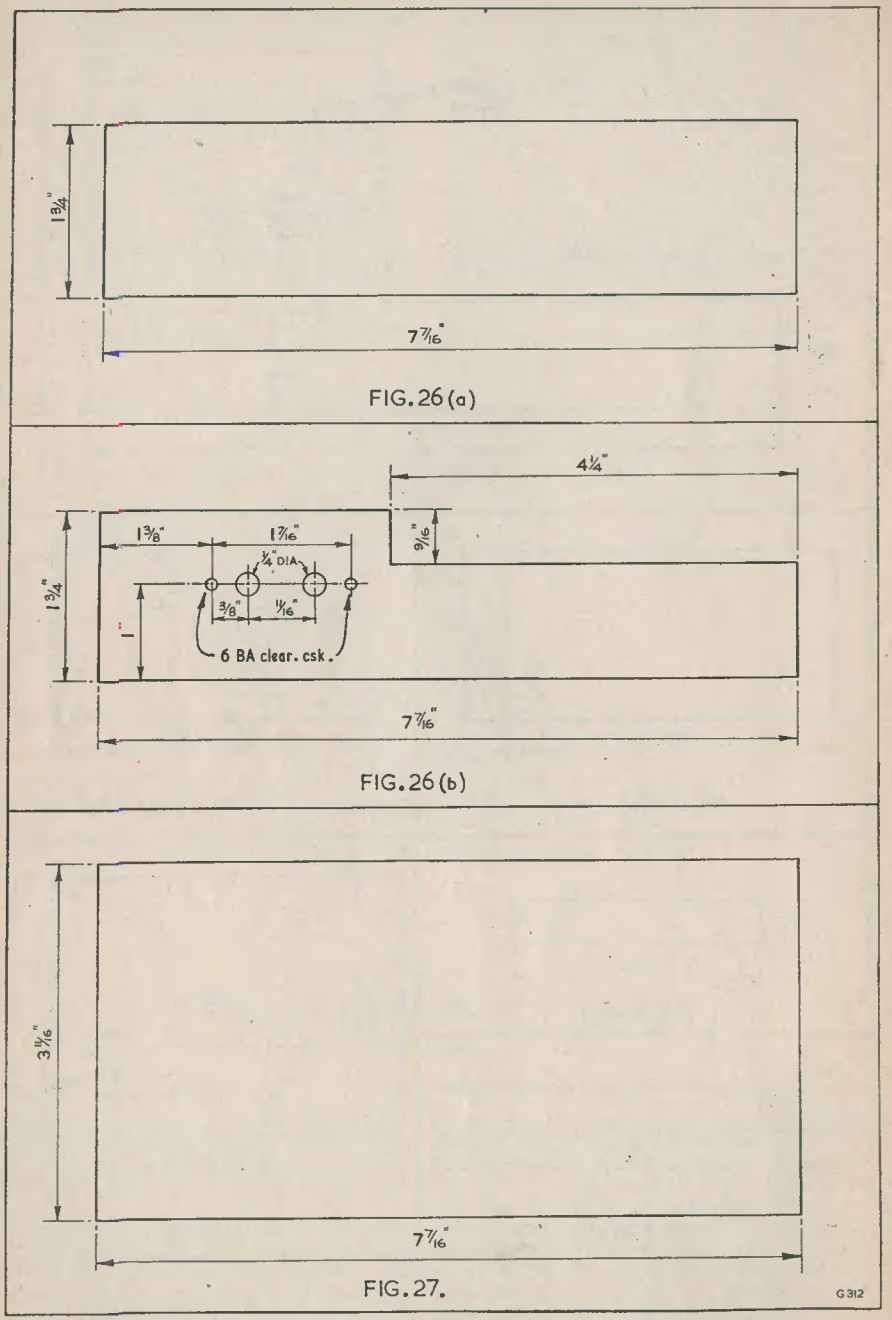

Fig. 26 (a) and (b). The side sections. Fig. 27. The dimensions of the cabinet bottom

fixed by small rectangular pieces of Perspex stuck to the inside of the bottom, these locating with the inside walls of the cabinet. An alternative arrangement would be provided by the use of small hinges, or similar fixtures.

Fitting the Chassis

Before fitting the chassis to the cabinet it is necessary to mount the loudspeaker. It is possible to employ two of its mounting screws to hold a battery housing as well, and a typical example of such a housing is shown in Fig. 28. No fixed dimensions are given in this diagram, since the available tolerances are quite wide and the constructor may wish to take advantage of what materials he may happen to have on hand. Also shown in Fig. 28 is the loudspeaker itself; and this should be fitted so that its tags lie below those of the aerial-earth panel.

The output transformer can be mounted by bolting it to the side panel—that shown in Fig. 26 (*a*) of the cabinet. In the photographs, this component is shown mounted to a small bracket integral with the chassis. It is felt that the construction of this bracket is more complicated than the simple overall design of the receiver warrants, and that the alternative method of mounting suggested here is preferable. The transformer will occupy the same position as that shown in the photographs, although its axis will now be turned through 90 degrees.

All that remains is to fit the chassis in the cabinet. As was mentioned above, this is done by passing the bushes of the volume control and tuning condenser through the ⅜-inch holes of the control panel. To ensure a snug fit, it is advisable to remove the locking nuts and washers from the bushes before passing the latter through the holes. They may then be fitted and tightened down again on the outside of the panel. It is recommended that the appropriate Panel-Sign transfers be fitted to this panel, as these give an extremely neat finish to the whole assembly. For best results, the transfers should be affixed to the front panel and allowed to dry firmly before finally tightening the bush nuts.

Warning

As it is possible that the h.t. battery may be replaced by non-technical persons, it is important to ensure that the battery compartment is adequately marked with the polarity of the appropriate terminals. A dab of red paint could be used on the positive contact spring. An effective warning notice is given in Fig. 29. This notice can be cut out and stuck in a prominent place in the cabinet.

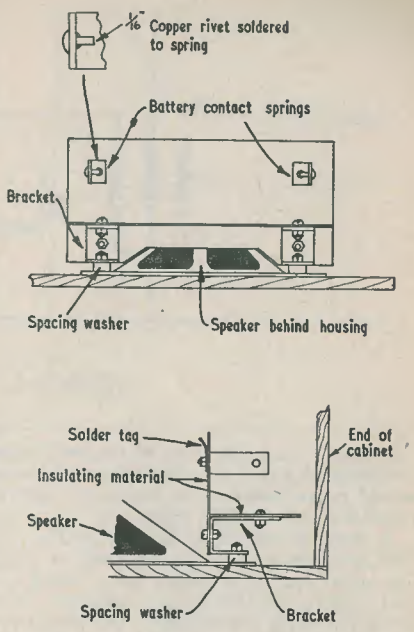

Fig. 28. A suggested housing for the h.t. battery

Selectivity

Due to the simple tuning circuit employed, it is possible that sufficient selectivity may not be available in one or two parts of the British Isles where medium-wave interference levels are very high. Although this fact was not considered detrimental to per-

WARNING

CONNECT BATTERY CORRECT WAY ROUND OR TRANSISTORS WILL BE RUINED

Fig. 29. Warning Label. This label may be cut out and fixed in a prominent place in the cabinet

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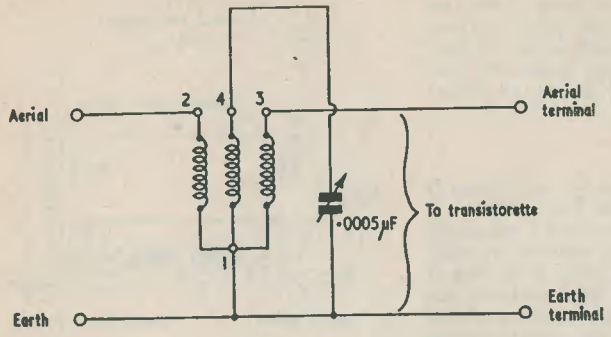


FIG. 30.

Fig. 30. The circuit of a medium wave trap. This should be required only in areas of heavy medium-wave interference

formance during the tests of the prototype, it was decided that a simple wave trap circuit would prove beneficial to those who experienced difficulty in this respect.

A suitable circuit is shown in Fig. 30. This employs a triple-wound coil, in which the aerial energy is passed to a tuned coil and, thence, to the tertiary winding. This tertiary winding then connects to the receiver. A suitable coil for this application is the Teletron type HAX, and the numbers shown in the diagram apply to the tags of this coil. The tuning condenser shown in Fig. 30 may be a bakelite dielectric model similar to that used in the receiver itself; in which case the external wave trap can be built into a very compact little unit indeed. As was just stated, such a wave trap will only be required for districts which suffer from heavy medium-wave interference.

VHF FEEDER LOSSES

by H. E. SMITH, G6UH

SATISFACTORY RECEPTION OF BAND III stations in fringe areas will only be achieved by making full use of the available signal. The most important thing to remember in connection with weak signal reception is that as much as possible of the signal must be conveyed to the actual aerial input of the receiver.

Those not familiar with operation above 100-Mc/s may be surprised at the following comparisons between Band I and Band III reception conditions.

We will assume a location, say 50 to 60 miles from Alexandra Palace, where the field strength of the signal is approximately 200 M/vM. Standing waves plus feeder loss will reduce this figure to something far less by the time the signal reaches the input to the receiver. This will be due to the following factors:

At 45 Mc/s, 50 ft of good quality coaxial feeder will have an attenuation figure of something like 1.5 db. 1.5 db represents approximately 30% power loss.

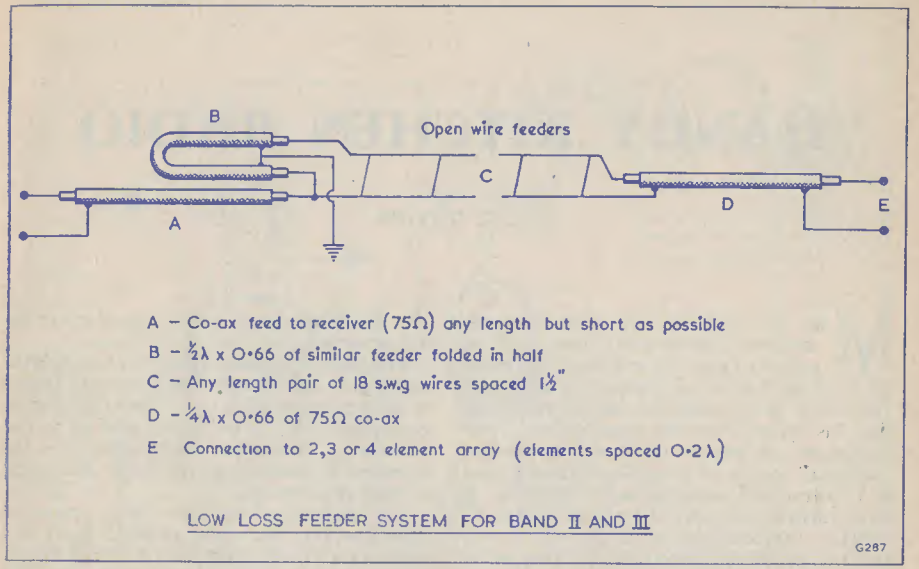
Aerial to feeder mismatch will probably introduce a standing wave ratio of at least 2 : 1 which corresponds to a power loss ratio of 1.2 : 1. The final loss is, therefore, something like 36%, or more than *one-third* of the available signal lost before it reaches the input to the receiver.

There are probably many thousands of Band I installations where this state of affairs exists, but as the sound and picture are considered to be reasonable, nobody seems to worry.

Now supposing we apply the same conditions to Band III. We can assume that something less than half of the Band I signal will be available at the location referred to above. Even if the transmitter were radiating the same effective power as on Band I, the attenuation and "shadow" effect of surrounding buildings and trees will reduce the local field strength to an extent far greater than on Band I.

Using 50 ft of the same good quality coaxial feeder for the Band III aerial, and paying particular attention to the matching at both ends, we are still faced with an overall power loss of at least 65%!

One important fact emerges from the



above, and it doesn't take much mental effort to see it. It is that even the best of the coaxial feeders generally available for domestic use are not suitable for efficient fringe area reception of Band III stations. Let us make another interesting comparison with two types of feeder, relating to local interference.

Feeder Loss v. Local Interference

It may not be generally appreciated that the use of low loss feeder results in a higher signal-to-noise ratio. The following example, calculated for Band III operation, will show how this comes about. Assuming that Feeder "A" consists of 100 ft of 300 ohm ribbon and Feeder "B" is 100 ft of high quality semi-air spaced coaxial cable, we find the attenuation figures for 28 Mc/s to be 0.82 db and 1.8 db respectively. (28 Mc/s is chosen for calculation purposes because many forms of local interference peak up between 26 and 32 Mc/s.) This means that interference voltage peaks will be attenuated by 17% on Feeder "A" and 35% on Feeder "B."

For 200 Mc/s operation, the attenuation figures for the two feeders are 4.5 db "A," and 8 db "B," or 64% and 85% respectively. (These figures assume perfect matching to aerial and input to receiver.)

Simple calculations will show that if both the signal and the interfering pulse have an amplitude of 200μ/V, the result is as follows:

Feeder "A" will deliver 72μ/V of signal to the receiver input, plus about 42μ/V of interference pulse.

Feeder "B" will deliver 30μ/V of signal plus about 33μ/V of interference.

As it is usually much easier to obtain a lower standing wave ratio on the higher impedance feeder it can be assumed that the figures given for Feeder "B" are somewhat optimistic.

Spaced Feeder Lines

High impedance air spaced feeders seem to be the logical answer to this loss problem. A pair of 18 s.w.g. tinned copper wires spaced at 1½in and operating on 200 Mc/s have an attentuation figure of 0.25 db per 100 ft (5% power loss).

Even if the feeder to aerial mismatch is so poor that a standing wave ratio of 4.5 : 1 is introduced, the overall power loss will be no greater than approximately 12%.

With spaced feeders, difficulties arise in the matter of connection to the aerial, bringing them into the house, and connecting into the coaxial socket of the receiver. These difficulties can be overcome by using simple "baluns," made up from lengths of coaxial cable, or by using linear transformers, utilising lengths of lower impedance balanced feeder.

Fig. 1 shows one method of using spaced feeders with a typical Band III installation. The improvement in signal will be well worth the additional trouble taken over the installation.

An identical installation can be constructed for Band II (f.m.) remembering that the

(*continued on page 635*)

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HANDY KITCHEN RADIO

by E. GOVIER

MOST OF US HAVE, AT SOME TIME OR another, wanted that cheap, easy to construct and efficient receiver for use either in the kitchen or, perhaps, a bedroom. The writer is no exception to the rule, and cast his mind over the possibilities. For cheapness the answer obviously lay in the "straight" variety of receivers, while for ease of construction, together with efficiency, a three valve circuit seemed to be the complete answer. Accordingly, a circuit was drawn and the prototype constructed, using parts and component values already to hand. Following several modifications in the light of experience, the circuit shown in Fig. 1 was finally evolved.

Circuit

The circuit consists of a detector stage built around the 6SL7 octal base high-mu double triode, one half of which is utilised as the first audio amplifier stage. The output circuit uses the well-known 6V6G/GT beam tetrode, while the rectifier is a 5Y3GT type valve. These octal base valves are all obtainable at "surplus" prices.

A short "throw out" aerial, some ten to fifteen feet in length, is connected to an Osmor type QR11 coil. Reaction is provided in the normal manner by varying C_1, the other end of the winding being connected to anode 1 of the 6SL7. C_2, together with R_1, is connected to the grid, one end of R_1 being wired directly to the cathode and thence to chassis. Tuning is carried out with C_3, a 500pF paxolin type variable condenser. Anode 1 is taken to the h.t.+ line via the resistors R_2 and R_3, the former being of the one watt rating type. C_4 is the decoupling component and this should be of good quality if efficient operation and reaction control are to be achieved.

It will thus be seen that the first half of the 6SL7 acts as a leaky grid detector.

The resulting audio signal is fed, via C_5, into the grid of the second part of the valve, R_6 being the grid leak. R_5 and C_6 provide the necessary bias, and note should be taken of the polarity of C_6 and the other electrolytic condensers shown in the circuit diagram. The amplified signal is now passed on to the following stage via C_7.

The variable potentiometer R_7 controls the audio gain and also the on/off switch shown in the a.c. mains input line. The output stage is conventional, C_9 being included as a tone corrector. The output transformer is of the standard 6V6 matching type easily obtainable at most radio stores.

The full-wave rectifier valve provides adequate h.t. for this receiver, and the smoothing components, an old 10H 60mA choke already to hand, together with the associated condensers C_{10} and C_{11}, ensure that the resultant power is well smoothed.

Little else need be said about the circuit as shown; it can be made up on a 5" × 7" × 2¼" chassis in a couple of hours or so. When completed, it may either be enclosed within an existing cabinet or one made for the purpose. The writer did neither of these, but included the whole chassis and speaker in an unused drawer of the kitchen cabinet, a speaker fret being first cut out in the drawer front.

Variations

Several variations may, of course, be made to the circuit as shown, according to the individual preferences of the reader. A tone control could easily be added by removing C_9, and connecting a 0.1μF tubular condenser, of 350V working, from the anode of the 6V6 and thence via a 50kΩ variable to chassis. A further alternative would be the replacement of the smoothing choke by a 10kΩ 5 watt resistor, this being much cheaper than a choke where the latter is not already to hand. A further point to remember is that the 6SL7 may be replaced, without any base alterations, by the 6SN7 double triode. The effect of this replacement is that somewhat less audio gain is available.

A glance at the component list will show that all the values used are standard and all are easily available. Once completed, the receiver will prove well worth the time and trouble taken to construct. Cheap and simple to build, it will provide excellent service to the owner.

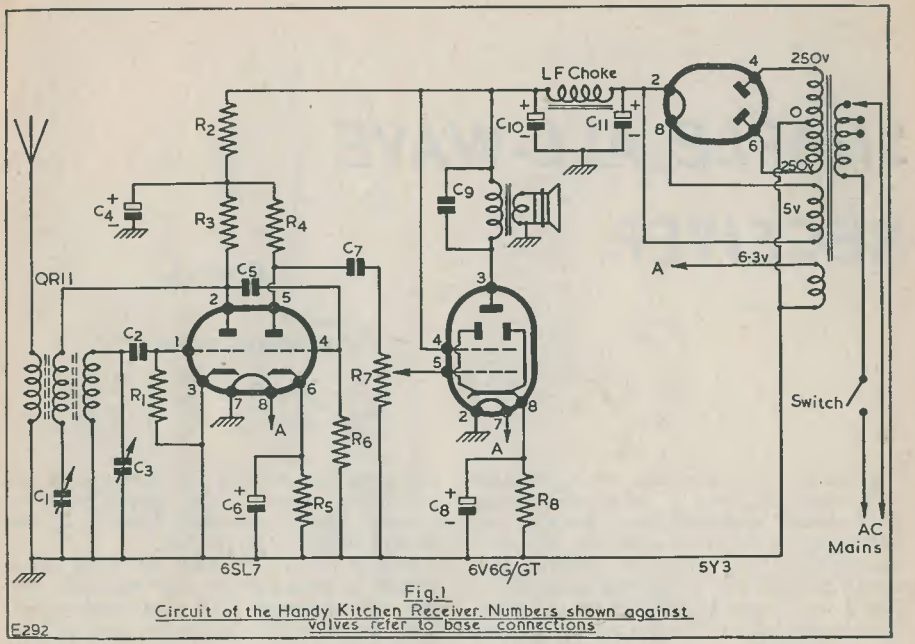

Fig. 1
Circuit of the Handy Kitchen Receiver. Numbers shown against valves refer to base connections

COMPONENT LIST

Resistors

R_1	2MΩ ½ watt
R_2	150kΩ 1 watt
R_3	47kΩ ½ watt
R_4	47kΩ ½ watt
R_5	1kΩ ½ watt
R_6	470kΩ ½ watt
R_7	1MΩ pot with switch
R_8	300Ω ½ watt

Condensers

C_1	500pF variable, mica
C_2	200pF mica
C_3	500pF variable, mica
C_4	8μF, 350V wkg., electrolytic
C_5	0.01μF, 350V wkg.
C_6	25μF, 12V wkg., electrolytic
C_7	0.01μF, 350V wkg.
C_8	25μF, 25V wkg., electrolytic
C_9	0.002μF, mica
C_{10}	16μF, 350V wkg., electrolytic
C_{11}	8μF, 350V wkg., electrolytic

Valves

V_1	6SL7 (see text)
V_2	6V6G/GT
V_3	5Y3

Coil
Osmor, type QR11

Mains Transformer
Ellison type MT162

Speaker
5" Rola

Choke
10H, 60mA (see text)

Speaker Transformer
6V6 matching or multi-ratio type

Other items
Chassis (see text), valveholders, nuts and bolts, wire, etc.

V.H.F. FEEDER LOSSES—*continued from page 633*

electrical lengths of coaxial and balanced feeders are determined by the velocity factor, which is approximately 0.66 for coaxial and 0.85 for 100 ohm balanced and 300 ohm ribbon. A quarter wave section of coaxial will, therefore, be 0.66 of a quarter wavelength, and the balanced feeder of 100–300 ohm types will need to be cut to 0.85 of a quarter wavelength wherever these are used in "baluns" or matching transformers.

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SIMPLE ALL-WAVE RECEIVER

Part 1

by JAMES S. KENT

A SIMPLE RECEIVER DESIGNED TO OPERATE efficiently over a fairly wide range always maintains its popularity and adherents. Although the receiver about to be described was designed primarily as a simple standby job, it occurred to the writer that it was in fact an ideal set for the beginner to construct. Following on this thought, it was decided to go one further and to construct a similar receiver for the more advanced, using the modern miniature valves, in a parallel design. Thus, with the present set, offered herewith, an octal based double triode feeding into an octal output tetrode, will be followed in Part 2 with the self-same arrangement but with the difference that two valves of the Noval range will be featured. The same remarks also apply to the power supply unit.

Receiver designs specifically intended for the beginner are, unfortunately, not very plentiful—although several excellent designs have appeared in the past within this magazine. However, as these newcomers are constantly arriving within the hobby, so to speak, it is felt that a further design would most certainly be of advantage to them as a whole—not to mention the new reader picking up the magazine for the very first time!

Circuit Description

With this receiver, the minimum of components has been used consistent with reasonable efficiency. The power supply has been constructed as a separate unit, partly for the reason that it is required for other apparatus at times, and partly for the fact that most beginners prefer to build a power supply as an individual item of equipment.

In the first stage of the receiver, a 6SL7GT high-mu double triode acts as detector and first audio amplifier, the resultant audio being fed directly into the output stage via a volume control. The output stage is entirely conventional and consists of the 6V6GT output beam tetrode.

Plug-in coils are used as these have several advantages for the beginner over the manufactured coil assembly types. They are available separately, and may be thus purchased one at a time if required; also the use of these coils obviates the need for a switching system with its attendant losses and, to the beginner, its complex wiring. Those used are the miniature Eddystone coils (see component list). Coverage of the complete set, as listed, is from 32 Mc/s to 730 kc/s.

As the above coils have a common earthing point for all three windings, the reaction condenser is inserted between the anode and the "hot" end of the appropriate winding.

A series aerial condenser is incorporated in order to avoid "dead spots" with the reaction control. In the prototype shown herewith, this is mounted on the chassis, but if preferred, this could easily be mounted on the front panel thus allowing instant variation without recourse to screwdriver adjustments for each coil inserted.

The output transformer is of the midget variety enabling this to be mounted under the chassis and on the chassis backdrop.

Circuit

This is shown in Fig. 1, the aerial being fed into the primary winding of the coil via C_1, the variable condensers C_2 and C_3 being the bandset and bandspread controls respectively. R_1 and C_4 form the grid components of the leaky grid detector. Reaction is obtained by varying the condenser C_5. As this is in series with the anode it therefore has an r.f. potential across it.

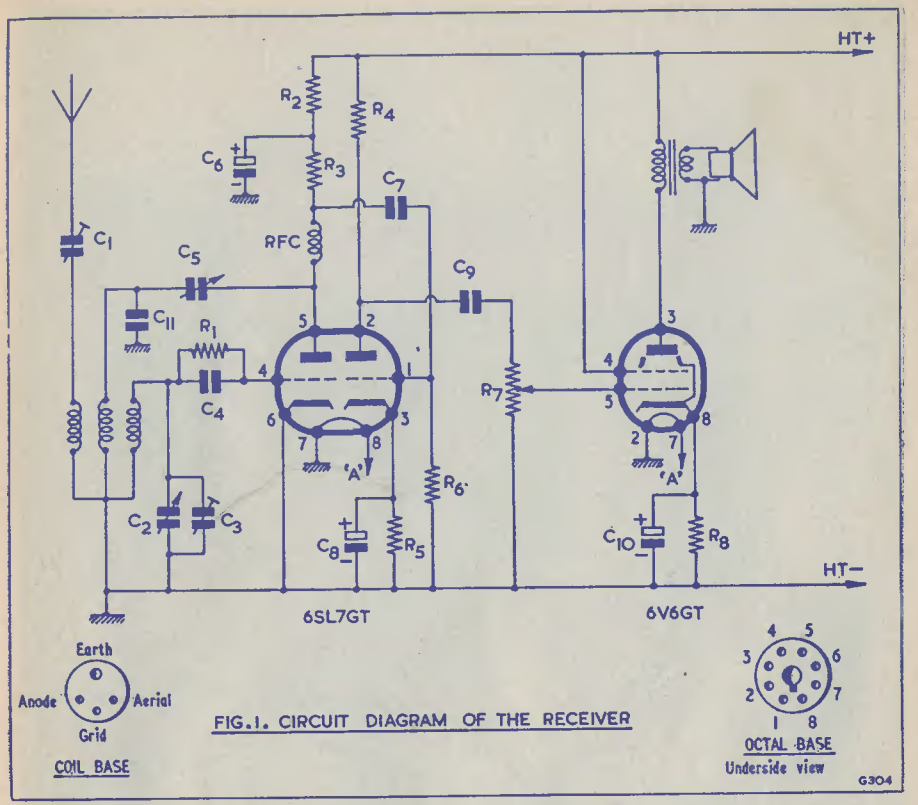

FIG. 1. CIRCUIT DIAGRAM OF THE RECEIVER

This being so, the actual condenser must *NOT* be earthed to the chassis at any point. As mounted in the prototype, two insulating washers and a short length of paxolin tube have been used in securing the component to the front panel—effectively isolating the metal parts from the chassis and panel. The same object may be achieved by cutting out a small square from the panel and bolting into position a slightly larger square of paxolin, through which a hole has been drilled enabling the condenser to be mounted. If adopting this method, however, ensure that the condenser fixing nut does not itself come into contact with the panel or chassis.

The resistors R_2 and R_3 form the anode load components which, together with the associated by-pass condensers C_6 and C_{11}, ensure that smooth reaction is obtained, in association with the other detector circuit components, over the range of the receiver.

The audio output of the detector stage is fed, via C_7, into the grid of the following triode portion of the 6SL7GT, where R_6 acts as the grid leak component. Cathode bias is supplied via the resistor R_5 and the electrolytic condenser C_8. R_4 is the anode load and the output of this first audio amplifying stage is taken, via C_9, into the volume control R_7.

The output stage is entirely conventional and one with which the beginner soon becomes conversant, the 6V6GT being a very popular output valve with home constructors. R_8 and C_{10} are the bias components.

Constructional Notes

Providing the circuit as shown in Fig. 1 and the illustrations are studied carefully from time to time as construction advances, no difficulty should be experienced by the beginner. The layout is straightforward and, commencing with the detector portion of the double triode valve, the logical sequence of wiring follows thus: 1st audio stage followed by the output stage.

All the resistors are ½ watt and the ratings and types of the various condensers are given in the component list. All of the specified parts are currently obtainable on the market—suppliers of the various items used being stated where applicable.

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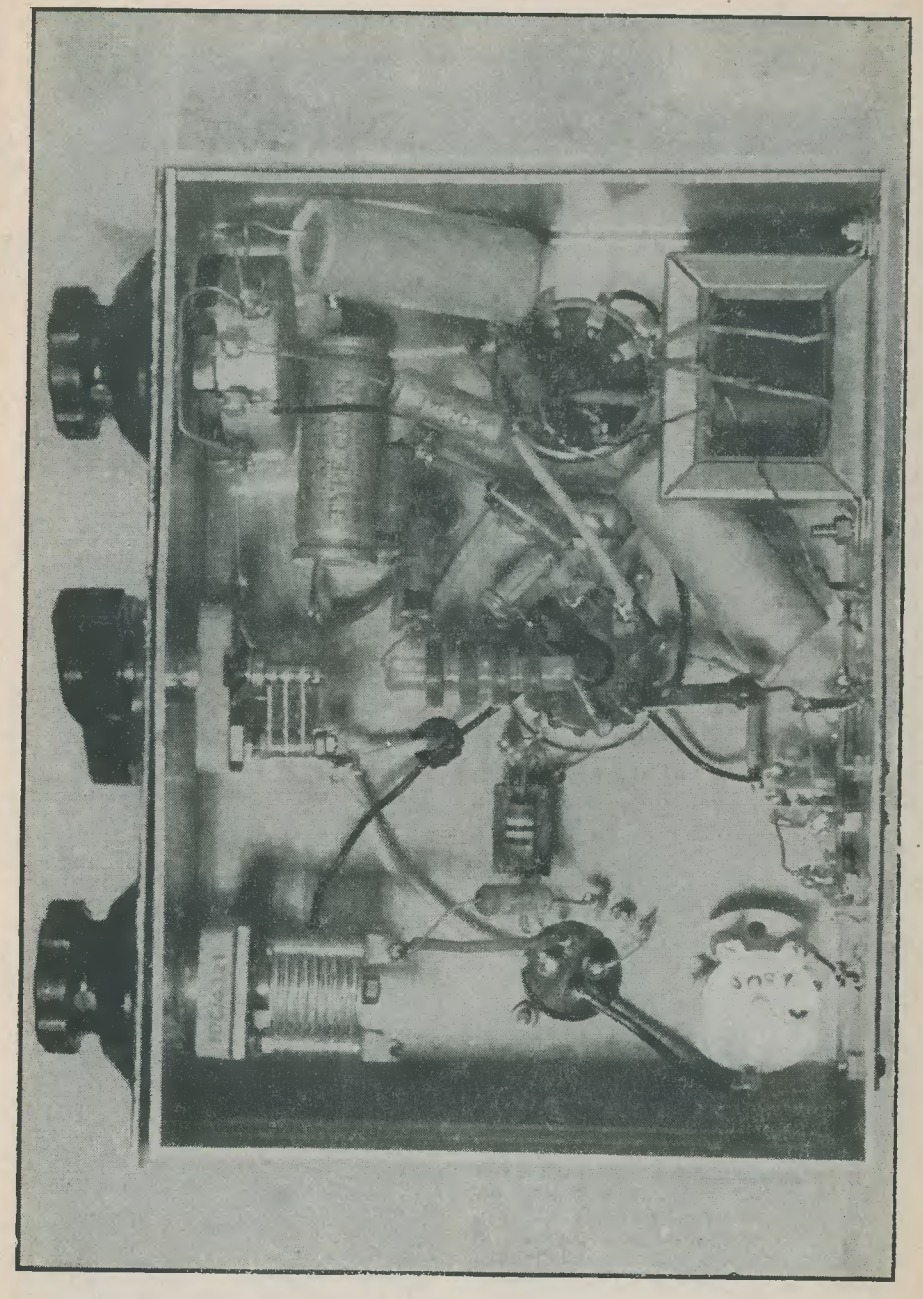
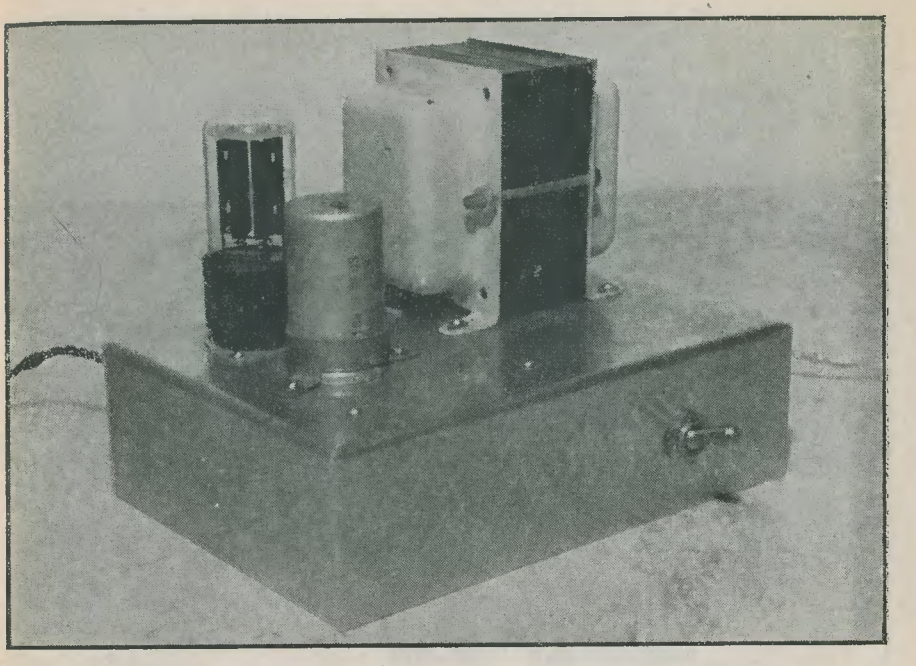


Underchassis layout of the original "Simple All-wave Receiver." Most important points are that grid and anode leads should be kept well apart, and should be kept as short as possible



The original power supply unit. If built separately, it is always available for use with other equipment—but there is, of course, no objection to the power pack being built on the same chassis as the receiver, provided that it is sited on the end furthest away from the detector stage. A larger chassis will obviously be required

Drilling details of the front panel, chassis and chassis backdrop are given in Part II of this series and will be featured next month. For the moment, beginners are advised to first obtain the components and also a chassis size 7in by 5in by 2in together with an aluminium panel size 7in by 6in. A slightly larger panel and chassis will, of course, do no harm; one does not necessarily have to conform strictly to either the sizes stated or the drilling details given next month. Provided the panel and chassis are of sufficient size, the remaining point of importance is to ensure that the layout of the components, as shown herewith, are followed reasonably closely.

Fig. 1, in addition to showing the circuit of the receiver, also features two small insets. One of these is the octal valve base as seen from the underside, and this, in turn, refers to the numbers shown on the circuit around each valve. Thus, in the detector stage pin 6 is the cathode and must therefore be wired to an earth tag.

When mounting the actual valveholders, one earth tag should be bolted to each holder, using one of the self-same bolts which secure the valveholder to the chassis. In this way, each valve has its own earth return.

The speaker is separate from the receiver, a small 5in type being sufficient for the purpose, it being fed from a paxolin strip mounted on the receiver chassis backdrop.

Power Supply

This is shown in Fig. 2. It is generally conceded that the power pack is the item of equipment which frightens the beginner most of all. Having perhaps had some experience of battery supplies with 90 or 120 volts of h.t., the—to the beginner—"high voltages" of mains equipment, in this case 200 volts or so on load, is apt to be somewhat of a problem. This being so, it is proposed to clearly itemise the construction of the power pack.

The chassis size is the same as that for the receiver—5in by 7in by 2in. Provided the same mains transformer and rectifier as specified are used, the following instructions, if carefully carried out, will result in a power supply which will cause no worry at all.

Before commencing, however, a few words about power supplies and the very obvious precautions to be taken AT ALL

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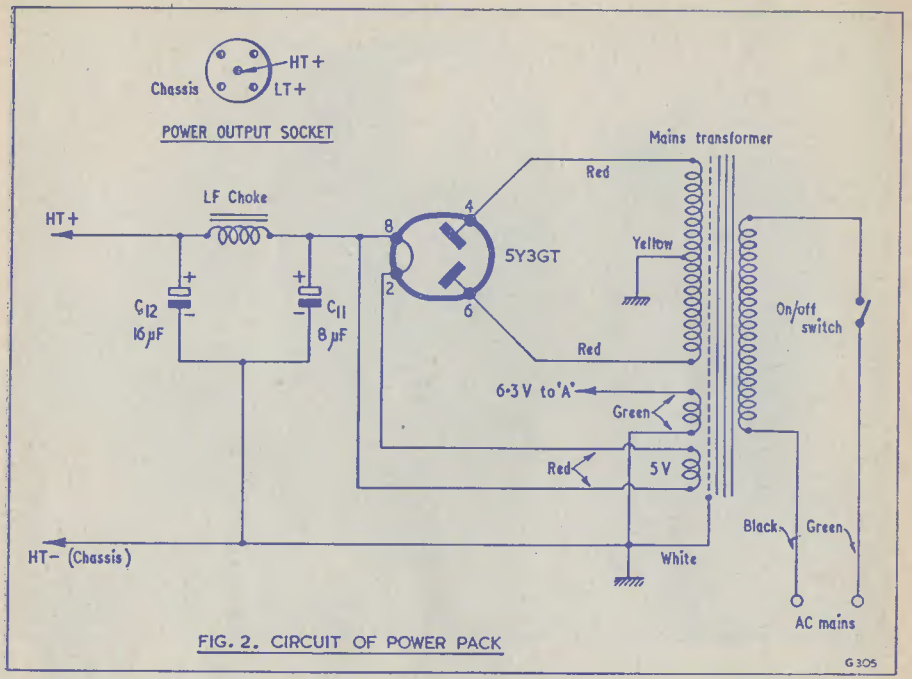

FIG. 2. CIRCUIT OF POWER PACK

TIMES will not come amiss. With the unit completed, and connected to the receiver, NEVER make any adjustment or alterations to the circuit with the power supply either switched on or connected to the mains. If you insist on making any alteration while the set is working, then place one hand behind your back—or better still—put one hand in your pocket.

With the components mounted on the chassis as shown in the photographs, not forgetting the use of rubber grommets for ALL leads going through the chassis deck, commence wiring as follows.

Mains transformer.—White, yellow and one green lead (one of the thick enamel covered ones) should be connected to chassis. In the photo this is shown wired to the earthed tag of the tag strip mounted on the chassis wall. The other thick green lead is connected to pin 3 of the valveholder, and from there a short length of wire is taken to the appropriate tag of the power output socket (see Fig. 2). NOTE: In case you are mystified with the use of pin 3 of the valveholder, this is used solely as a holding tag—no connection is made to the actual valve, by virtue of the fact that the 5Y3GT has no pin 3 at all. The thin red and blue wires should have their open ends taped with insulation tape and then be tucked away under the paxolin strip. Ensure that the taping is done efficiently, that neither open end is in contact with each other and that no accidental connection is made with the chassis.

The thin black wire should next be soldered to a free tag, i.e. not an earthed one, of the tag strip. The thin green wire should be similarly treated.

A length of twisted mains lead should now be fed through a rubber grommet affixed to the wall at the rear of the chassis. Baring both wire ends, solder one each to either side of the on/off switch. At a point near the tag strip, cut one wire only. Bare both ends of these cut lengths and solder one to the same tag already holding the thin black wire. Solder the other end of the cut length to the tag to which the thin green wire has previously been soldered.

On the other side of the mains transformer there are four red wires. Select the two thick wires (these are enamel covered), solder one to pin 8 and the other to pin 2 of the valveholder. Before attempting to solder, however, ensure that the enamel is removed, otherwise a bad connection will result. One way of removing this enamel is to scrape away the covering with either an old knife or a single-edged razor blade.

The two thin red wires should now be soldered to pins 4 and 6 of the valveholder —one wire to each pin of course.

From either pin 2 or 8, it does not matter which, solder a length of covered wire, the other end of which is secured to the 8μF tag of the smoothing condenser, and from there to the tag of the smoothing choke—it does not matter which tag.

From the other tag of the smoothing choke, solder a length of covered wire to the 16μF tag of the condenser and from there to the power output socket (see Fig. 2).

The power supply is taken from the power pack to the receiver via a short length of 3-way cable. This cable is terminated at each end with a miniature plug arrangement which inserts into an appropriate socket forming part of a paxolin assembly mounted on both the receiver and power pack chassis backdrop.

Having completed the wiring as described, next check that the above instructions have been carried out, check with the circuit diagram, then insert the valve. Connect to the mains supply socket via a suitable plug and switch on. The valve filaments should glow red, switch off. Do not allow the power pack to run for a long period when not connected to the receiver as this will eventually damage the valve.

Conclusion

With the information given in this issue, together with the circuit diagrams and the illustrations, the beginner, and those requiring a small standby receiver, may go ahead and construct the power pack while at the same time gathering the components for the receiver. Next month, a comparable design using the miniature valves 12AT7, 6BW6 and EZ41 will be featured. The instructions for the dial cursor and the panel fitments will be dealt with in the next issue.

Those then that are attracted to the circuit design may care to adopt next month's offering in preference to the one featured here.

COMPONENT LIST

Resistors

R_1	1MΩ ½ watt
R_2	10kΩ ½ watt
R_3	100kΩ ½ watt
R_4	100kΩ ½ watt
R_5	1kΩ ½ watt
R_6	470kΩ ½ watt
R_7	500kΩ Pot
R_8	270Ω ½ watt

Valves
6SL7GT Brimar
6V6GT Brimar

Chassis and Panel
H. L. Smith & Co. Ltd.

Output Transformer
Miniature type—H. L. Smith & Co. Ltd.

Coils
Eddystone types 707/LB, 706Y, 706/R, 706/W and 706/P
Coil Base type 707.
Home Radio or Southern Radio and Electrical Supplies.

Condensers

C_1*	25pF variable
C_2	140pF variable, Eddystone, 586
C_3*	25pF variable
C_4	100pF, mica
C_5*	75pF, variable
C_6	2μF, 350V wkg, TCC type CE17N
C_7	0.02μF, 350V wkg, TCC type CP33N
C_8	25μF, 25V wkg, electrolytic
C_9	0.02μF, 350V wkg, TCC type CP33N
C_{10}	25μF, 25V wkg, electrolytic
C_{11}	100pF, ceramic

* Available from R.C.S. Products (Radio) Ltd.

RF Choke
The Teletron Co.

Valveholders
McMurdo

Paxolin Strips etc.
H. L. Smith & Co. Ltd.

Power Pack Component List

Chassis
H. L. Smith & Co. Ltd.

Mains Transformer
Ellison type MT162

Tag Strips, Plugs and Sockets etc.
H. L. Smith & Son, Ltd.

LF Choke
10H, 60mA—H. L. Smith & Co. Ltd.

C_{11} and C_{12}
8×16μF, 350V wkg, electrolytic—H. L. Smith & Co. Ltd.

Valve
5Y3GT Brimar

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Using Mains Transformers Having Unconventional Voltage Tappings

by G. W. SHORT, *M.A.*

Introduction

A MAINS TRANSFORMER IS OFTEN THE most expensive item in a piece of equipment. From time to time, non-standard mains transformers appear on the market at give-away prices. Often, these apparently useless items can, with a little ingenuity, be made to yield quite standard voltages. This article describes how one typical transformer was utilised. The general principles can, however, be applied by constructors to adapt other cheap non-standard transformers to their particular needs.

The transformer used in the power pack described here had normal a.c. mains primary tappings, and the following secondary voltages:—

120V	..	..	350mA
9V	..	..	1A
12V	..	..	2A

Probably because none of the above voltages is of direct use for general radio work, it cost only 7s. 6d., although it is a well-constructed component. Nevertheless, without resorting to any drastic measures such as re-winding, it was made to provide the following supplies:—

- H.T.$_1$ 250V 100mA
- H.T.$_2$ 250V 50mA
- L.T.$_1$ 12.6V a.c., 2A (for 12V a.c. mains valves)
- L.T.$_2$ 0-10V d.c., 10MA. This can be used for bias supplies, transistor collector voltage, etc.

The circuit of the power pack is shown in Fig. 1. The primary is mis-volted by 10 volts, the 230V a.c. mains being connected to the 220V primary tapping. This is a negligible voltage overload, but it has the useful effect of raising the voltage of the 12V secondary to 12.6V, so that it can be used for supplying valve heaters. Valves with 12.6V heaters are supplied direct, while pairs of valves with 6.3V heaters and similar current ratings can be connected in series across the supply. The h.t. secondary, which now gives 126 volts, supplies two full-wave voltage doubler circuits. Metal rectifiers such as the RM series can be used, or centre-tapped 250V rectifiers.

The exact arrangement of the h.t. supply is a matter of convenience. In the writer's case, two separate supplies were provided so that several pieces of equipment could be operated at the same time. If only one supply were provided, instability might result from stray couplings in the power pack. If, for instance, a radio tuner feeding a high gain audio pre-amplifier, in turn feeding a power amplifier, were all connected to one h.t. source, motor-boating would probably occur. With two h.t. supplies, the feeder and pre-amp can be connected to one and the power amplifier to the other. This greatly reduces the risk of motor-boating.

Low Voltage D.C. Supply

A half-wave metal rectifier was used here. It is not normally considered good practice to employ half-wave rectification in conjunction with transformers not specially rated for it, because d.c. flowing through a transformer winding can cause saturation of the core, and this results in a damaging increase of primary current. However, in the present case only a few milliamperes are drawn. The supply is designed to operate with the positive side earthed, for grid bias and transistor collector voltage supply. There is no reason why it should not be used with earthed negative, however.

Construction

This was quite straightforward, the unit being built on a wooden "bread board." This type of construction is to be recommended where no valves are used, and where, as in the present case, electrolytic condensers are employed in circuits where the negative

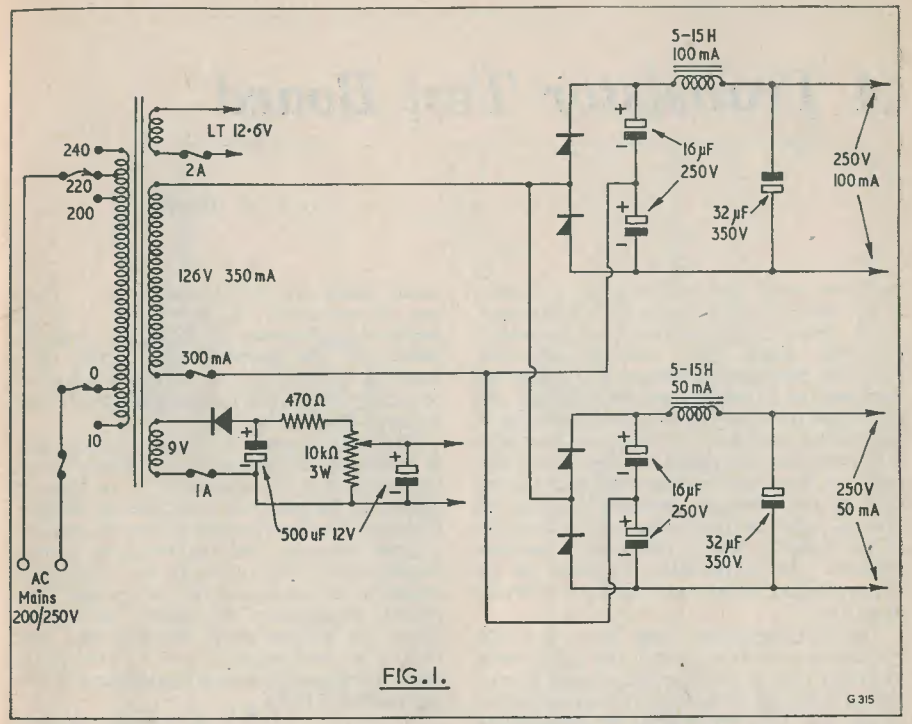

FIG. 1.

Circuit of the writer's power supply using a surplus mains transformer. Several other ways of using the same transformer are possible, and these are discussed in the text

side is not earthy. (If the chassis was a metal one, precautions would have to be taken to insulate the cans of some types of electrolytic from the chassis).

Alternative Circuits

Taking the same transformer as an example, several other ways of using it are possible:

1. *Battery Eliminators*
   H.T. Supply. A half-wave rectifier fed from the 120V winding will yield enough voltage for any normal battery set (i.e. 70-125V). R.C. smoothing can be used, the series resistor being chosen to drop the h.t. voltage to the required value.
   L.T. Supply. 7.5V, from the 9V or 12V winding, with either half-wave or bridge rectifier, and R.C. smoothing. 1.5V *or* 2V, by connecting the 12V and 9V windings in series, opposing one another. This gives 3V for a small bridge rectifier. Excess voltage can be dropped in the smoothing circuit.
2. *Step-down Mains Transformer*
   The 120V winding could be used to supply American-type 115V a.c.-d.c. receivers. Power available is 42W.
3. *Unusual L.T. Voltages*
   The 9V and 12V tappings in series give 21V. This voltage is correct for certain a.c./d.c. valves such as the UF42 high slope h.f. pentode. A current of 1A is available, enough for 10 such valves.
   Alternatively, by feeding the 230V mains supply into the 250V primary tappings, 19V l.t. is available. This would be suitable for an amplifier having, say, two PL33 output valves (heaters 19V, 0.3A). Three amplifying valves having heaters of 6.3V, 0.3A, could be connected in series across the l.t. ($3 \times 6.3V = 18.9V$).

It is hoped that enough has been said to encourage constructors to keep a sharp lookout for genuine bargains in the way of unusual mains transformers. Before making a purchase, however, it is advisable to do a little rapid mental arithmetic to make sure that the item in question is really useful and not just another white elephant.

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A Transistor Test Board

by V. T. ROLFE

NOW THAT TRANSISTORS ARE BECOMING increasingly popular with home constructors, the need for some method of checking them has become apparent. Probably the simplest method is to regard the transistor as a double germanium diode, and check the forward and reverse resistances of the emitter-to-base and collector-to-base with a low voltage ohmmeter. When doing this test, it is important to remember that the red lead of the meter is normally *negative* on "ohms," and that the low resistance direction of the collector-base circuit is with the base negative. (It is normally operated in the high-resistance connection, with the collector negative.)

The test described only gives a rough indication of whether or not the transistor is working, and is useful only when it is suspected that the transistor is non-operative, either due to overloading, or overheating when soldering into circuit. With transistor circuits still in the experimental stage, it is not unknown for a constructor to build up a piece of equipment, only to find it doesn't work. In such cases it may be desirable to check the transistor characteristics. Apart from any circuit faults, non-operation may be due either to a faulty transistor, a low current gain, or high leakage current.

The test-board to be described will reveal any of these shortcomings. It is primarily intended for checking junction transistors such as the Mullard OC70 and OC71, although it could be used for other types with certain modifications, and probably with point contact types as well providing suitable batteries were employed.

The transistor is tested in the grounded emitter connection, since this is the arrangement which gives the greatest current gain, and is most likely to be encountered in practice. First of all the leakage current (I_{co}') is to be checked. This is the current which flows in the collector circuit when there is no input to the base. The basic circuit for checking this is shown in Fig. 1. The lower the value of I_{co}', the better the transistor, in some applications. Average values for the OC70 and OC71 are 110μA and 150μA respectively, whereas the maximum values are 225μA and 325μA. These are measured at $V_c = -4.5V$, with an ambient temperature of 25°C. In practice, owing to the pentode like curves of a junction transistor, I_{co}' is independent of collector voltage, but increases markedly with a rise in temperature.

The method used to measure current gain is to supply a certain base current to the transistor and by means of a backing-off circuit to balance out the collector current flowing. The base current is then changed by a given amount, and the resultant current measured by the meter is the change in collector current caused by this change. The circuit arrangement is shown in Fig. 2. Since the voltage drop between base and emitter is very small (approx. 100mV), the resistor required to give a base current I_b can be calculated from $R = \frac{V}{I_b}$. Thus with a 1.5V battery, and a base current of 10μA, a resistor of 150kΩ is required. The resultant collector current is balanced out by adjustment of R_3. Changing the value of the base bias resistor will change the base current. A resistor of 25kΩ will give a base current of 60μA, an increase of 50μA.

The current gain a′ is given by

$$\frac{\text{Meter reading (in mA)}}{50} \times 10^3$$

$$= 20 \times \text{Meter reading.}$$

In the practical circuit, the meter is shunted in this position to give a full scale deflection of 5mA, and this corresponds to a current gain of 100. Thus the meter scale can be directly calibrated. The value of the shunting resistor R_4 will depend on the meter resistance, and will be given by $R_4 = 0.25R_m$.

The limits of current gain to be expected with the two transistors mentioned are 20 to 40 for the OC70, and 30 to 80 for the OC71.

Practical Details

The full circuit is given in Fig. 3. A switch and pilot lamp are incorporated to indicate when the unit is on, as it is not desirable to connect a transistor to the test terminals with the supplies already connected. A three-pole three-way switch is required for the main

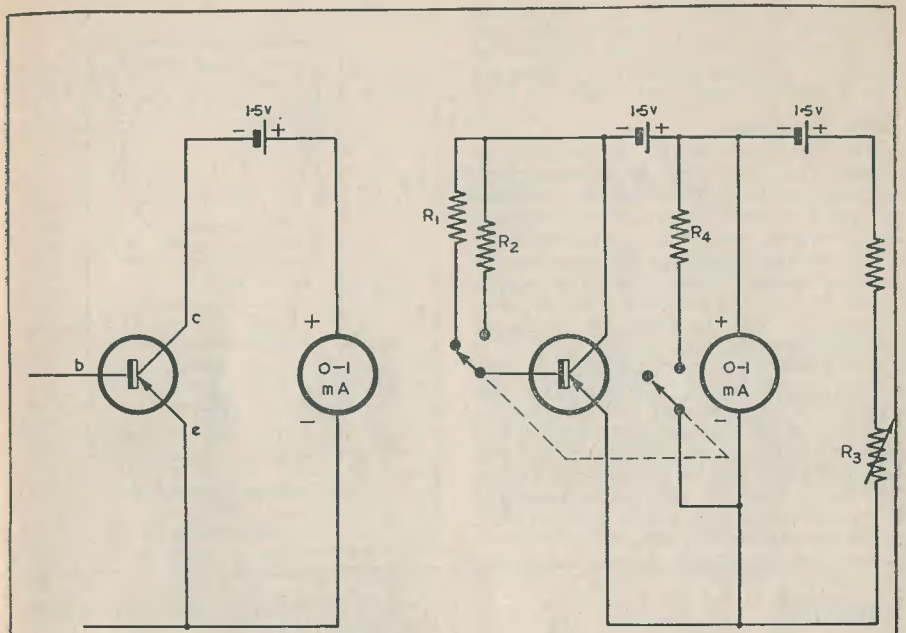

Fig.1
Circuit for measuring Ico′

Fig.2
Circuit for measuring α'

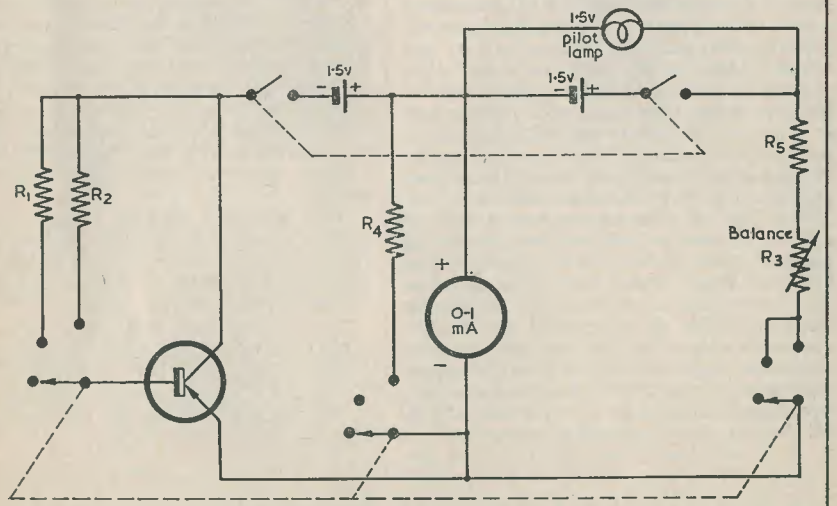

Fig.3
Practical circuit of test board

Components list

R_1 — 150RΩ		2 penlight cells
R_2 — 25RΩ		3-pole 3-way switch
R_3 — 10RΩ	variable	2-pole single-throw switch
R_4 —	see text	1·5v pilot lamp
R_5 — 500Ω		0-1mA meter

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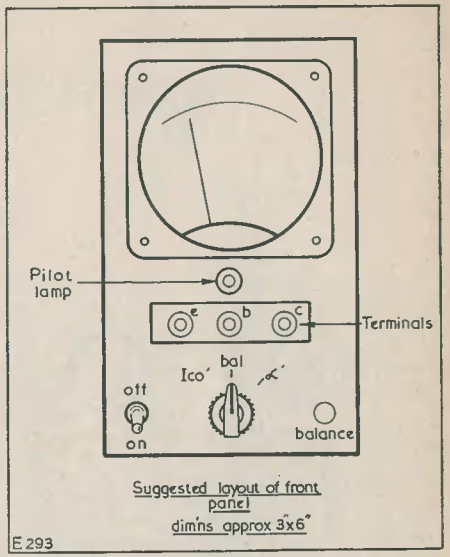
selector; this should be a good quality component with low contact resistance. Small pen-light cells can be used for the batteries. A typical panel layout is shown in Fig. 4, although this is not critical.

Safety Precautions

The test-board should be switched off before a transistor is either connected to or disconnected from the terminals. It is also advisable to check that the connections have been correctly made before switching on, as a reversal of polarity, particularly in the collector circuit,may permanently damage the transistor. For this reason it is important to ensure that the batteries are connected correctly when building the unit.

Transistors may also be damaged by surge currents, such as may occur from the discharge of a condenser, or over-heating. Although these two points are not likely to arise in connection with this test-board, they are mentioned here to remind constructors that care is essential when using transistors. A heat shunt should always be used when soldering them into circuit.



Mullard Educational Service

"The White Paper (Cmd. 9703), which was issued in connection with the Government's recent announcement of plans for increased facilities for technical education, is well worth careful study, not only by those responsible for higher technological training, but also by head teachers and science masters in grammar, secondary technical and secondary modern schools, for whom the section (paragraphs 13 to 22) headed "The School Background" is of especial interest.

"The Mullard Educational Service will do all in its power to assist schools in carrying out the policy outlined in these paragraphs.

"In this connection, it has occurred to us that while much of the material we already make available is acceptable for science specialists in grammar schools, we may have somewhat neglected the needs of the secondary modern school. We therefore cordially invite suggestions as to how we may help to fill the gap if, indeed, such a gap exists."

A NEW FILMSTRIP FOR TELEVISION SERVICING CLASSES

The Mullard Filmstrip No. E60 on "Servicing Projection Television" is now available. It covers the principles of the Mullard projection television system and gives comprehensive information concerning the maintenance and servicing of the optical unit and such features of the circuitry as are peculiar to projection television. The filmstrip has been prepared particularly for use in connection with the City and Guilds of London diploma course in television servicing.

Very complete teaching notes have been prepared and contain reproductions of all the illustrations in the filmstrip. These notes will also be available in bulk for distribution to the members of the class.

The filmstrip, with one copy of the teaching notes, can be obtained from Unicorn Head Visual Aids Ltd., 184 Aldersgate Street, London, E.C.1, price 12s. 6d. Further copies of the booklet of notes are available at the nominal price of 6d. each.

R.S.G.B. V.H.F./U.H.F. Convention

The R.S.G.B. and the London U.H.F. Group are holding a one-day convention for V.H.F./U.H.F. enthusiasts at the Bonnington Hotel, Southampton Way, London, W.C.1, on Saturday, 26th May, from 10 a.m. to 11 p.m. Tickets and full information are available from F. G. Lambeth, G2AIW, 21 Bridge Way, Whitton, Twickenham, Middlesex, or from the R.S.G.B. Headquarters, New Ruskin House, Little Russell Street, London, W.C.1, telephone Holborn 7373,

RIGHT—*From the Start*

PART 5. LF AMPLIFICATION

by A. P. BLACKBURN

WE SAW LAST MONTH THAT THE VALVE could be used as an amplifier of electrical disturbances. Although we only spoke of one-valve amplifiers, we did mention that requirements do exist where a greater number of valve stages are necessary.

In these cases we are faced with the problem of coupling the stages together, and we shall now consider how this may be done. Many methods have been used in audio amplifiers, but most of them have been discarded in favour of the modern practice of "resistance capacity" coupling. We shall, therefore, concentrate on this type but a brief glance at some of the other methods would be useful, and can be saved for later on.

R.C. Coupling

At first sight, one may wonder what all the fuss is about. It seems simple enough; if the anode is the output of the valve and the grid is the input, surely the anode of valve No. 1 merely has to be connected to the grid of valve No. 2? True, this sounds perfectly logical, but take a look at Fig. 1.

Now the anode voltage of V_1 is, say, +100 volts, but the correct grid bias voltage for V_2 is −2V. Clearly then, we cannot connect points A and B together, because the grid (point B) would become positive with respect to its cathode and excessive grid current would flow and overheat the grid.

The voltages at A and B are both d.c. voltages; they are supplied by h.t. and grid bias batteries. Now, if we apply a signal to the grid of V_1, an enlarged or amplified version of this signal will appear at the anode of the valve. You will remember, however, that this signal is necessarily of an alternating character, as we pointed out in a previous article. At the anode of V_1, then, we have an alternating voltage superimposed on a d.c. voltage. So what we want is a component that will pass the a.c. voltage to the grid of V_2, but will *not* pass the d.c. Fortunately, someone has already thought about this, and such a component is readily available: the capacitor. Incidentally, the capacitor is often called a "condenser," but the former term is becoming more common nowadays.

The circuit of Fig. 1 may be connected as shown in Fig. 2. Any number of stages may be now "cascaded" in this way. This is the most common way of coupling audio stages together: by "resistance capacity" coupling.

Transformer Coupling

Another type of component which will pass a.c. but not d.c. is the transformer. Fig. 3 shows one method of connecting a transformer between two valve stages. Very briefly, the current in V_1 flows through the primary winding of the transformer. This current sets up a magnetic field which interacts with the secondary and induces a voltage into it, which is applied to the grid of V_2 as shown. The important thing is that a d.c. current in the primary produces no voltage across the secondary, but an alternating current in the primary does produce a secondary voltage.

One advantage of the transformer is that more volts may be obtained at the secondary than are applied at the primary. If, for example, there are five times as many turns of wire on the secondary as there are on the primary, then 5 volts will appear across the secondary for every one applied to the primary.

This means that a stage of valve amplification might be saved by using a transformer instead of R.C. coupling.

Another way of connecting a transformer is shown in Fig. 4. This has the advantage that the standing current in the valve does not flow through the transformer as it is blocked off by the capacitor. The a.c. or signal will, however, still be fed to the transformer via the coupling capacitor.

Choke Capacity

A method of coupling rarely used nowadays, but still worthy of mention, is shown in Fig. 5. An iron cored choke takes the place of the usual anode load resistor. The advantage is that a lower h.t. voltage may

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be used because the choke has a low d.c. resistance and few volts are dropped across it by the flow of standing anode current.

If the choke has a high inductance, say 20 henrys, or so, it will have a high reactance down to relatively low frequencies, and the gain of the stage could be as high as with a normal resistor. The capacitor C couples the anode to the next grid in the same manner as R.C. coupling.

Advantages

The advantages and otherwise of the methods of coupling illustrated are as follows:

1. R.C. coupling provides a system where the gain of the whole amplifier is constant over the widest band of frequencies. That is, the distortion is low.
2. Transformer coupling does not give such low distortion as R.C. coupling unless the transformer is elaborate, bulky and expensive. It does have the advantage of voltage "gain" from primary to secondary if required.
3. Choke coupling does not give low distortion either. If the distortion can be tolerated, the efficiency of the stage may be higher than for R.C. coupling.

So much for the moment on the matter of interstage couplings. However, later we will return to the R.C. method and examine its "frequency response"; that is, whether all frequencies are treated as equals in that circuit.

Grid Bias

In all the circuits in this article so far, this grid bias has been indicated by a vague arrow marked "G.B." This, of course, indicates that a battery is connected there. Grid bias batteries have been in use for years, but most modern designs make use of other ways of obtaining the operating bias for the valves.

Fig. 6 shows how an ordinary grid bias battery might be connected to an amplifier. The positive end of the battery is connected to earth and the grids are connected to the appropriate negative voltages. In early battery-driven receivers, this system was widely used, but in some later types

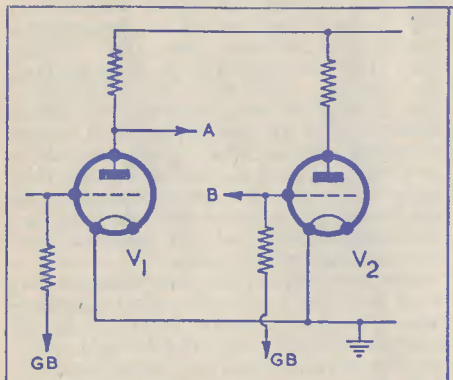

FIG.1.

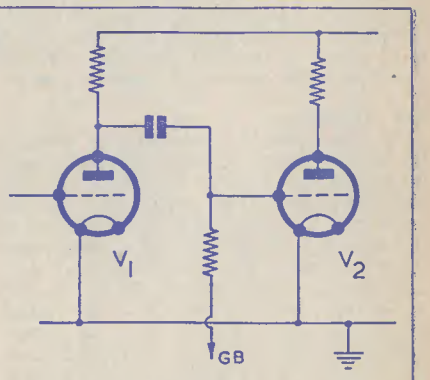

FIG.2.

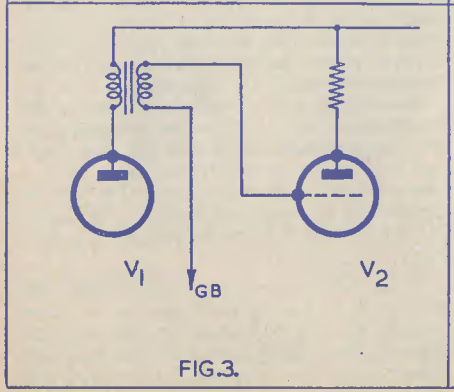

FIG.3.

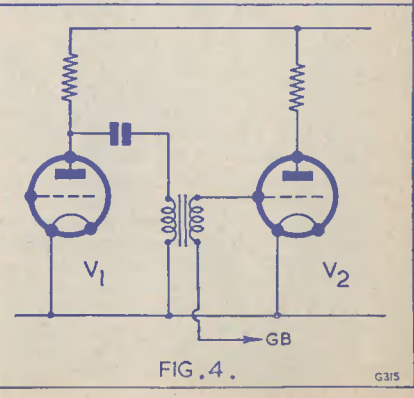

FIG.4.
G315

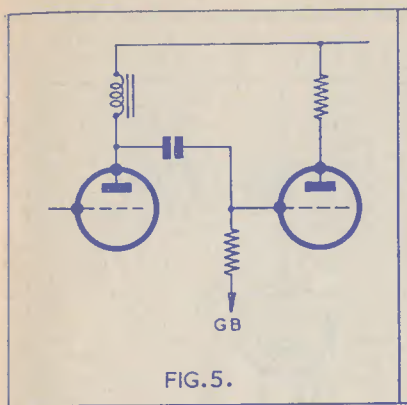

FIG.5.

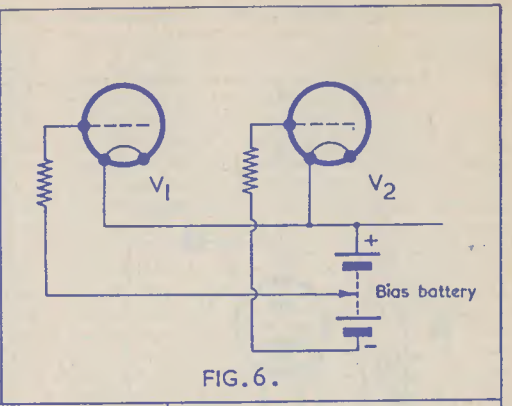

FIG.6.

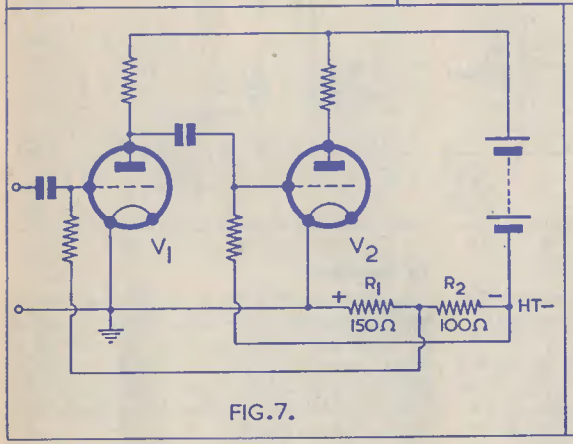

FIG.7.

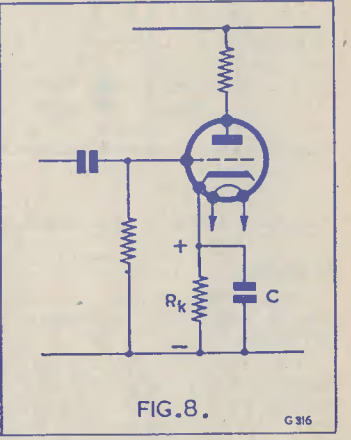

FIG.8.
G316

an "auto bias" circuit appeared. The total valve h.t. current is caused to flow through a series of resistors as shown in Fig. 7. This means that the filaments are *positive* with respect to h.t.−, due to the valve current producing a voltage across R_1 and R_2. The grids can now be connected to the points shown which are *negative* with respect to the filaments.

Say, for example, that the total valve current were 20mA and V_2 required a grid bias of 5 volts. Then the total resistance (R_1+R_2) would be by Ohms Law:

$$R=\frac{E}{I}=\frac{5}{0.02}=250\Omega;$$

but if V_1 only required a bias of 3 volts, a resistance of

$$R=\frac{3}{0.02}=150\Omega$$

would be required.

Therefore R_1 would be 150Ω and R_2 100Ω, thus making the total of 250Ω for the bias of V_2. The arrival of indirectly heated valves produced another "automatic" biasing system. First, however, it should be explained that the indirectly heated valve is so called because the surface emitting the electrons is a tubular cathode placed around the filament. This enables an a.c. voltage to be used for the filament, as the cathode is electrically insulated from the filament. If a.c. were applied to the filament of a directly heated valve, some of the a.c. would be superimposed on the signal, resulting in an objectionable hum.

The method of automatic bias mostly used with indirectly heated valves to-day is shown in Fig. 8. The principle of operation is rather similar to that of Fig. 7. Here, however, only the current in individual valves is used to produce the bias voltage. The current flowing in R_K produces a voltage which is positive at the cathode. The grid, which is returned via its grid leak to the other end of R_K, is therefore negative with respect to the cathode.

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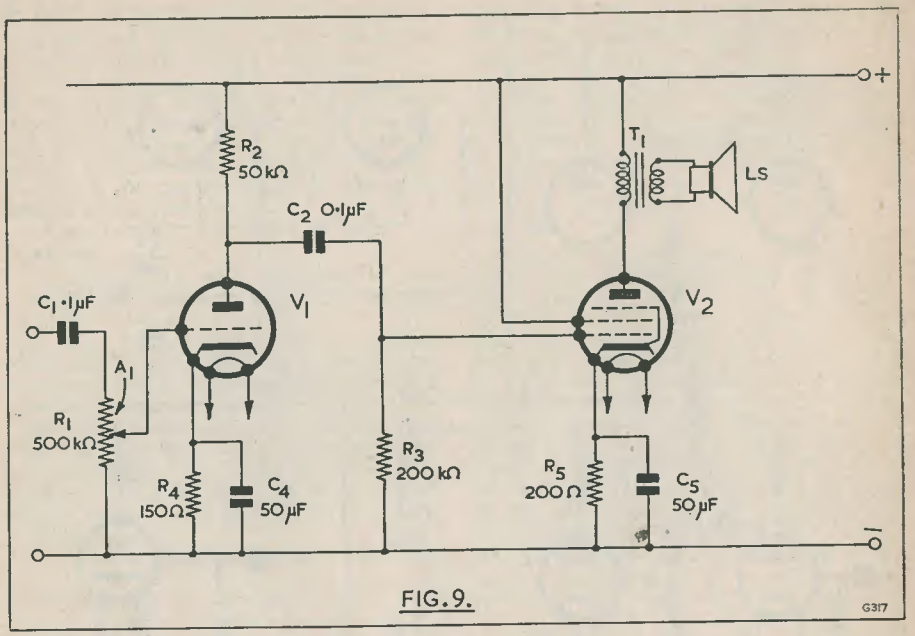

FIG. 9.

Decoupling

There still remains one component in Fig. 8 which has not been mentioned—the capacitor, C.

If we recall that the current in the valve varies with the applied signal, then the bias voltage will vary also. For example, if the grid signal momentarily became more positive, the current in the valve would increase. The voltage drop across R_K would therefore increase also, thus increasing the bias on the valve, i.e. making the grid more negative and decreasing the current in the valve. The result is a loss of gain in the stage because the change in current in the valve, and therefore the output voltage, are partially cancelled by the changing bias voltage.

The remedy is to "bypass" the cathode resistor with a capacitor, as shown in Fig. 8. If we remember that the reactance of a capacitor decreases with increasing frequency, a large value of C in the figure will effectively short out the cathode resistor, *but only to a.c.* As no d.c. flows in a capacitor, placing C across the cathode resistor will have no effect upon the voltage developed across it, but any rapid changes of voltage, such as those caused by a signal, will not occur because the capacitor will bypass them to earth.

There are many other uses for bypassing components as we shall see. The technique is often called "decoupling."

An Amplifier

As we are now in a position to couple stages together and derive bias for them, the next step is to see how all this looks when combined in a simple amplifier. Fig. 9 shows a low power output amplifier which might find typical application as a gramophone amplifier.

The R.C. coupling circuit and biasing arrangements are exactly as already described, but there are one or two features not touched upon so far.

The first is R_1, the volume control. The action is simple enough. The signal is applied across the two ends of the potentiometer R_1 and the position of the "wiper" connected to the grid of V_1 fixes the amount of resistance between the grid and earth. Now, the signal will cause a current to flow in R_1 so the signal reaching the grid will be the current multiplied by the resistance between the wiper and earth. When the wiper is at position A_1 all the signal will be fed to the grid. As the wiper is moved toward earth, less and less signal will be transferred.

The "output" stage V_2 is a pentode. The pentode is a higher gain valve than the triode, but the distortion it introduces is a little higher than the triode.

In the anode of V_2 a transformer is used to couple the valve to the loudspeaker. There is very little choice about this. In moving coil loudspeakers the impedance of the coil is of the order of 2 to 15 ohms. This is so because it is necessary to have as little wire on the coil as possible in order that it may be light enough to move easily.

Now every valve has a recommended "load" to work into for maximum power output. It may have values anywhere from 2,000Ω to 20,000Ω or higher, dependent upon type. If the speech coil of the speaker were connected direct to the anode of the valve, very low power output would result. It is a property of the transformer that it can "match" one impedance to another. Therefore the transformer is connected as shown. Unfortunately, the transformer is one of the weakest parts of amplifier circuits, unless they are very well designed. Their weakness is the distortion they produce.

Voltage and Power

The two stages in Fig. 9, although providing gain, have in one respect different roles to play. V_1 is purely a voltage amplifier, taking the input voltage and amplifying it as we have seen earlier. V_2, however, has to produce *power* into the loudspeaker. For this reason the output stage is often called the power amplifier.

The output of amplifiers is usually specified in watts. This forms a measure of the loudness of the sound produced. For ordinary domestic purposes, the minimum required is about 1 watt, but larger powers are usually provided, up to 10 watts in some cases. In the interests of quality of reproduction it is advisable to have a little in hand; that is to say, if the amplifier is to produce 3 watts for comfortable listening, a 5 watt amplifier is required.

This article, of course, leaves a lot still unsaid about amplifiers. What would happen, for example, if C_3 in Fig. 9 were changed to 0.01μF, and why has 200kΩ been chosen for R_3? But these questions bring us closer to the question of the design, rather than the mere operation of the circuit.

Can Anyone Help?

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

L. J. POYNER, 7 Love Lane, Weymouth, Dorset, wishes to buy or borrow the circuit of the American G.E. radio GE L-643, range 540 kc/s to 1720 kc/s.

R. MULLINS, 72 St. Mary's Road, Tonbridge, Kent, requires manufacturer's circuit and details of Murphy V114 9in t.v. receiver (1947?) and is willing to pay for information.

S. C. ROBERTS, 24 Sutherland Avenue, Welling, Kent, wants the circuit or any information on the RT34/APS.13, 430 Mc/s transmitter/receiver, and is willing to purchase or borrow.

D. KENNEDY, 33 Greystoke House, Peckham Park Road, London, S.E.15, wishes to buy or borrow the circuit and alignment details of the Ferguson model 204XL receiver.

J. BALDWIN, The Dingle, Habberley Road, Bewdley, Worcs, requires the circuit and information on the v.h.f. receiver type R1392A; any expense will be gladly refunded.

J. ALLEN, 7 Chaucer House, Tabard Gardens, London, S.E.1, would like to obtain information on the v.h.f. transreceiver X78A. It is spot tuned and only the receiver information is required.

B. PAGE, 7 Queen's Gardens, Eaton Socon, Hunts, would gladly pay any expenses for manual, circuit or data on the CR100 receiver and also the Siera 3-waveband receiver type SA1010U—valve line-up believed to be UY42, UL41, UBC41, UF41 and UCH42.

N. V. DINSDALE, Crayke, York, would be grateful for information on the ex-A.M. 1448 receiver, especially the circuit. Has any reader succeeded in adapting this set for higher frequencies?

R. REYNOLDS, G3IDW, 136 Beech Avenue, Swindon, Wilts, requires information in respect of a pre-war RME70 receiver. Circuit diagram or manual, buy or loan—your price.

P. DALY, 12 Stella Avenue, Glasuevin, Dublin, would like to buy or borrow the manual of the Hallicrafters Sky Challenger SX18 receiver. Any information on this set would be much appreciated.

D. CLOSS, 41 Culverden Road, London, S.W.12, urgently needs a replacement dial, reference number 70,307 for a 5 valve Pye receiver, and is willing to pay for same.

B. PHILLIPS, 24 Ombersley Road, Bedford, Beds, wishes to buy or borrow the handbook for the Eddystone 358X receiver.

C. W. FALKNER, "Thames Mead," Abbey Drive, Laleham-on-Thames, requires details and operation data for the receiver type 78, A.M. reference No. 10D/1307.

W. EVANS, 109 Tansley Road, Kingstanding, Birmingham, wishes to tender his sincerest thanks to all those readers who kindly offered to supply him with back numbers of the magazine. The response to his appeal was enormous, and it will take some time to reply to each one individually.

M. WRIGHT, 54 New Hall Lane, Bolton, Lancs, has just purchased an indicator unit type 6L, reference number 10QB/299 and wishes to convert to a t.v. receiver. Any information on this conversion would be appreciated; alternatively, he is willing to pay for conversion work.

B. HAYES, G3JBU, 7 Western Terrace, Northampton, would like some information on fitting a noise limiter and "S" meter, together with any other improvements, to the Marconi CR100 receiver. He would also like to thank all those readers who replied to his previous appeal for information on the German RL12P35 valve. Having found it impossible to reply to all who wrote, owing to the very large number of replies received, he hopes that this short acknowledgment will suffice.

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Radio Miscellany

CENTRE TAP *talks about* **T.V. AERIALS, PAINT SPRAYING, THE BEAUFORT SCALE**

ON A RECENT SUNDAY MORNING I HAD occasion to pass the Crystal Palace T.V. site and was very surprised at the number of people there sightseeing. More surprisingly they seemed to stop and stare for a long time although there is nothing much to see. The main aerial tower, which is to be 640 ft when complete, will not be ready for about another 15 months. It will, of course, also carry the I.T.A. aerials. Close by stands the 250 ft temporary mast (B.B.C.) at present in use; the I.T.A. mast being nearly a mile away. Both look puny affairs compared to the uncompleted tower. From the road nothing much else is visible as the buildings have been sunk under the terrace to leave the ground available for public use.

An absurd idea suddenly came to me. Suppose an enterprising spiv had been around the Alexandra Palace area buying up their superfluous attenuators, he would probably find a good market disposing of them half-price to the South Londoners now finding themselves swamped with the increased power right on their doorstep. Even those they might have left over will find a brisk sale next year when the permanent tower is finished and the maximum power, 200 kilowatts, brought into use. Why wasn't I born a business-man?

One innovation at Crystal Palace is that both the vision and sound transmitters are in duplicate, working simultaneously in parallel. Thus the continuity of the programme can be preserved in case of breakdown although there will naturally be a corresponding reduction in reception strength. Viewers will be warned by pre-recorded apologies which can be radiated at the touch of a switch!

Finishing Touches

A month or two ago I wrote on paint spraying. Since then I have been impressed by the interest evinced by many readers on this subject. At first I thought the topic would be of close interest only to transmitting amateurs who use large metal areas in their racks, etc., but I am beginning to think that almost every reader has something enclosed in metal work, chiefly instrument cases and test gear. Quite a lot of them have something to say on the subject. The vast majority used the cheap spraying heads, now widely marketed, in conjunction with a hand bulb or foot pump, and the results obtained vary considerably. While many managed to make a good job of it at the first effort, a greater number seem to have met with varying degrees of disappointment. So much so, that I am approaching an expert with a summary of their difficulties, and hope to find space in this column next month to pass on any advice he has to offer.

One thing rather pleased me. Among those readers who prefer external crackle finishes such as Panl, several mentioned that they have sprayed the insides of their cases with cellulose enamels. It is pleasing to know that even in these days of mass production, there is still pride in good workmanship, and a feeling that the inside should look as good as the outside.

Ill Winds

For several months now the B.B.C. have, in the weather reports and forecasts, used the Beaufort Scale to describe wind forces. Yet it is astonishing to find how few people are familiar with this scale. In fact the index numbers seem to be completely meaningless to the vast majority of people. My own interest in wind was greatly heightened when my very first v.h.f. aerial took off in a gale and landed in the garden of an already hostile neighbour. Incidentally, when re-erected, I made provision to lower it whenever gales were threatened—a precaution which, strangely enough, is still far from usual. Many nervous people are alarmed at the possibility of lightning striking the aerial, yet the danger of it sustaining damage and consequently doing further damage to person or property when it, or one of the elements, comes down, is many hundreds of times greater.

In my school days, we had no electric mains within some hundreds of yards, and my first interest in the wind was to harness it for the generation of electrical power. It would save hauling accumulators for recharging and the prospect of getting something for nothing strongly appealed to the faint streak of Scot in me. I also built up a simple anemometer of the Robinson type. It consisted of four metal cups mounted on cross-bars geared to an indicator which moved across a scale relating the number of revolutions to m.p.h. There is another type, the Dines, in which a recorder floating on water is used.

The Beaufort Scale, of course, has long been used for the more detailed type of weather reporting. It was devised by Sir Francis Beaufort in 1805 and the numbers 0 to 12 are used to indicate wind velocities in m.p.h.

During the power cuts of 1946-47 I wrote an article for *Short Wave News* on home-made power by wind-driven generators. Quite a number of amateurs have used them, especially when ex-W.D. generators of various patterns were cheaply available.

The more weather-conscious reader will have noted that wind forces of from 3 to 8 are common in the British Isles, so with reasonably sized storage cells, power for many uses could be available during the rare periods when wind pressures fall below 3. Writing, at that time, of the Beaufort Scale, I gave the generally accepted effects of the various wind forces to enable those without access to detailed reports, to judge wind speeds. Now that the Beaufort index numbers are regularly broadcast the velocity figures can be put to use the other way round—visualising the wind force by knowing the scale number. At least, you will be able to know just how much your aerial is likely to sway! As the "effect" details are likely to be of use to readers who missed the original article, no apology is needed for repeating them below.

Force	*M.p.h.*	*Description*	*Effect*
0		Calm	Smoke rises vertically
1	1 to 3	Light air	Direction discernible by smoke drift but not by wind vanes
2	4 to 7	Slight breeze	Felt on face, leaves rustle. Vanes moved by wind
3	8 to 12	Gentle breeze	Leaves and small twigs in gentle motion
4	13 to 18	Moderate breeze	Raises dust and loose leaves and small branches are moved
5	19 to 24	Fresh breeze	Small trees begin to sway
6	25 to 31	Strong breeze	Large branches moving, telegraph wires whistle
7	32 to 38	Moderate gale	Whole trees in motion. Hard to walk against it
8	39 to 46	Gale	Breaks twigs off trees
9	47 to 54	Strong gale	Liable to bring down occasional chimney pots, slates and tiles
10	55 to 63	Whole gale	Trees may be uprooted, structural damage
11	64 to 75	Storm	Widespread damage
12	Over 75	Hurricane	—

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Stroke P

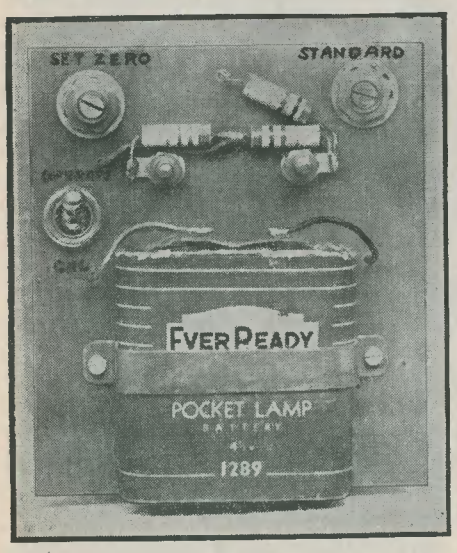
Following my last month's references to holiday-making I am reminded that last year many amateurs enjoyed their holiday part of that wonderful summer on the Norfolk Broads. This is an ideal way of spending a holiday for those who have a highly developed sense of freedom to satisfy—especially the freedom to carry on with one's hobby. Thus during the season there were quite a number of transmitting amateurs on the Broads operating portable on top band. Unfortunately the QSO's were fewer than they would have been had schedules been planned.

To make the most of such opportunities this year it is suggested that those who intend to operate /P should make previous contact with either the R.S.G.B. Territorial Rep. or with Dr. Arthur Gee, G2UK, "East Keal," Romany Road, Oulton Broad, Suffolk. The certainty of a greatly increased number of contacts will then be assured.

I am not sure whether /P on the Broads ought not to count as "another county." Top Band County Logging is quite an idea for listeners eager to test set performance and operating skill. How many counties have you heard on 160 metres? If you haven't tried you will find it a harder test than you might at first think. The maximum is over a hundred (counting Eire, Isle of Man, etc.) but unless you are pretty good, or very well sited, it will take you months to get a third of that score!

A certain amount depends on luck. If you are able to put in a good spell of band searching during a contest for instance, you might get off to a magnificent start. But even that will only bring you to the tantilising state of looking for the rare counties a few weeks earlier. From that point the adding of a new county makes the event something of a red-letter day!

Thermistor-operated Thermometer—*continued from page 657*



switched off and VR_1 adjusted to give full scale deflection on the meter. The switch is now changed to the "Calibrate" position and VR_2 is also adjusted to give a full scale reading. This control will need no further adjustment and should be sealed with wax to prevent further movement.

As the thermistor cools, readings should be taken every 5 degrees on the thermometer to enable the calibration to be completed. The use of ice may be found necessary to carry the calibration curve to zero, should the ambient temperature be too high. If ice is unot tainable the last part of the scale could be calibrated by interpolation. That is, a graph is drawn from the figures obtainable and the curve carried on in a natural line over the desired range. Although this may not sound very precise, in practice the results obtained will be found to be reasonably accurate. After the short across SW_1 has been removed, the "Thermistor Thermometer" is ready for use.

Exhibition at Bexleyheath

The North Kent Radio Society, in co-operation with three other local clubs, is holding an exhibition, open to the public, at the Bexleyheath Congregational Hall on Saturday 12th May. The North Kent Radio Society will be showing working equipment, and the club station—call sign G3ENT—will be in operation. The other clubs exhibiting cater for the model aircraft, yachting and engineering enthusiasts.

The North Kent Radio Society holds its meetings at 8 p.m. on the second and fourth Thursdays of the month at the Congregational Hall, and the Hon. Sec., F. C. Beadle, G3KLI, of 56 Balliol Road, Welling, Kent, will be pleased to see prospective members at these meetings or at the exhibition.

TRANSMITTING WITH THE EL43

by G3XT

"FB FR QRP, OM!"—THAT'S THE SORT OF comment on your signals that you want to hear if you are keen on low-power transmitting; and I have heard it a good many times recently while trying out the EL34, a comparatively new Mullard pentode.

Although of course it is primarily intended for use in the output stage of an audio amplifier, the EL34 seems to be quite a promising valve for QRP transmitting purposes. It has been tried out at G3XT during the past few weeks, under very adverse conditions, and has given encouraging results in a single-stage Colpitts oscillator running at about 5 watts on the 7 Mc/s band.

As G3XT had been off the air as far as transmitting is concerned for the past two years (since moving to a new QTH), a temporary transmitter had to be rigged up in order to try out this new valve. Impatience to get on the air again resulted in the construction of a rather makeshift transmitter hooked together with ex-Government surplus junk; and a hastily-erected aerial of very doubtful efficiency, only about 20ft in height and rather badly screened.

Despite these handicaps, the whole thing worked from the word "go," and a QSO resulted from the very first call. Exceptionally poor conditions prevailed on the band throughout the greater part of the period during which I have been trying out the EL34, and no doubt it would have given a much better account of itself in more favourable circumstances.

Over 30 QSO's were obtained, however, with 7 countries, including EI, F, HB, ON, and SM, as well as with a number of British stations in places ranging from Edinburgh, Kirkcaldy and Glasgow in the north to Southampton and Plymouth in the south; and from Liverpool and Bristol in the west to Southend-on-Sea in the east. Due to poor conditions, no doubt, the average strength reported was not high—only S5—but when conditions improved now and again for a brief spell, the reports rose to S7 or S8.

With a properly designed and carefully constructed transmitter, an efficient aerial and normal conditions on the band, this valve can reasonably be expected to yield reports averaging RST 579, with probably a fair number of 589's and a few 599 reports. That prediction is based on my experience with other valves which have given considerably poorer results when used under adverse conditions comparable with those in the test of the EL34.

QRP enthusiasts should find this valve worth a trial, either in a single-stage VFO or CO; or as the PA valve in a more ambitious type of low-power transmitter.

In designing a transmitter around the EL34, you should bear in mind that it radiates quite a lot of heat, so you should give it plenty of space above the "deck," and see that the cabinet is adequately ventilated. See, too, that the screen-grid feed resistor is of adequate wattage rating, otherwise this will run hot too! A potentiometer would probably be better.

Owing, probably, to the somewhat haywire construction of the temporary transmitter at G3XT, it was found advisable to run the grid circuit on 80 metres and extract the signal on 40 metres by tuning the anode circuit to that band. This frequency-doubling arrangement gave less RF output, but the valve was much "tamer" than when used with both tuned circuits on the same frequency.

Stability was excellent, the tone consistently T9 (except on one solitary occasion when a temporary fault in the power pack resulted in a T8 report), and the keying was free from chirp.

Catalogue Received

We have received from Messrs. R. Fagelston, 46 Hardwicke Road, London, N.13, a copy of their current catalogue, together with inserts. Readers may obtain their copies by sending 3d. along to the address quoted; periodic supplements will also be issued.

The catalogue, which is duplicated and well produced, consists of 18 pages listing the usual range of components, plus other items not so usual, such as Scratch Remover. Also included are kits for various items which have been described in this magazine, such as the Transistorette, the Mullard 3 Watt Amplifier, a Modern Pre-amplifier, and so on. There is also a range of Band III converters, and a number of simple receiver kits. A number of bargain lines are being currently offered.

The prices quoted throughout are, we consider, very reasonable, and we suggest readers should obtain a copy.

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A THERMISTOR-OPERATED THERMOMETER

by J. W. BAGNALL

IT IS OFTEN DESIRED TO MEASURE THE temperature of an object which is so positioned that the use of a mercury thermometer is most inconvenient. A machine bearing, or even a domestic hot water tank situated in some inaccessible corner, are but two examples that spring to mind.

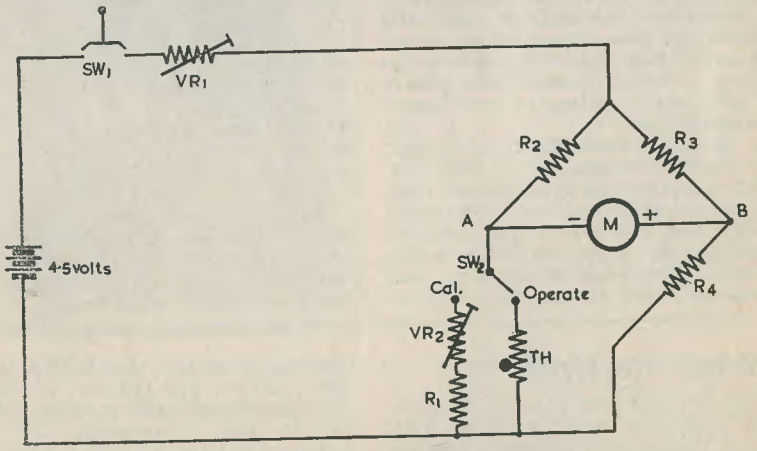
The instrument about to be described is a temperature indicating device which makes use of a block type thermistor to deflect a meter which is calibrated from 0 to 40 degrees centigrade. A thermistor is a semi-conductor whose resistance drops rapidly with an increase in temperature. It consists of a pressed, sintered block of thermistor material soldered to a metal plate.

The instrument itself is made in two sections, one being a small case containing the meter, battery and bridge resistors; this being connected by a length of twin flex to the thermistor, which is placed in close contact with the object of which the temperature is to be monitored. Should the ambient temperature be required, say, of the air outside the house, a U-shaped cover should be placed over the thermistor. This will shield it from direct sunlight and inclement weather, but still allow the air to circulate freely around the semi-conductor.

The Circuit

It will be seen that a bridge circuit has been employed, powered by a 4.5 volt battery, with the thermistor forming one arm of the bridge. The current flow through R_3 and R_4 is constant, therefore a constant potential will exist at point "B." Assuming that the same potential exists at point "A," then the deflection of the meter will remain at zero.

When the thermistor is heated its resistance will fall, and current will flow from point "B" through the meter to point "A" and via



R_1	220Ω	VR_1	500Ω (set zero)
R_2	2·7kΩ	VR_2	500Ω (standard)
R_3	100Ω	SW_1	"press-to-make" switch
R_4	100Ω	M	1mA F.S.D. meter
		TH	KB 1391/80 S.T.C. thermistor

S.217

the thermistor to ground. From this it will be realised that as the temperature of the thermistor is further increased, the greater will be the current flow giving a larger deflection on the meter. To allow for deterioration of the battery over a period of time, the bridge network is fed via a variable resistance VR_1, the value of which is decreased as the battery voltage falls. To increase the voltage across the bridge willy-nilly would cause the calibration of the instrument to be incorrect. To obviate this, a switch is provided to remove the thermistor and insert a pre-set value resistor in its place. This is VR_2 plus R_1. The resistor VR_1 is then adjusted for full scale deflection of the meter and the calibration is unaffected.

A push-to-read switch is mounted on the front panel so that current from the battery flows only when a temperature reading is being taken. The current drain from the battery is of the order of 10mA.

Construction

Although the reader will no doubt wish to use his own layout, some idea of the prototype will be gained from the illustrations. The resistors, battery, etc., are mounted on a paxolin panel, which in turn is held by the meter terminals. This makes for a compact arrangement which is easy to remove from the case.

The thermistor in this instance is mounted on a small block of paxolin, and is coupled to the bridge by a length of twin plastic flex. The use of shielded wire is not necessary.

Calibration

When construction is completed, it remains to calibrate the meter. In the original meter the scale was replaced with a thin card on which the new scale was drawn, using indian ink and a fine mapping pen, Should the constructor prefer not to dismantle the meter to fit another scale, an alternative would be to draw a graph which could be referred to the original meter calibration.

To calibrate the instrument as a whole, a thermometer is placed in close contact with the thermistor and embedded in a ball of plasticine; this is done to ensure an even temperature rise. The assembly is now placed inside a suitable container, such as a metal box, together with a 100-watt electric light bulb, this being a convenient means to raise the temperature.

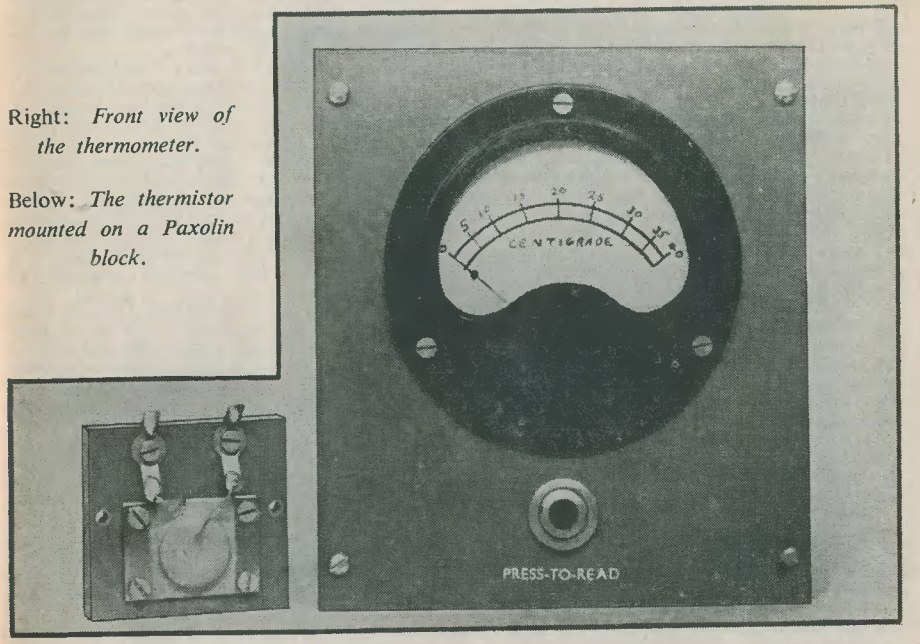
For the purpose of calibration, the press-to-read button should be shorted out and the switch SW_2 set in the "Operate" position. VR_1 is turned to maximum resistance.

When the temperature inside the "hot-box" reaches the desired maximum, in this case 40 degrees centigrade, the bulb is

(*continued on page 654*)

Right: *Front view of the thermometer.*

Below: *The thermistor mounted on a Paxolin block.*



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The First London Audio Fair

IT IS A DEFINITE FACT THAT, SO FAR AS HIGH-fidelity reproduction is concerned, British audio equipment stands amongst the finest obtainable in any country to-day. This statement is supported by the fact that one of our most flourishing export markets is in hi-fi sound reproduction products, these continuing to be sold in large quantities all over the world. Frequently, British audio equipment has to compete against tough local opposition, yet, despite shipping costs and import tariffs, the British goods still sell in large quantities.

For a long time it has been apparent that British firms have needed a high-fidelity "shop-window." In America, audio shows and "fairs" have evolved an ingenious and highly effective technique to demonstrate the exhibits which have been entered. Instead of using a large hall, as is done for most normal exhibitions, several floors of a hotel are taken over, the individual rooms thereby giving just the right conditions for high volume demonstrations without mutual interference between exhibitors, as well as providing listening rooms of the same size as would be used by most prospective purchasers. The London Audio Fair Committee have now employed this device very effectively themselves, with the result that the first British Audio Fair occupied all the rooms in the first three floors of the Washington Hotel in Curzon Street. In addition, the front hall and main hall of the hotel were employed for exhibitors' stands. Practically all the firms at the fair had a stand on the ground floor, plus one or two demonstration rooms.

The popularity of the London Fair was well exemplified by the very large number of people who attended. Indeed, on the Saturday afternoon (the fair was held on Friday, 13th April to Sunday, 15th April) it was necessary to keep some people outside the hotel until a sufficient number inside had left. This was a wise move on the part of the organisers because, despite the inconvenience to those waiting outside, it prevented too heavy a crush in the show itself.

The Exhibits

It would be difficult to try and categorise the various exhibits demonstrated, as all were in more or less the same field. It would also be fruitless to comment on the standards of workmanship, design and performance obtained, as comparisons here would be out of place. Suffice it to say that everything shown was very good, and that some things were excellent indeed. So far as this report is concerned, it would be best to deal with exhibitors in alphabetical order. If some firms have been omitted, this is only due to the lack of space available here.

Acoustical

The Acoustical Manufacturing Co. make a good "first" on any audio list, as this is the firm which has produced the well-known Quad II amplifier. The Quad has been the subject of considerable discussion in audio circles, and was used in recent comparisons of live and recorded music at Carnegie Hall. For the Fair, Acoustical exhibited an electrostatic loudspeaker employing the principles recently discussed in *Wireless World*. This speaker incorporates its own polarising supply.

Armstrong Wireless and Television, who specialise in custom-built chassis, were exhibiting their A.10 amplifier; this having been originally introduced a year or so ago. The A.10 is a fully tropicalised job which, amongst other things, can work in conjunction with the firm's f.m. tuner type 56. Armstrong also supply the "Sonix-gram," a complete cabinet-housed high-fidelity system with chairside control.

Dynatron Radio Ltd. have a high reputation for individual and well-engineered designs. At the show they exhibited their f.m. tuner type FM1. This is a seven-valve receiver which has the attractive feature of pre-set tuning. The station selector switch spindle passes through the surface of the chassis at right angles. Dynatron also make a hi-fi amplifier (LF10) together with a tone control unit (TC10) and an a.m./f.m. tuner (T10). The f.m. tuner, amplifier and tone control unit can be obtained in a complete radiogram assembly called the "Windsor."

E.M.I. need no introduction here, as their contributions to the hi-fi world have been appreciated for many years. In addition to their normal 78 and 33⅓ r.p.m. records, this company is making single channel tape records and twin-channel "Stereophonic" tape records (both 7½in/sec.). The Stereophonic tapes pass through a twin head, and the two separate recordings are reproduced via two separate loudspeakers spaced some distance away from each other. The two recordings on the tape were originally recorded, of course, with separate microphones similarly positioned. E.M.I. have also introduced a new tape (type 99) on a PVC backing. The thinness of this backing enables more tape to be stored on a standard reel.

The Garrard Engineering and Manufacturing Co. specialise in high-fidelity pick-ups, gramophone motors and changers. One of their products, the BA1.45 r.p.m. Single Record Player is intended to be powered from batteries for use in transistor record players. Consumption from the battery is only ¼ watt. In addition to a wide range of electric motors, Garrard also showed their Model 24 motor, this meeting a particular need insofar as it is spring-wound. The Model 24 has three speeds.

The "Presence Unit" type BCS 1852 is a high frequency unit which has now been introduced by G.E.C. especially for use with their metal cone loudspeakers. The unit has been designed to screw into the centre of the BCS 1851 metal cone loudspeaker, the Bakelite insert in the latter being removed for this purpose. This ingenious combination of two speakers is further simplified by careful design, the impedance of the presence unit being such that a cross-over network requires only a series 10 μF condenser. Also shown were the home-constructor "912" amplifier, plus manufactured amplifiers for 12 and 25 watts output.

"Axiom" and "Audiom" are the names employed by Goodmans Industries for their loudspeakers. Goodmans Industries also make an exclusive Acoustical Resistance Unit. This provides a means of reducing the overall size of an enclosure whilst retaining the same bass response.

Grampian

Grampian Reproducers are manufacturers of loudspeakers, amplifiers, microphones and recording equipment; a large proportion of their output being placed on the export market. Grampian cutter-heads are used by the B.B.C. and by broadcast and recording companies throughout the world. Their 1255/15 speaker was exhibited at the Fair, this having a duralumin voice coil former, and a voice coil wound by special methods.

One of the engineers in the Grundig demonstration rooms went especially out of his way to assist the writer in preparing his copy. Grundig were exhibiting their TK820/3D "Specialist" recorder, this having a response of 40–14,000 c/s at 7½in/sec. The TK820/3D is a high fidelity instrument, and was demonstrated as such with its own internal speaker. One of the secrets behind the Grundig performance is the gap width of the head, this being quoted as 7 microns only.

His Master's Voice attracted large crowds with demonstrations of their "Stereosonic" reproducer. This employs the E.M.I. twin-track tapes mentioned previously.

Mr. H. J. Leak is now back from America and Canada where his equipment has been selling very well against strong local competition. The Leak "Point-One" series needs no further description here, although some readers may be unfamiliar with the new Leak "Trough-Line" f.m. tuner. This employs a Seeley-Foster, instead of a ratio, discriminator, and the oscillator is tuned by a "trough-line" arrangement, rather similar to Lecher wires. Tuning drift is kept, by this device, to less than 10 kc/s from the instant of switching on. The tuning indicator functions from the d.c. voltage on the discriminator load. H. J. Leak and Co. will shortly be marketing an electrostatic speaker.

The Lowther Manufacturing Co. exhibited their loudspeaker units and amplifiers, and Lustraphone demonstrated their microphones, transformers and accessories. A full transistorised power amplifier is a new Lustraphone product.

Mullard high-fidelity amplifiers for the home constructor have been built by many amateurs, and this magazine has assisted in providing constructional details of Mullard laboratory designs. Mullard showed, in addition to their amplifiers, many of their products in the valve and semi-conductor fields.

Pamphonic have introduced a quote-worthy term to the amplifier sphere, this being "Ab-Fi" (Absolute Fidelity). Pamphonic now have available a compact 10 watt amplifier designed for domestic use which is housed in a very stylish cabinet (type 1003). Their 1002/1002A 25 watt amplifier is claimed to be flat from 2 to over 100,000 c/s, with hum and noise 90dB down, and a total harmonic distortion of 0.05% at 15 watts (1,000 c/s).

Plessey

Plessey are in the high-fidelity market and, in addition to a conventional range of audio equipment, have now introduced an Ionophone loudspeaker. The Ionophone principle has been discussed for quite a few years in audio circles, and has been the subject of much imaginative development work. The basic principle consists of ionising air in a cylinder, closed at one end, by means of r.f. at a high voltage. This r.f. is modulated by audio, whereupon the glow discharge in the cylinder varies at a.f. Sympathetic air pressures are then set up which may be applied to a loading horn. The device has attracted engineers owing to its inherent simplicity: there are no moving parts whatever and the loading applied to the drive circuit is constant, irrespective of audio frequency. Indeed, the only limitation to the audio range available is that imposed by the horn itself; and the dimensions of this can be calculated from well-established formulae. The Plessey Ionophone should be in production by the time of the Radio Show.

The Pye "Black Box" is, nowadays, a familiar piece of equipment, but it represents only a small proportion of Pye high-fidelity products. This company has now introduced a wide range of amplifiers and loudspeaker systems. Some of these are capable of being fitted into existing radiogram cabinets by "do-it-yourself" enthusiasts.

R.C.A. Photophone have been making hi-fi news with their new products over the last few years. In addition to good performance, R.C.A. Photophone believes also in good cabinet design, and seems to pay much more attention to attractive styling than do some other firms. This company has introduced a new 8-pole variable reluctance pick-up head, in which all electrical connections are encapsulated in polystyrene.

Another stereophonic reproducer, designed for the E.M.I. twin-track records, is made by Specto Ltd. This reproducer, for which sample export orders have already been met, is now in full production. Truvox demonstrated their new tape recorder to advantage (*cf.* the R.E.C.M.F. report in this issue); the speaker system being that housed in the recorder itself.

Wharfedale Wireless Works are well known, not only for their products but also for their association with Mr. G. A. Briggs, who has helped so much to introduce hi-fi equipment to the general public. Wharfedale were exhibiting their Super 3 Two-Speaker system, which enables a full frequency response to be obtained in a remarkably small enclosure.

Wright and Weaire have specialised in tape recording for many years. Their Tape Deck has, indeed, become a "standard." Wright and Weaire "Ferrograph" products shown at the Fair included two tape recorders designed especially for portable use.

The Future

Thus was introduced the first London Audio Fair. Its organisers are to be congratulated for their imaginative outlook; and there is little reason to doubt that both home and export high-fidelity markets will have benefited accordingly. The London Audio Fair now becomes an exhibition to be anticipated eagerly each year by all who appreciate high quality reproduction.

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A Constructor at the 1956 R.E.C.M.F. EXHIBITION

FOR SOME YEARS NOW IT HAS BEEN POSSIBLE to direct strangers to the R.E.C.M.F. Exhibition by the simple device of telling them to start at Marble Arch and walk against the stream of people carrying Ersin Multicore wallets. This year proved to be no exception, and the prominent red Multicore folders added their colour to the cheerful spring scene in Park Lane during the three days on which the R.E.C.M.F. Exhibition was held.

The 13th private exhibition of the Radio and Electronic Component Manufacturers' Federation took place in the Great Hall of Grosvenor House on April 10th, 11th and 12th, and was once more a scene of bustling activity. The necessity of moving the exhibition to a larger hall becomes more evident every year, and one cannot help but sympathise with the staff on the stands who have to deal with a continual barrage of questions under very cramped and crowded conditions.

Despite this, the Radio Component Show—to give it its short title—was up to its usual standard, and gave evidence once more of the high quality to be found in British components and radio equipment.

Export figures for British components reflect this quality. To take an example, direct exports of components and sound reproduction products in 1955 had a monetary value greater than £13 million, this being an increase on 1954 of 23%. One large market was provided by the U.S.A. (£900,000), who were also the largest purchasers of sound reproduction products.

Trends

So far as new developments were concerned, this was a fairly quiet show. The changes introduced by such things as Band III and FM have now become established, and manufacturers appeared to be concentrating more strongly on increasing and improving the reliability and performance of their existing products. If there was a significant trend at the exhibition, it was probably that towards miniaturisation.

In this particular field the battery manufacturers showed some new and interesting developments. Ever-Ready were well to the fore with a comprehensive range of dry batteries, this extending from large batteries for radio and photoflash equipment to tiny miniatures for valve and transistor hearing aids. Mallory exhibited their mercury cells, these having the advantages of low cubic capacity and weight. A 1.34 volt Mallory mercury cell, shortly to be introduced, has a diameter of 0.45in and a height of 0.125in only. This is the type R.M. 400, and its weight will be 0.04oz.

Batteries as small as this deserve equally small components and circuit assemblies. Typical of these were the components and amplifiers shown by Fortiphone, the former including several miniature transistor a.f. coupling transformers, and the latter a complete encapsulated a.f. amplifier using transistors. Lustraphone, who manufacture microphones and accessories, are in the miniature field with a tiny electro-magnetic microphone (type E.M. 6.2). This has been designed for deaf-aid and similar applications and employs a new principle of operation.

Transistors were well in evidence elsewhere, being exhibited by Mullard, Standard Telephones and G.E.C. Mullard showed also the photo-transistor type OCP71; this component changing from a partially conducting to a fully conducting state whenever light falls upon it. With this photo-transistor it is possible to operate a relay directly, without the necessity for amplifying valves or similar devices; and the consequent circuitry involved is extremely simple. The OCP71 may be featured shortly in this magazine. Included in the Standard Telephone transistors, incidentally, were the TS1, TS2 and TS3 range, as specified for the "Transistorette" receiver.

Other transistor amplifier applications were also to be seen. Lustraphone showed a fully transistorised power amplifier suitable for a record player, and Fortiphone a four-transistor hearing-aid amplifier fitted into the side arms of a pair of spectacles. The problem of obtaining maximum audio output from transistor a.f. stages is eased considerably by the introduction of a specially designed loudspeaker by Plessey. This has a centre-tapped voice coil, thus enabling push-pull transistor output stages to be connected directly to the speaker without the necessity of an output transformer at all.

Printed Circuits

Printed circuits are now, of course, here to stay, and development appears to be following two parallel paths; these consisting of work on the circuit boards themselves and on the components designed to be mounted on them.

T.C.C. exhibited a large range of printed circuit assemblies, these including a complete television "front end" (incorporating a tuner for Band I and Band III reception), an f.m. tuner, and transistor panel units for use in electronic computers.

Valveholders for printed circuit work were available from McMurdo. These were in B7G, B8A and B9A sizes, had "pen-nib" contacts for ease of dip-soldering, and could be supplied with skirts, if desired, for screening cans. Egen Electric showed resistors especially designed for printed circuit panels, whilst an extensive range of printed circuit components of all types was to be seen on the Plessey stand.

In the printed circuit sphere it would appear that steady progress over the last year is evident, but that no startlingly new techniques have been evolved.

Tools and "Hardware"

A firm which has gone to considerable lengths to make the lot of the service and production engineer easier is the Spear Engineering Co. (Warlingham, Surrey). In addition to the manufacture of components, this company makes tools which are especially applicable to the radio industry. These tools include screening can and valve extracting tools for valves of varying sizes, a complete set of trimming tools (capable, incidentally, of tackling those "awkward" trimmers used by some manufacturers), a control knob remover which enables spring-mounted knobs to be pulled safely without scratching the cabinet, and what is described as "The Trigga-Snip." This latter tool not only cuts wires, it holds them afterwards as well. It appears to work on a nibbling principle. The device has a pistol grip from which protrudes a rod some six inches long, the cutting action being incorporated in the end. The rod can pass through a quarter-inch hole and should be ideal for nosing into a crowded chassis. The really imaginative design and manufacture of tools of this type for the use of radio engineers is a trend that deserves to be warmly commended.

The "Bib" wire cutter is by now a well-known radio and electrical worker's tool, and it affords a good introduction to its manufacturer, Multicore Solders. Also exhibited by this firm were their established "Bib" recording tape slicer, together with an extensive range of solders. A new solder displayed at the Show is the Ersin "Savbit" alloy. This is a five-core solder and contains a small percentage of copper. It is claimed that the new solder can increase the useful life of a soldering bit by 10 times. "Savbit" alloy is covered by patent, and is already being made in 14, 16 and 18 s.w.g. Its melting point is approximately equal to that of conventional 60/40 solder, and its cost appears to be less.

Enthoven Solders exhibited an interesting new development, this being a solder which can be applied to aluminium. The tinning of a sample strip of aluminium was effectively demonstrated on the stand, the writer being given to understand verbally that the solder functioned best with commercial-grade aluminium, i.e. with metal that has slight impurities. The solder had a special flux, and this flux could be obtained separately, if desired, in paste or liquid form. For the stand demonstration a conventional soldering iron was employed. The cored aluminium solder has the type number AS20.

Other exhibits in the "hardware" line were represented by the very large number of metal, ferrite and plastic parts to be seen. Magnets and laminations fall into the "metal" category, but there was little here that was new. In the ferrite department, Salford Electrical Instruments (associated with G.E.C.) showed a range of cores made with "Gecalloy." One of the Plessey core materials is "Caslam," and this was employed in many applications, these ranging from coil cores to deflector coil rings. Mullard "Ferroxcube" was also in evidence, the new "Ferroxcube" beads being of particular interest. These beads, threaded on to a straight piece of wire, increase its inductance by a sufficient amount to make it act as a choke at v.h.f. The beads may, therefore, be threaded on to the heater and h.t. wiring of v.h.f. equipment to replace more costly wound chokes.

The plastics side of radio is now assuming such large proportions that the two sciences are practically inseparable. Here again, no startlingly new developments were to be seen, but the sure and steady progress over the last few years is very evident. An interesting departure was shown on the Belling Lee stand, this consisting of the flexible terminal blocks made by this firm. The insulating material is PVC, and the terminal blocks can be bent around any desired contour. This particular development well illustrates the wide field and variety now evident in radio plastics.

Encapsulating techniques were also shown, these mainly employing the epoxy resin, "Araldite," manufactured by Aero Research Ltd. Encapsulated assemblies enclose an entire circuit in a block of resin or similar material, the only connections being given by lead-out wires from the block. Once encapsulated, all components are virtually immune from physical damage and humidity.

Television

There was not a great deal new this year in the field of television. However, a number of 90 degree picture tubes were of interest; and it is probable that they will make their appearance in manufactured television sets before the next six months are out. A reflection on the present Government policy of hitting home-market TV is illustrated by a new Edison-Swan tube. This is the CRM93, and it has a nine-inch screen, plus all the latest developments to be found in larger tubes. Originally developed for portable TV, it is thought that it might now also be welcomed in receivers designed to reduce the hire-purchase deposit. (No comment from this writer.)

A smart-looking little "Table-top" Band III aerial was shown by Wolsey. This is their "Hi-Q" model, and is intended for use within a range of 10–15 miles from the Band III transmitter. The aerial is mounted on a rotatable base, with a cross-over network to take the existing Band I aerial, should this be desired. A lead from the "Hi-Q" may then be used to connect to the receiver aerial socket. The design is rather like that of a single loop, and a front-to-back ratio of 6 db is quoted.

Assemblies

Complete assemblies and instruments seemed to be rather more numerous this year than has previously been the case.

As an example of what was to be seen, Truvox were announcing a new tape-recorder, type R1; this being scheduled for release in mid-July. The R1 is a complete unit. Also to be seen on the Truvox stand was an adaptor for recording telephone messages.

Advance Components exhibited their range of test equipment, this including a.m./f.m. signal generators especially designed to meet the new requirements of servicing sound and television v.h.f. receivers. Advance also showed their new "Q" meter. The writer understands that this instrument represents an improvement on existing "Q" meter practice, insofar as the r.f. injected into the coil under test is modulated. It is the *modulation*, and not the r.f., which is then read by the "Q" meter valve voltmeter. Avo also have new equipment available to meet present-day requirements. A particularly interesting item is their a.m./f.m. signal generator type TFM, this being especially useful for television and f.m. work. A new, moderately priced, Avo instrument is the a.m. signal generator type III, this covering 150 kc/s to 220 Mc/s on fundamentals.

(*continued on page 664*)

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The Moving Coil Meter

by DAVID A. MORRIS

THE MOVING COIL METER IS THE MOST common type of meter in use for measuring d.c., and at some time or another every radio experimenter will have found it necessary to use one. But I wonder how many readers have ever bothered to look up the theory of operation of such a meter? Very few, I'm sure! The purpose of this article is to give readers a brief account of the construction, design, theory and modifications of the moving coil meter.

Form

Briefly, the instrument consists of a small rectangular coil having a large number of turns of fine wire, uniformly wound upon a light aluminium former. This former is pivotted on jewelled bearings, and swings between the pole pieces of a strong permanent magnet. The pole pieces are cut so that they form a hollow cylinder around the coil. There is also a fixed cylinder of soft iron within the coil.

Attached to the pivots are two flat springs which exert a couple which acts against that of the deflecting current. When the current is switched off these springs return the coil to its original position. The springs have an additional function of carrying the current from the terminals to the two ends of the coil.

A light aluminium scale-pointer, a uniformly divided scale, and an outer protective case complete the meter (see Fig. 1).

Theory of the Instrument

Imagine our coil to consist of n turns on a former 1 cms. long and b cms. wide. If the field strength of the magnet is H oersteds, and the current to be measured is i amperes, then there will be a turning force of $Hiln$ on each side of the coil, holding it an angle of $\theta°$ to its original position (see Fig. 2).

Thus the moments of the forces about the axis of the pivot

$$= H\,i\,l\,b\,n.\ \cos\theta$$
$$= H\,i\,A\,n.\ \cos\theta \quad (\text{where } A = l \times b = \text{area of coil}).$$

In practice, however, the presence of a soft iron core and the shape of the pole pieces ensures that the field is radial, and so, whatever the angle of deflection, the plane of the coil is always parallel to the field.

Thus, our expression becomes: $H\,i\,A\,n$.

The coil comes to rest when the above turning couple is equal to the opposing couple due to the springs (or $c\theta$, where c is the controlling couple per unit deflection).

Thus,

$$c\theta = H\,i\,A\,n$$

or

$$i = \frac{c}{H\,A\,n}\theta$$

i is therefore equal to $K\theta$, where θ is the scale deflection and K is a constant depending upon the dimensions of the coil, field strength of the magnet and the torque supplied by the springs. The current is therefore proportional to the angle of deflection, and when a meter is calibrated against a standard, it will have a uniform scale.

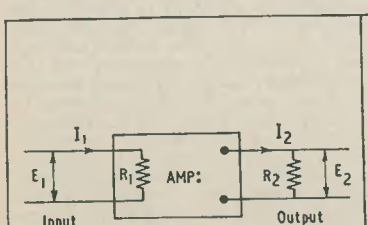

FIG.1.

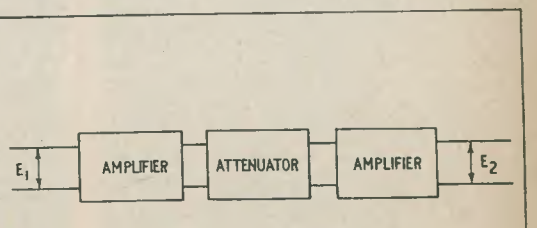

FIG.2.

G168

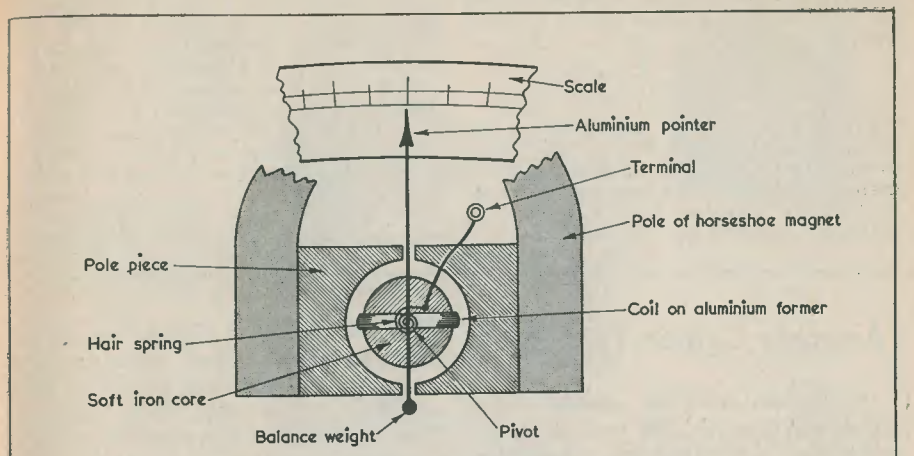

FIG.1. DIAGRAMATIC ARRANGEMENT OF METER

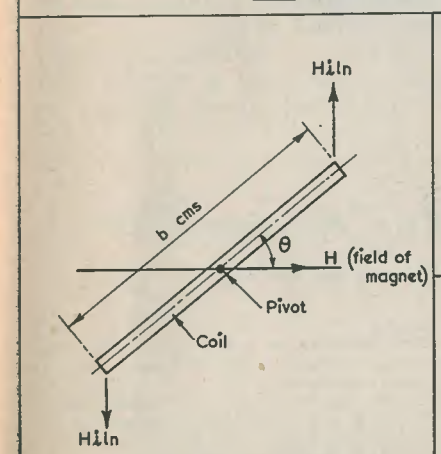

FIG.2. THEORETICAL DIAGRAM SHOWING DIRECTION OF FORCES (plan view)

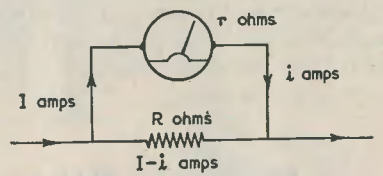

FIG.3(a). AMMETER (for theory see text)

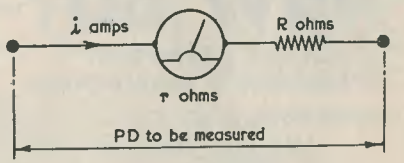

FIG.3(b) VOLTMETER

G166

Design of a Moving Coil Meter

A number of points must be considered when designing a meter. A meter for general use must be sensitive, easy to read, accurate and robust. A well designed meter provides all these points to a certain degree, hence its popularity for measuring d.c.

The sensitivity is given by θ/i, in other words, the angle of deflection for unit current. As $\theta/i = HAn/c$, the field strength of the magnet and the size of the coil have to be made as large as possible, without becoming too cumbersome.

The meter also has to be "damped" so that the coil comes to rest quickly, without oscillating across the required reading before it does finally stop moving. Electrical damping is usually provided by the eddy-currents induced in the metal coil former.

Finally, here are a few points of interest concerning the various ways in which the meter is used.

As an ammeter, the m.c. meter has to be wired in parallel with a resistance. The value of this resistance will depend upon the maximum current to be measured. If

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you know the internal resistance of a meter, it can be used for different ranges by "shunting" with a resistance whose value is obtained from the equation

$$R = \frac{r \times i}{I - i}$$

where R is the required resistance, r is the resistance of the meter, I is the new maximum current, and i is the original maximum current for which the meter was designed. Multi-range ammeters have a number of switched resistances (see Fig. 3a).

As a voltmeter, the moving coil meter is used in series with a high value resistance. In this case the formula is $V = i\ (rÆR)$. V is the p.d. to be measured, i is the current required to give a full-scale deflection, r and R are the resistances of the meter and the required resistor respectively (see Fig. 3b).

A last word of advice—remember that your meter is a valuable friend and should be treasured as such! With careful handling it will remain accurate for years; however, if it is given rough treatment the meter will soon become insensitive.

Amateur Colour Television

On Saturday April 8th, amateur colour t.v. signals were sent and received for the first time. G3CVO/T, near Chelmsford, received very clear colour bars and patterns from G2WJ/T at Dunmow. The colour equipment was built by Mr. C. G. Dixon of Ross-on-Wye, and runs at 150 lines, 100 fields per sec sequentially scanned, giving 33⅓ complete colour pictures per second. Both monochrome and colour receivers were used, and at the flick of a switch either colour bars or the G2WJ "studio" was seen. This is the first time that colour t.v. has been transmitted by amateurs anywhere.

Vision frequency 436 Mc/s, sound 145.7 Mc/s. Distance 13 miles.

There are now 21 /T stations in the U.K., and the DX record is 38 miles between G2DUS/T (Baldock) and G3KKD/T (Ely).

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R.E.C.M.F. Exhibition

(*continued from page 661*)

Gadgets

An exhibition is not a real show without working "gadgets," but these were rather disappointingly absent this year. Nevertheless, Plannair, manufacturers of blowers, gave a convincing and eye-catching demonstration of weights being blown up glass cylinders under the pressure of normal air blowers.

Probably the most interesting working model was exhibited by the United Insulator Co. Ltd., who, amongst other things, make ceramics and piezo-electric devices. Their exhibit incorporated a miniature "water-wheel," the outer edges of whose vanes just entered the surface of apparently placid water in a glass bowl. Despite this, the "water-wheel" rotated. The "drive" for the wheel was given by a small piezo-electric transducer immersed in the water about a foot or so away. This transducer agitated the water at a frequency of 3 Mc/s with a power of 30 watts. Whilst the writer discussed the device with an engineer on the stand, the engineer put his hand into the water to dispel a few small bubbles that had formed on the surface. Bubbles apparently reduce the efficiency of water as a supersonic power-conducting medium quite noticeably, since, without them, the "water-wheel" rotated nearly twice as quickly!

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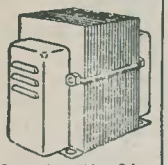

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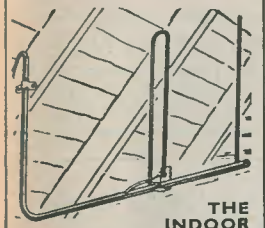
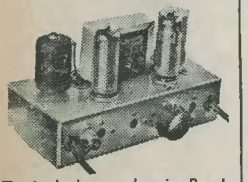
BAND III AERIAL



THE INDOOR

This is a ½ wave, 3 element array. Of all-alloy construction, the aerial is completely assembled and ready for instant mounting in loft, bedroom cupboard, window frame, etc. Price 12/6 plus 2/–

THE "ESTRONIC" BAND III CONVERTER



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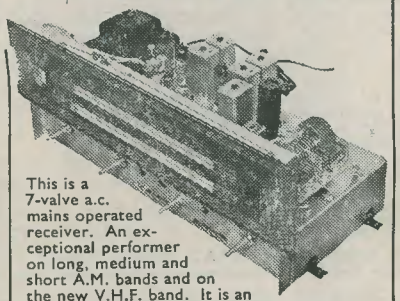
A 4-valve truly portable set with very many good features as follows: Ferrite rod aerials, low consumption valves, superhet circuit with AVC, ready built and aligned chassis if required, beautiful two-tone cabinet covered with I.C.I. Rexine and Tygan, guaranteed results on long and medium waves anywhere. All parts, including speaker and cabinet, are available separately, or if all ordered together the price is £7 . 15 . 0 complete, ready built chassis 30/– extra. Instruction booklet free with parts or available separately price 1/6.

AM/FM RADIOGRAM CHASSIS



This is a 7-valve a.c. mains operated receiver. An exceptional performer on long, medium and short A.M. bands and on the new V.H.F. band. It is an ideal unit for a quality radiogram. Special features include magic eye tuning indicator, extra long scale and pointer travel —latest circuitry employing full a.v.c. feedback, etc., etc.

Undoubtedly one of the finest AM/FM chassis available to-day. Chassis size 17¼" x 6¼" x 7¼". Price £23 . 17 . 6, carriage, packing and insurance 20/– extra

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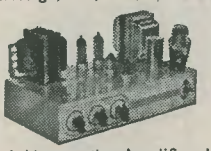
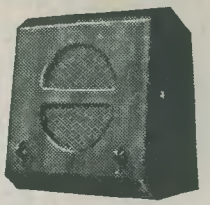


MULLARD AMPLIFIER "510"

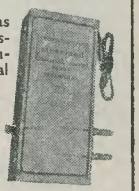
A high quality Amplifier designed by Mullard engineers with a power output exceeding 10 watts. The price of the unit completely made up and ready to work is £12 . 10 . 0 plus 10/– carriage and insurance.

OFFICE INTERCOM



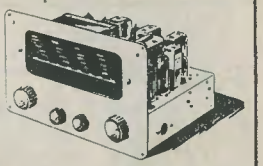
This is a very special offer of a master (two-station) unit using push-pull circuitry, operated from A.C. mains, and is complete in polished cabinet. Price only £4 . 19 . 6. Sub-stations 17/6 each

BAND III PRE-AMP



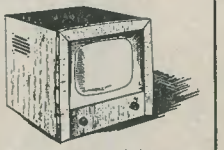
In difficult areas it will be necessary to increase the signal level and this is the ideal unit for this purpose. It is A.C. mains operated and is fitted with input and output coax. plug. Price £4, post and packing 3/6

THE ARGONAUT AM/FM



All parts are available and total cost is only £14 . 10 . 0 which includes drilled metal chassis and nine valves

—THIS MONTH'S SNIP—



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5Z4G	8/6	6L6G	9/6	DL94	7/6	EF92	4/9
6AG5	6/9	6Q7GT	8/6	DK92	7/6	EK32	8/6
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6F6G	8/–	58	7/6	ECL80	10/6	PCC84	11/6
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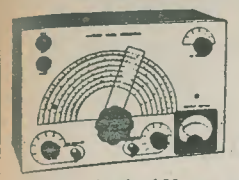

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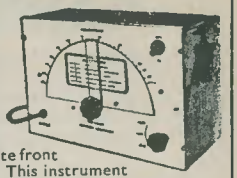

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(continued on page 671)

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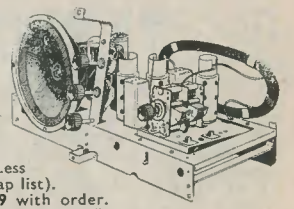

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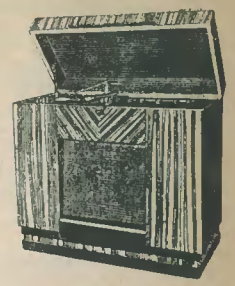

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(continued from page 669)

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(continued on page 672)

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(continued from page 671)

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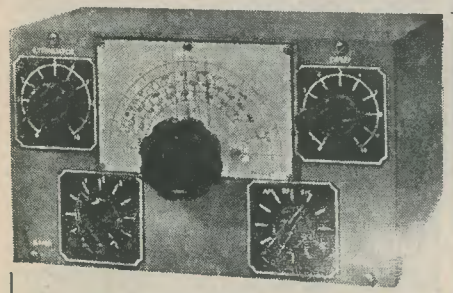

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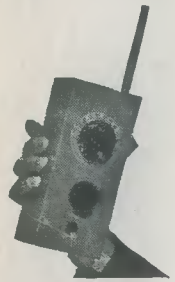

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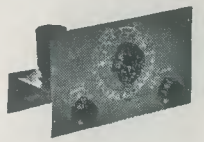

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