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MARCH
1957

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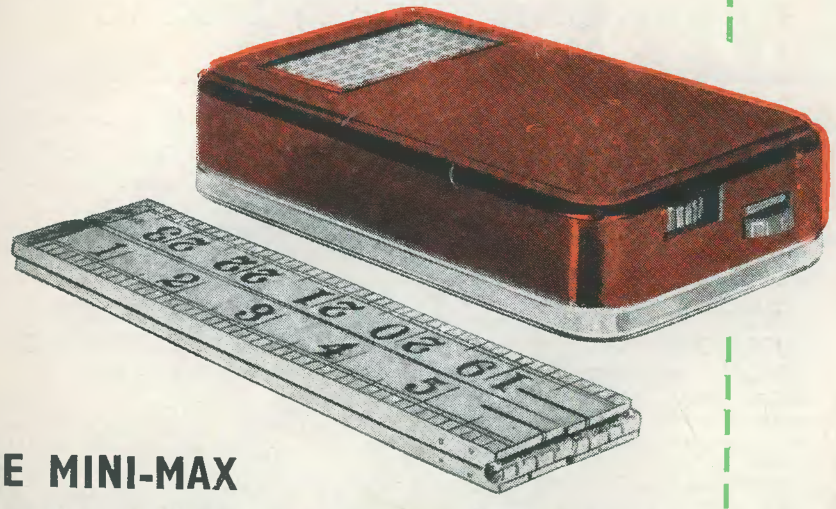

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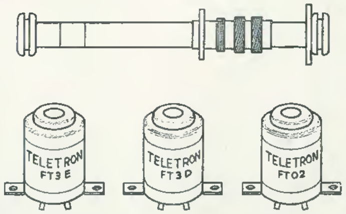

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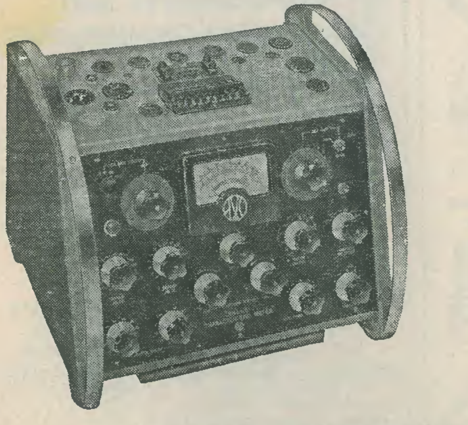

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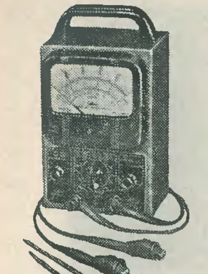

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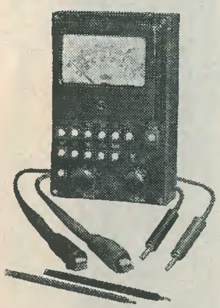

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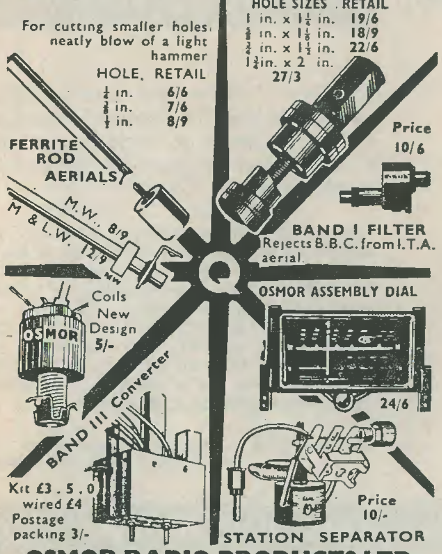

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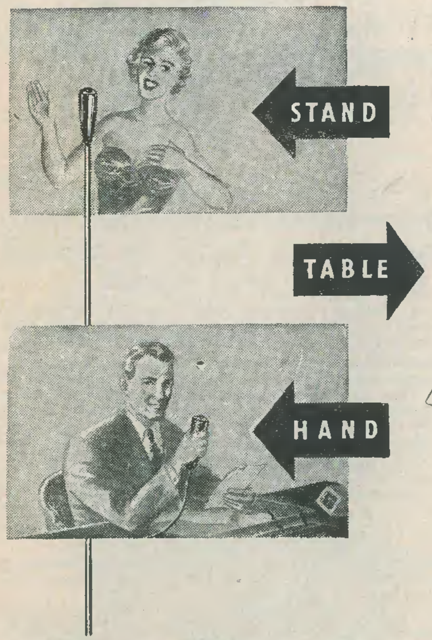

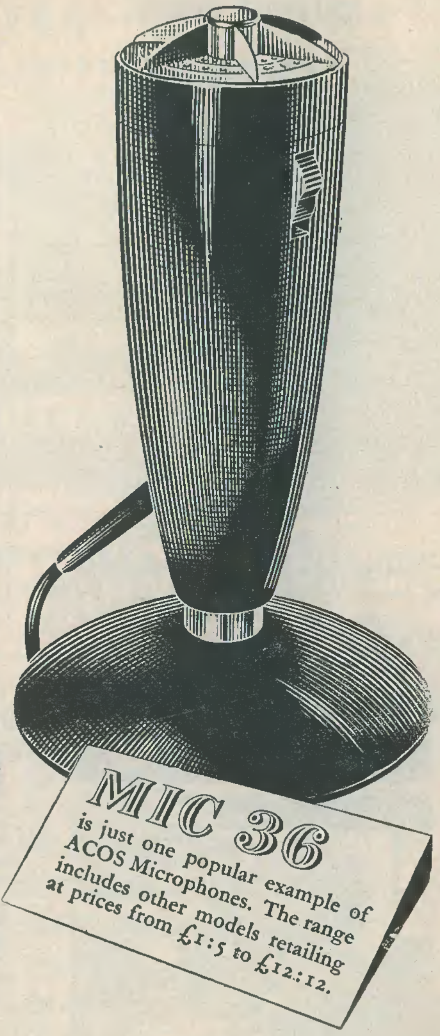

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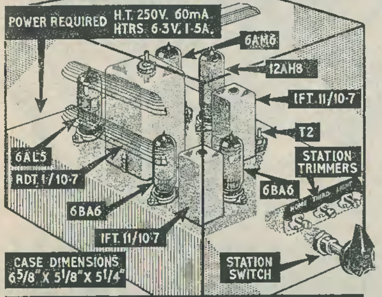

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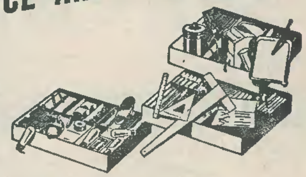

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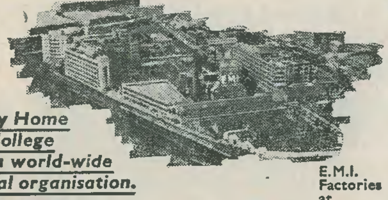

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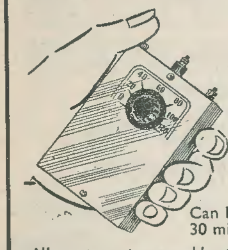

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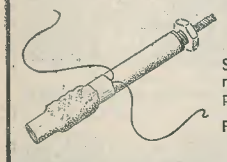

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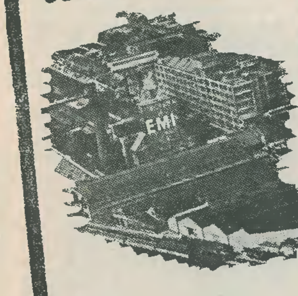

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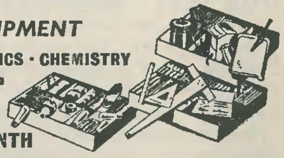

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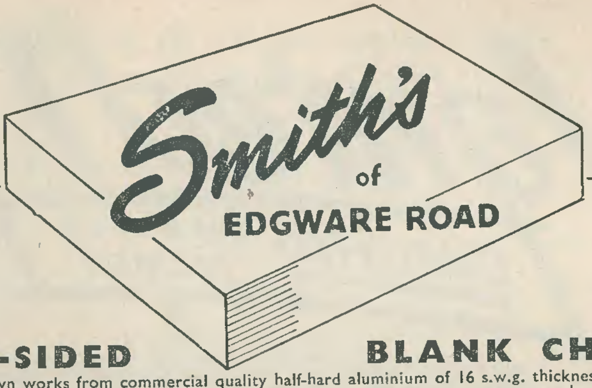

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9 x 7 x 2	6/6	12 x 7 x 2½	8/–	14 x 7 x 3	9/6	17 x 9 x 3	11/6
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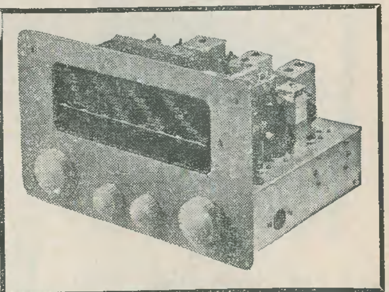

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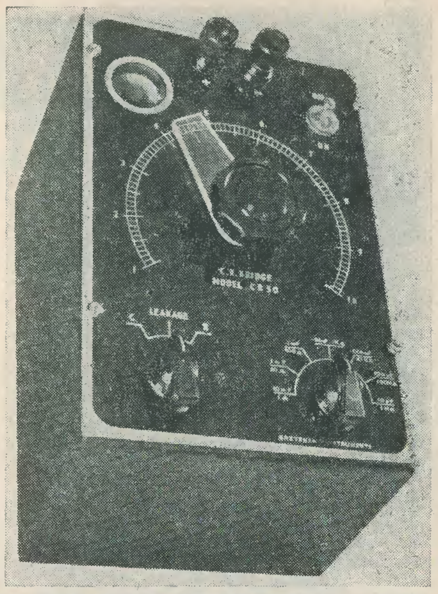

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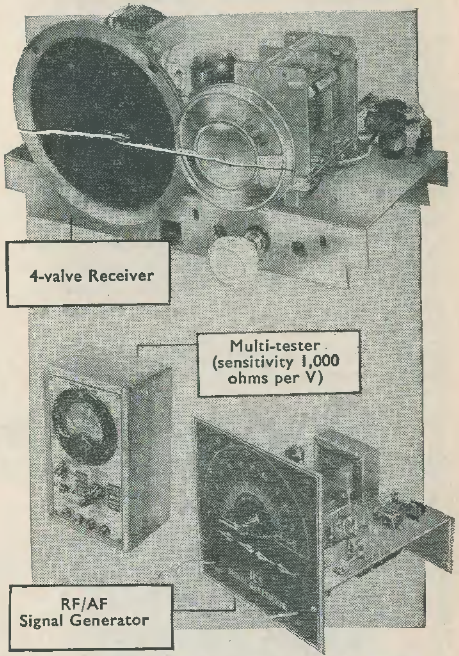

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NOTICES

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

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

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

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

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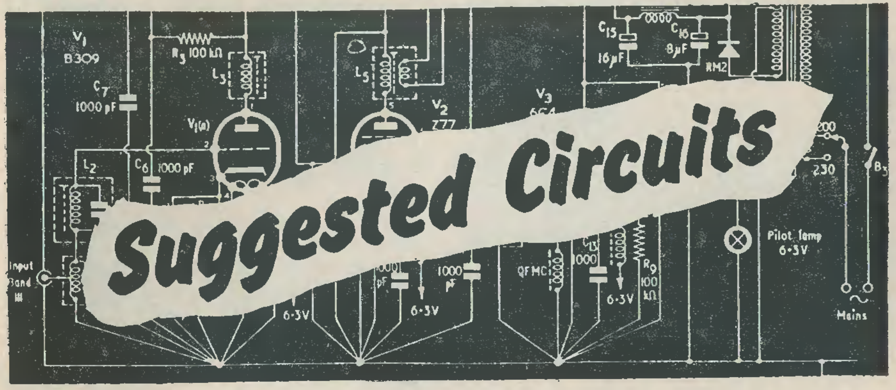


Suggested Circuits

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

No. 76. A SIMPLE REMOTE CONTROL DEVICE EMPLOYING EXISTING SPEAKER LEADS

THE WRITER HAS RECENTLY RECEIVED several letters from readers who, whilst remaining complimentary in general, have had a minor complaint to make. This complaint has been that, over the past few years, the circuits offered for the experimenter in these columns have suffered from a tendency to become rather "highbrow." The correspondents concerned have stated that the beginner should be kept just as much in mind as the more advanced constructor.

The writer has given some thought to this argument and will in consequence endeavour to present, every now and again, devices employing fairly simple principles in future "Suggested Circuits." (It is, of course, possible that other readers may then complain that the articles are becoming too elementary!)

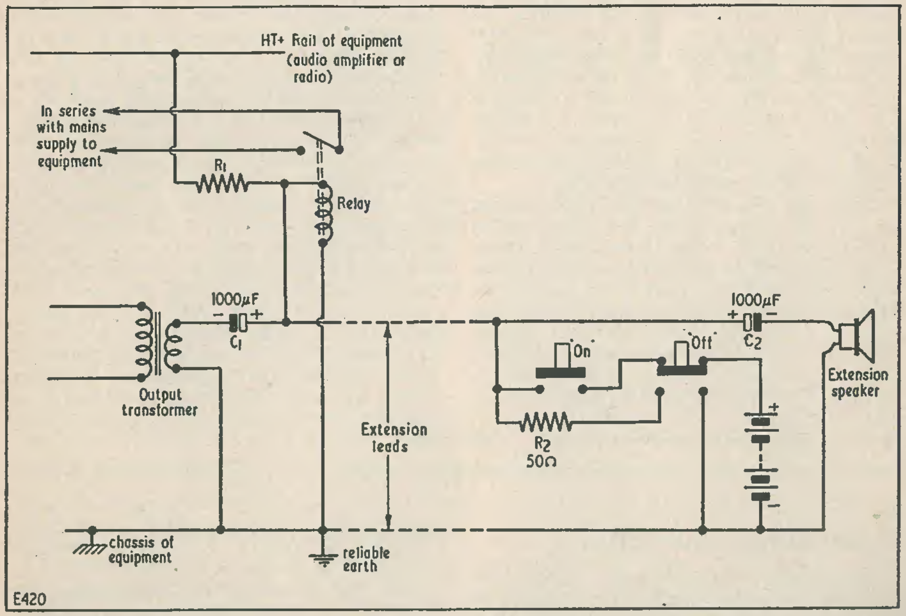
This Month's Circuit

This month's circuit is one which, it may be safely stated, falls well within the simpler class, insofar that no special equipment is required for its construction and because the principles involved in its operation are easy to visualise. No new techniques are involved in its design, and the circuit takes advantage of several known factors to produce a device which should prove to be extremely useful in its own particular application.

The circuit is that of a remote control system which is capable of switching electronic equipment on or off from a distance with the minimum of interconnecting wires. In the particular circuit discussed here it is assumed that the equipment under control is a radio receiver or an a.f. amplifier, whereupon the remote control facility is obtained over the same pair of leads that feed the remote loudspeaker. No other interconnecting wires are needed. It must be pointed out that the circuit is not recommended for use with equipment having "live" chassis unless some form of mains isolating transformer is fitted. This is because such equipment can cause the remote control wiring to attain the same potential as that of the mains supply, with consequent risk of shock. However, for a.c. equipment employing a mains transformer, functioning should be safe and reliable.

In order to obtain a switching facility over the existing loudspeaker wiring, the circuit takes advantage of the fact that it is possible to connect a condenser of some 500µF in series with the low impedance wiring to an extension loudspeaker without incurring any noticeable loss in quality of reproduction, or undue attenuation of bass frequencies. The insertion of such a condenser may not recommend itself in high fidelity applications (using the term in its undebased sense). For normal domestic reproduction, nevertheless, the effect is negligible.

In this month's circuit, a capacity of 500µF is inserted in series with the leads to the extension loudspeaker in the form of two 1,000µF condensers connected in series. One of these condensers is fitted at the equipment end of the interconnecting wires, and the other at the loudspeaker end. The presence of the condensers then enables a d.c. control voltage to be passed along the speaker lines without upsetting a.f. operation.



Functioning

The complete circuit is shown in the diagram which accompanies this article, and its functioning may be described as follows. Let us assume that the controlled equipment is switched off and that the operator is at the remote, loudspeaker, end of the interconnecting lines. The operator presses the "On" button, thereby causing the battery at the remote station to energise the relay at the equipment. Current from the battery does not flow through the loudspeaker or the secondary of the loudspeaker transformer due to the presence of the two condensers C_1 and C_2. It will be noted that the polarity of the battery corresponds to that of the two condensers, with the result that the latter are not subjected to incorrect usage.

When the relay energises, its contacts complete the power circuit to the equipment being controlled, this becoming switched on in consequence. After a period (dependent on the type of rectifier employed) h.t. becomes available in the equipment, with the result that a voltage is applied to the relay coil via the series limiting resistor R_1. This energising voltage has the same polarity as that of the remote battery.

The "On" button at the remote station may now be released, whereupon the voltage obtained from the equipment h.t. supply maintains the relay in the energised condition. At the same time this voltage polarises the two electrolytic condensers C_1 and C_2, enabling them to function in correct manner.

When it is desired to switch off the equipment from the remote position, the "Off" button is depressed. This button effectively short-circuits the coil of the relay which then becomes de-energised, switching off the supply to the equipment. (The small-value resistor R_2 prevents the flow of excessive discharge current from C_1 and C_2.) The "Off" button needs to be depressed only for the short time needed for the h.t. voltage in the equipment to fall to a low value, after which it may be released. The equipment is now switched off and the circuit is ready for a further switching-on cycle, as desired.

Practical Points

As will be realised, the whole circuit is quite simple in theory, and should give positive and reliable results in practice. A slight disadvantage is introduced by the necessity of having a battery at the remote station, but as this is required to supply current only for the short period before h.t. appears in the controlled equipment, its useful life should be quite long. In order to make the circuit foolproof, additional contacts are added to the "Off" button, these "making" when it is released. The purpose of these contacts is to prevent the battery being short-circuited if both buttons are accidentally pressed at the same time.

It should be emphasised that care must be taken to ensure correct polarity throughout the wiring of the circuit. If, for instance, the battery is connected up with reversed polarity the circuit will not operate properly and the electrolytic condensers may suffer damage. Similar incorrect working would be given if the remote leads to the speaker became reversed. When plug and socket arrangements are used in the remote lines, these should be of the non-reversible type.

The relay employed in the circuit should have a high resistance coil, coil resistances of 2,000Ω or more being normally suitable. Such relays will usually operate with energising voltages around 9 volts or so, and can be maintained in the operated state by energising currents of several milliamps. The voltage needed to energise the relay will, of course, dictate the working voltage required for C_1 and C_2. The series resistor R_1 should have a value sufficiently low to enable the relay to hold on after it has been energised. This current will be lower than that needed to operate the relay and ensures minimum drain on the equipment h.t. supply. R_1 also limits the current drain from the h.t. supply when the "Off" button is pressed. Suitable P.O. type relays for the circuit are available in the surplus market. Although the contacts of such relays are rather light for switching mains voltages, they appear to cope quite adequately in practice. It would be advisable to mount the relay in such a manner that its yoke is isolated from the chassis of the controlled equipment. The earth connection illustrated in the diagram ensures that mains voltages may not find their way onto the remote control wiring. The relay should be employed for switching *a.c.* mains circuits only.

Two final points which need to be discussed concern the h.t. supply in the equipment being controlled. The first of these is that it should be ascertained, before using the circuit, whether the h.t. power supply circuits are capable of providing the few extra milliamps needed by the relay after it has been energised. In practice this precaution should cause little difficulty, as the extra loading involved is so low. The second point has to do with the delay between the remote "On" button being pressed and the appearance of h.t. in the controlled equipment. As will be realised, it is desirable to keep this delay to as low a figure as possible. If the equipment employs a metal h.t. rectifier, h.t. voltage will appear almost immediately after the relay has been energised; with the result that the "On" button needs to be pressed only for a very short while. When a directly-heated valve rectifier is used, a delay of some ten seconds may occur before the full h.t. voltage appears, this being not too excessive. With indirectly-heated rectifiers the delay will be longer (depending upon valve type) but, even here, it may not be longer than twenty seconds or so in some cases. It must be pointed out that, where equipment circuitry allows, the delay caused by an indirectly-heated rectifier can be reduced by replacing it with a directly-heated type.

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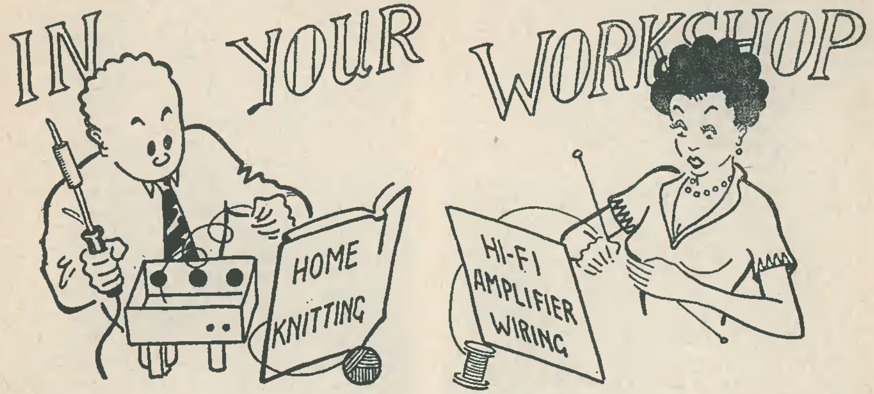

Smithy continues to run the Workshop, aided once more by his able assistant, Dick

"Ah, well, that's got another set finished!"

This remark, made with the evident self-satisfaction of a man who considers that by his own agency a job has been done well, emanated from Dick, Smithy's assistant in the Workshop. Dick looked with pride at the 12-channel television chassis on which he had been working, then proceeded to insert it into its cabinet. He fitted the last knob and tightened the last screw, after which he picked up the set preparatory to placing it on the shelf reserved for finished work.

"Hello!" remarked Smithy, who had been watching him out of the corner of his eye. "Aren't you forgetting something?"

"What's that?" asked Dick.

"Well, you know the rule we always have in this workshop. Never to let a set go until it has been finally checked in its box."

"Oh, that!" remarked Dick, a little impatiently. "I don't think it applies to a set like this. Surely sticking the chassis in the cabinet isn't going to make it faulty!"

"That may very probably be true," said Smithy quietly, "but you can't be absolutely certain till you've tried it."

Smithy returned to his work whilst Dick, rather unwillingly, connected the television set he had just repaired to the mains, plugged in an aerial feeder, and switched it on.

Sound On Vision

The workshop settled down quietly for the next ten minutes or so, the silence being broken only by the sound from Dick's receiver, as he checked its performance. After a while his face creased into a frown, this becoming fiercer and fiercer as time went on. Finally, he gave a rather self-conscious cough and walked over to Smithy.

"I'm Sorry, Smithy," he remarked contritely, "but I'm afraid you were perfectly right when you told me to check that set in its cabinet. It *has* got a fault now, and I'm not quite certain what to do about it."

"Not to worry," remarked Smithy soothingly, "that sort of thing happens to the best of us at times. What's the snag?"

"So far as I can see, it's sound on vision," replied Dick. "I'll show you."

Smithy followed Dick and examined the receiver. He noted that the set was tuned to a Band III channel, and that a musical programme was being reproduced. The louder notes of the programme caused heavy horizontal bars to run up or down the screen. Smithy checked the setting of the fine tuner, then varied the volume of the receiver. The bars became more noticeable as volume increased. It seemed apparent, also, that certain notes were causing more interference with the picture than were others. Smithy gave the side of the cabinet a light smack with the flat of his hand and was rewarded with a momentary succession of horizontal bars on the screen.

"Well," he remarked, "there's no denying that this is a case of sound on vision. Also it's almost certainly caused by a microphonic stage in the receiver; the oscillator stage being the most probable suspect. One reason why I'm certain that the trouble is caused by microphony is because it has only shown up since you put the set back in its cabinet. When the chassis was on the bench the sound waves from the speaker probably had very little effect on the chassis, whereas, with the set in its box, you have the speaker tightly coupled to whatever it is that is microphonic. Add to that the fact that the cabinet, like most television cabinets, is not far from being a perfect cube, and you have a nice resonant effect around several hundred cycles or so which makes dead certain that the trouble isn't likely to be missed! I think you noticed how some notes made the effect worse than others. Those notes were probably closest to the resonant frequency of the cabinet. The most important fact pointing towards microphony, however, is that the sound on vision becomes worse as you turn the volume up."

"If the oscillator is causing the trouble, do you think we should change the mixer valve?" asked Dick.

"That would be quite a good idea," agreed Smithy, "but it might be worth while having a little tap around first of all, just in case."

Whereupon Smithy unearthed a favourite tool of his, this being a thin insulated rod. He put his hand in the back of the cabinet and tapped around the chassis. His first experimental taps were around the turret tuner, this being the most probable seat of the trouble, since it contained the oscillator stage. The horizontal bars on the screen became very evident when he tapped the screening can of the mixer valve.

"Well, it certainly *seems* to be in the mixer," he remarked. "Nevertheless, I'll just rock the screening can and the valve back and forth a little. This makes sure that the can is making good contact to its mounting and the valve to its holder. In this case we get no improvement so we had better try another valve."

Dick fetched a replacement from the cupboard, whilst Smithy switched off the set and removed the suspect valve. He plugged in the replacement and switched on again. The picture reappeared soon afterwards, and there was no recurrence of the sound on vision.

"We were lucky!" remarked Smithy, philosophically. "Sometimes microphonic mixer stages are extremely difficult to cure. However, the new valve certainly seems to have cleared the trouble this time. I should leave the set on for an hour or two, though, just in case the trouble reappears. Mixer valves run fairly hot, and they may not show up as being microphonic until they've reached full working temperature."

Dick pushed the set to the back of the bench, so that he could keep an eye on it as he continued with his other work.

"I notice," he remarked, "that you changed the mixer valve in the turret without making any comments about probable differences in self-capacities between the two valves. Isn't it possible that the new valve might upset the pre-set tuning in the turret?"

"You've made rather a good point there," replied Smithy, "because changing a valve in a turret can often upset its tuning if the self-capacities in the new valve differ by a large amount from those of the old one. In this case the valve was the mixer and the circuits in which the new valve could have caused mistuning are the oscillator tuned circuit, the first i.f. coil in the anode circuit, and the signal frequency tuned circuit connected to the mixer grid. So far as the oscillator tuned circuit is concerned you can tell whether the new valve has changed the pre-set tuning by checking the optimum position of the fine tuner with the new valve as against that for the old. Such a check needs to be carried out at Band III if it is to be really effective. In this case the fine tuner position had hardly altered at all, so we could count that point as being reasonably well covered. The i.f. coil shouldn't normally worry us as this is flatly tuned in any case."

"What about the i.f. tuned circuit to the mixer grid?"

"That," replied Smithy, "is the one which you cannot check. It is doubtful if you would lose much *gain* if the new valve caused relatively heavy detuning, but you might get a lopsided turret response curve. Such lopsidedness has to be fairly bad to show up on the average picture and, unless the turret were tending to be regenerative, you wouldn't get any noticeable peakiness at any one frequency. You might, however, get a slight falling off in response at high or low video frequencies. Unfortunately, I would be doing my customer a disfavour if I were to charge him for realigning a turret just because I had changed one valve in it; so, when I *do* change a turret valve, I normally try to see if the picture is as good as it should be, and leave it at that. I'm not too happy about this state of affairs, but quite frankly there is little else I can do about it."

Microphony

"I see," remarked Dick. "It's just a question of using a compromise approach which still protects the set-owner. Incidentally, I notice that this set uses the 'standard' triode-pentode in the mixer position, and that there are one or two more valves of the same type elsewhere on the chassis. Couldn't we just have swopped one of these with that in the turret, and saved the customer the price of a valve?"

"Normally, I might have done so," said Smithy, "but in this case the faulty valve was so very bad that it was best discarded. Perhaps if I were to digress for a minute or two and enlarge on the subject of microphony you might see what prompted me.

"The most prevalent source of microphony in valves is changing capacities between cathode and heater, this being followed by changing capacities between the other electrodes. The reason for this is that because of thermal expansion, it is rather difficult to make the heater of a valve fit really tightly into its cathode, whereas the other electrodes can be mounted quite rigidly. So far as the heater and cathode are concerned, a small amount of 'slop' is often liable to occur between these two electrodes; whereupon the capacity between them will vary if the valve is shaken. Changing capacities between cathode and heater can cause trouble if the valve is used in such applications as an electron-coupled oscillator, like this (Fig. 1). In this diagram the capacity between heater and cathode enters the tuned circuit. If an electron-coupled oscillator is employed in a mixer stage working at frequencies above 40 Mc/s or so, the risk of microphony due to heater-cathode movement can be quite high.

"It is partly for this reason that the electron-coupled oscillator has fallen out of favour in television mixer stages and has been superseded, as it is in this set, by the well-known Colpitts arrangement (Fig. 2). With the Colpitts oscillator the cathode is at chassis potential and varying capacities between cathode and heater do not affect the oscillator tuning. The Colpitts circuit has other advantages as well, of course, these including the fact that it makes best use of valve inter-electrode capacities and that only two connections are needed to the coil.

"When valve microphony occurs with the Colpitts arrangement it means that it is the cathode, the grid or the anode which is not held as securely in the valve structure as it should be. A loose cathode, grid or anode is, to my mind, a bigger risk than a heater which is loose inside a cathode. If, therefore, I get a valve in a Colpitts circuit which shows microphony as severe as that we have just seen, I feel that such a valve is best discarded.

"Incidentally, your remark about the same valve type being employed elsewhere on the same chassis raises rather an interesting point. If none of the valves have been changed since the set was made, there is a fair chance that they all came out of similar batches, made by the same valve manufacturer, at the set factory. If you were really anxious to prevent any excessive changes in the turret pre-set tuning when you changed a mixer valve it might, in consequence, be worth while using one of the valves already in the set as a replacement instead of one that is brand-new. I don't know whether such a course would be successful, but it could be worth trying if you were in a fringe area and were really 'pushed for gain'."

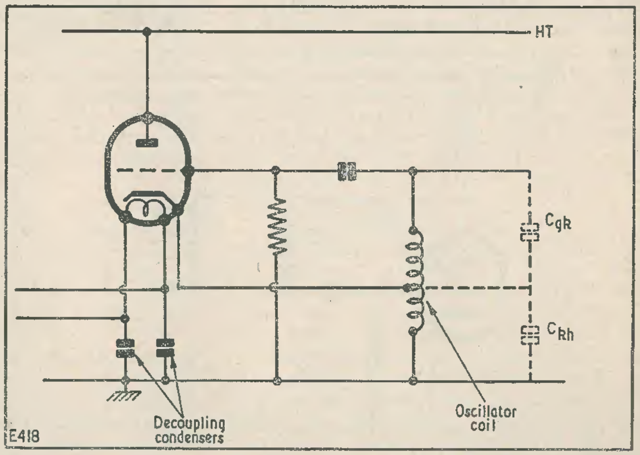

Fig. 1. A typical e.c.o. oscillator, showing how the capacities between grid and cathode, and between cathode and heater, assist in tuning the coil. All possible capacities are not shown here

"There you are, you see," commented Dick, proudly. "I do get a few bright ideas now and again; even if I don't quite realise why they *are* bright! By the way, just why should the oscillator of the mixer stage be the most prevalent cause of sound on vision? Don't the changing capacities in the valve cause frequency and not amplitude modulation?"

"They do, indeed," confirmed Smithy;

"but the frequency modulation given by the microphonic oscillator causes the signal to 'ride' up and down the skirts of the video i.f. response curve. The result is that the frequency modulation causes amplitude modulation, and it is that which appears on the picture. The oscillator is the worst offender in the sound on vision field because it only needs a slight change in its self-capacities to cause a considerable change in frequency and, hence, in video amplitude. You get the same effect on the short-wave bands of sound receivers, incidentally. In these sets a changing oscillator frequency causes the i.f. signal to similarly ride up and down the skirts of the i.f. response curve. As the i.f. response skirts of this type of receiver are usually relatively steep, the conversion to amplitude modulation takes place very readily. A microphonic frequency-changer oscillator can then cause a feedback howl to appear on the short-wave bands whenever a station is tuned in; the feedback loop being formed through the receiver to the speaker and back again. The final link in the loop is given by the sound waves from the speaker impinging on the microphonic oscillator. I hardly need to remind you, of course, that the microphonic effect gets worse as oscillator frequency increases. In television receivers, the risk of sound on vision due to microphonic oscillator valves or components is worse on Band III than it is on Band I."

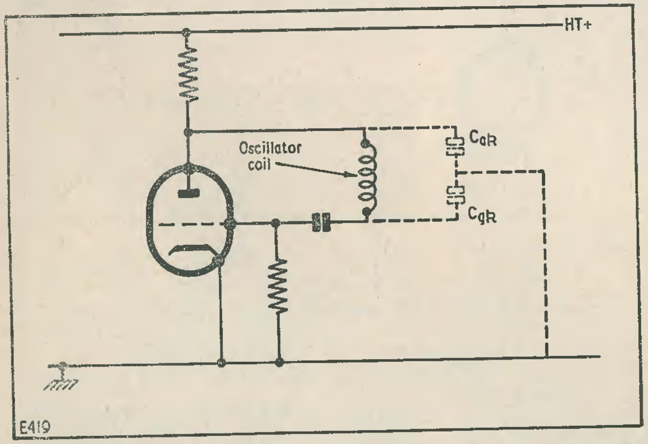

Fig. 2. A typical v.h.f. Colpitts oscillator, illustrating how the capacitive tap in the coil is obtained

Sound Rejection

"Well, I have added something more to my stock of knowledge," remarked Dick. "I can now say that, if I get sound on vision, I can start looking around the oscillator stage for microphony."

"You've only got half the picture if you say that," protested Smithy, "there are quite a few other things which can, and do, cause exactly the same trouble! I think the best thing I can do is to outline the routine of tracking down the cause of sound on vision for all receivers, and then you will have a more balanced idea of the subject.

"The first step consists of switching on the suspect receiver and seeing how it operates. If the sound on vision becomes worse as you turn the volume up, then the trouble is most probably of the type we have just discussed. In that case a few light taps—*light*, mind you, not heavy bashes—will help you to locate the faulty stage. If it is in the oscillator circuit, as is most likely, it may be the valve. If it isn't the valve you may have to dig around inside the turret, or mixer stage itself, to see if any particular component has become microphonic. I don't recommend actually displacing any of the oscillator components, especially if a turret is used, but a very light tap on each might help to locate the trouble. You don't want to spend too long on that sort of fault-finding, however, because it is easy to be misled by false scents. The best rule is never to change any suspected component unless it is *obviously* that which is causing the microphony. Fine tuner spindles occasionally work loose and cause microphony, by the way, and these should also be checked. Now and again the trouble is caused by intermittent contacts in turrets and not by true microphony at all. Intermittent contacts to the coils can usually be cleared by switching the turret back and forth a number of times over the required channel. I don't advise bending any contacts to ensure a better connection unless such a course is absolutely essential. Turret coil contacts are liable to break fairly easily. Valveholder contacts sometimes cause trouble, and you can occasionally clear what appears to be microphony by rocking the mixer valve in its holder. Here again, it pays to be reasonably gentle as with miniature valveholders rocking the valve usually causes a corresponding movement in the under-chassis components connected to the socket, whereupon these may become damaged.

"So much for the case where sound on vision is caused by microphony or intermittent connections. As I pointed out earlier, snags of this type can be recognised because the trouble becomes worse as you turn the volume up. Unfortunately, there is another occasional cause of sound on vision which has rather similar symptoms. The trouble is given this time by unwanted couplings between the audio stages and the rest of the receiver. In most cases the trouble is due to faulty decoupling to the audio output stage, whereupon this stage causes audio to appear on the h.t. line. In some receivers the sound output stage is decoupled from the h.t. line by its own separate electrolytic condenser, whereupon this component becomes a definite suspect. The electrolytic condenser decoupling the whole h.t. line should also be examined. Another condenser of the same value connected temporarily across a suspect condenser usually shows up any lack of capacity in the latter, and this test doesn't necessitate any disconnections or unsoldering. I should point out that if the suspect electolytic has a higher value than, say, 40μF or so, the additional condenser should be added and removed with the set switched off so that there is no necessity for sudden charges or discharges. You can get some very fat sparks from condensers having values as high as this, and they don't do the condenser any good at all!"

"Couldn't you differentiate this particular trouble from the microphony snag by disconnecting the speaker?" interjected Dick. "You would then still be able to adjust the volume to see its effect on the picture and the question of microphony would be settled one way or the other with certainty."

"It is a good idea to disconnect the speaker to identify cases of this type," agreed Smithy, "but I would strongly advise you to load the speaker transformer secondary with a resistor having approximately the same value as the impedance of the speaker you have disconnected. If the transformer is not loaded in this manner, you can get some very high a.f. voltages appearing across the primary when the volume control is adjusted to a high setting. It is quite easy for such voltages to cause sparking in the speaker transformer or between pins of the output valve base. Such sparking may cause a breakdown or may leave a 'track' which accelerates breakdown later."

"Life gets complicated at times," sighed Dick. "Still, I suppose that attention to these little points is all part of the game!"

"You'll get used to it in time," chuckled Smithy. "Anyway, let us now press on and assume that, when you originally examined your faulty set you found that the sound on vision occurred for all settings of the volume control, and was evident even when it was set right back at minimum. In this case, your snag lies in the i.f. strip, and the chances are that the sound rejector circuits have fallen out of alignment. However, before taking any serious servicing action in this event, it might be worth while making a few checks on the fine tuner control before finally condemning the chassis. In quite a few receivers the sound rejection circuits give a very sharp dig in the video i.f. response, and it may be found that a slight alteration in fine tuner setting will cause the sound i.f. to fall nicely into the centre of the dip, whereupon the sound on vision should clear. Indeed, assuming that the vision i.f. strip as a whole is reasonably well lined up, the position of maximum sound rejection nearly always corresponds to optimum amplification of the video i.f. When I refer to 'fine tuners,' incidentally, I don't necessarily mean the fine tuners brought out as a front panel control on 12-channel receivers. These fine tuners are capable of adjustment by the set-owner who can usually be relied upon to get the hang of their operation after he has had the set in his house for a while. Instead I meant, rather, the fine tuners or oscillator trimmers fitted at the rear of earlier sets which are normally adjusted by the service engineer. It sometimes happens that these fall sufficiently out of adjustment for sound on vision to appear without the picture becoming too badly degraded."

"I see," remarked Dick. "I always thought, though, that if you set the fine tuner for maximum volume you automatically obtained maximum sound rejection as well. Doesn't that make the adjustment of the fine tuner, or trimmer, a fairly simple operation?"

"Well, it does happen that maximum sound and maximum rejection occur at the same fine tuner setting in some receivers, but this cannot always be guaranteed," returned Smithy. "In fact, if a single coil performs the dual function of sound take-off and sound rejector, the two fine tuner settings are almost always slightly removed from each other. There is also the fact that the sound i.f. response curve is not always as sharp as the sound rejection dip, which means that tuning for maximum sound doesn't give a sufficiently accurate indication. If the sound i.f. strip has a.g.c. then the setting for maximum sound becomes even less well-defined. So the best plan, if you want really accurate results, is to adjust the fine tuner for minimum sound on vision."

"That's all very well," protested Dick, "but I'm still not too happy about it. For instance, what happens if you try to tune for minimum sound on vision if the sound programme at the time is of a quiet nature?"

"You can often," replied Smithy, "intensify the effect of sound on vision by turning up the r.f. gain of the receiver and reducing brilliance. In some sets working under such conditions you can actually see the sound carrier come up on the screen as a 3.5 Mc/s 'grain.' When that occurs you tune for minimum 'grain'."

"Well, I suppose it doesn't seem so complicated, really, when you think of it," commented Dick. "What it all boils down to is that, if the i.f. strip is properly aligned, it is best, with the average receiver, to tune the oscillator for minimum sound on vision rather than for maximum sound. In some receivers the sound rejection dip is very sharp and the oscillator tuning is, as a result, rather critical. If the serviceman has to adjust the fine tuner control himself he should make an attempt to do so as accurately as he can; if necessary using the dodge you have just mentioned. When the fine tuner is at the front of the set, you rely on the set-owner to find the best position."

"Yes, I think that sums it up pretty well," commented Smithy. "Although I think I should add that, when the fine tuner is on the front panel, the set manufacturer has probably done his best to prevent too sharp a sound rejection dip."

"What happens when the i.f. strip is out of alignment?"

"In that case," said Smithy, "the only really reliable advice I would give to anyone would be to align it with the aid of the service manual and a signal generator whose frequency calibration is known to be accurate. I certainly would not recommend an inexperienced person touching the i.f. cores of any television set unless he has the manual at his side. I must admit, nevertheless, that there are one or two little dodges that can be employed if a manual isn't available and you are only worried about adjusting the sound rejector coils. One consists of tuning the receiver for optimum picture on a test card transmission, whilst ignoring any sound on vision that may occur. To get a steady effect from the sound channel you then connect the output of a signal generator to the aerial socket, leaving the aerial still connected, and tune it to the sound carrier of the received signal. When the generator is at the correct frequency it beats with the sound carrier, and you finally adjust it for zero-beat from the loudspeaker. If you next switch the signal generator to give a modulated output and adjust its attenuators accordingly, you get the modulation showing up nice and steady on the screen. What you finally do is adjust the sound rejector coils for minimum modulation on the tube, whereupon the job is finished. If the signal generator range does not enable it to reach the sound carrier frequency, you will get the same result if you inject it into the i.f. strip at the sound i.f. frequency. Most sets have an i.f. test point somewhere around the mixer stage to which a signal generator can be connected. Alternatively, you may sometimes get enough i.f. injection by pushing an insulated lead between the mixer valve and its screening can, and by connecting the 'hot' side of the signal generator output to this lead. I should state, by the way, that I can only recommend this particular procedure for adjusting sound rejector coils as an idea to be carried out by the more experienced engineer. It is by no means as effective a process as that of aligning the strip according to the instructions in the manual. Also I can offer no guarantee as to its effectiveness in any particular case."

Dick chuckled. "You should have been a politician," he remarked. "I've never heard anyone make so many statements with so few guarantees!"

"One has to be careful in this business so far as statements are concerned," grinned Smithy. "Anyway, you have reminded me that, like many politicians, I seem to be in the middle of an excessively active Question Time just now. Perhaps we ought to get down to a bit of work for a change."

"O.K.," said Dick resignedly, turning back to his bench. "I thought the political atmosphere couldn't last for ever."

TELEVISION for the HOME CONSTRUCTOR

PART 9

by **S. WELBURN**

This month S. Welburn, our popular contributor on television topics, devotes his article to a discussion on wobbulator principles and techniques

FROM TIME TO TIME, THE WRITER RECEIVES requests from readers asking that space be devoted in the present series of articles to the techniques employed in alignment with a wobbulator and oscilloscope. Amongst other things, the growing interest shown by readers on this particular subject is due not only to the fact that devices of this type are becoming more and more frequently encountered, but also because a certain number of readers have active servicing interests or hope shortly to be actively engaged in such work. There is also, of course, the point that information on wobbulator techniques is of considerable interest to everyone who makes a hobby of television construction; and such information consequently deserves mention in these columns on this count alone.

A minor difficulty encountered in dealing with the subject of wobbulators is that it is a little difficult to avoid describing particular commercial instruments. Quite a number of commercial wobbulators are available on the market at the present date, and the writer does not wish, for various reasons, to refer to any of these specifically. As, however, their principles of operation are all inherently similar, he feels that generalised references will cover all the more important points likely to be encountered. Unfortunately, there is not sufficient space in a single article to deal with the subject of wobbulators in its entirety. This month's contribution will, therefore, deal with the basic theory behind wobbulator operation; and will be followed in next month's issue with some notes on the advantages and disadvantages incurred in their use.

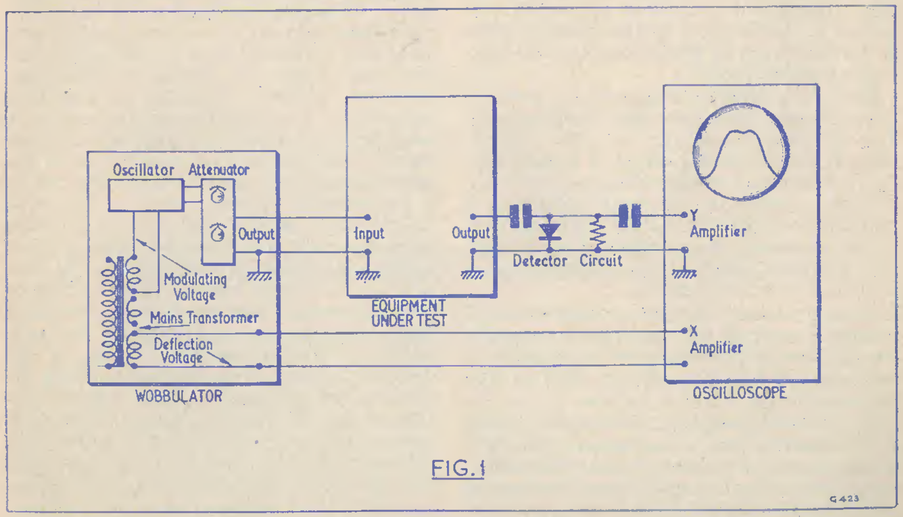

Fig. 1. Simplified diagram showing the basic set-up employed with a wobbulator and oscilloscope using 50 c/s sweep

Frequency Sweep

Wherever a series of tuned circuits are employed in radio or television equipment, there are two basic methods by means of which such circuits may be aligned and set up. The first of these methods consists of applying one or more fixed frequency inputs to the equipment, and of adjusting the various tuned circuits such that they resonate at the particular frequencies recommended by the designer of the equipment. The condition of resonance in each tuned circuit is indicated by a maximum or minimum reading, as applicable, on an indicating device connected to the output of the equipment. Usually the indicating device is a meter, but it may also be an oscilloscope or a loudspeaker. In the latter case the input frequency is modulated, and the appropriate tuned circuits are adjusted for maximum or minimum sound from the speaker.

The second method of alignment necessitates the use of test gear which is rather more complicated. For this method a frequency-modulated signal is applied to the input terminals of the equipment being aligned, the output of the equipment being applied to the Y amplifier (vertical deflection) of an oscilloscope whose horizontal deflection is synchronised with the modulation of the input frequency. When correctly set up, this arrangement enables a picture of the overall response curve of the tuned circuits in the equipment to be displayed on the tube of the oscilloscope.

Both the methods of alignment just detailed have inherent advantages and disadvantages. The greatest advantage of the second, frequency-modulated, method of alignment is that it enables a considerable amount of time to be saved when it is necessary to achieve a particular response curve. As was mentioned earlier, however, the question of advantages and disadvantages will be discussed more fully in next month's article.

Since the second method of alignment is of greater interest in this particular context, it would now be advantageous to consider its basic operation in more detail. This we may do with the aid of Fig. 1.

Fig. 1 illustrates a typical set-up employing a wobbulator (or, to use more "correct" nomenclature, sweep generator or frequency-modulated signal generator) the equipment which is to be aligned, a detector circuit, and an oscilloscope. The frequency of the wobbulator is made to alter continually, such that its output sweeps across the range of frequencies over which the response of the tuned circuits in the equipment being aligned is to be examined. The output of the wobbulator is then applied, via an attenuator, to the input of the equipment under test. The speed at which the wobbulator frequency is changed is normally kept to a relatively low figure; and at television frequencies it is becoming common practice to employ the 50 cycle mains voltage (stepped down by a transformer) to provide the frequency-modulating voltage.* Using the 50 c/s mains supply in this manner confers several advantages, one of the more important of these being that such a supply dispenses with the necessity for employing a separate modulating oscillator in the wobbulator. A second advantage is that a slow change in wobbulator frequency (as is given at 50 c/s) prevents excessive shock-excitation of high-Q tuned circuits in the equipment under test during the period of the sweep. Additionally, there is the fact that a sweep frequency of 50 c/s ensures that the voltages appearing at the output of the equipment being aligned can be handled in the Y amplifier of the oscilloscope without difficulty.

The frequency-modulated signal fed into the equipment under test passes through its various tuned circuits, appearing finally at its output terminals. However, whereas the amplitude of the wobbulator signal applied to the input of the equipment under test was constant at all frequencies†, the amplitude of the signal appearing at its output will vary with frequency according to the overall response of the tuned circuits in the equipment. At the output terminals of the equipment being aligned we are interested only in amplitude variations, and can forget the fact that the signal we obtain is frequency-modulated as well. To enable the amplitude variations to be handled by the oscilloscope Y amplifier, it next becomes necessary to *detect* them. This detection is carried out in the same manner as is used for a.m. detection in a conventional receiver; and, in Fig. 2, a crystal diode is employed for the purpose. After detection, we obtain a voltage which is varying in amplitude according to the particular relationship between the response of the equipment under test and the frequency being provided at any instant by the wobbulator. The instantaneous value of the detected voltage varies, therefore, during the sweep of the wobbulator; and it may be considered, in consequence, as an alternating voltage having a rather complex waveshape. The lowest basic frequency of this alternating voltage is the 50 c/s modulating source which controls the wobbulator sweep. Because of this, the detected signal can be treated by the oscilloscope Y amplifier almost as though it were a conventional audio frequency voltage, with the result that we may employ reasonably normal a.f. techniques in this amplifier. This similarity does not hold entirely true, however, because it is usual to ensure that phase shift is kept to a minimum and that the low frequency 50 c/s component of the detected signal is not excessively attenuated in the oscilloscope Y amplifier by employing coupling condensers which are somewhat larger in value, and resistive loads which are rather smaller, than those used for conventional a.f. work. As an example, the oscilloscope X amplifier shown in Fig. 1 would employ coupling condensers having values around 0.25μF or so, rather than the more common 0.01μF used in normal a.f. equipment.

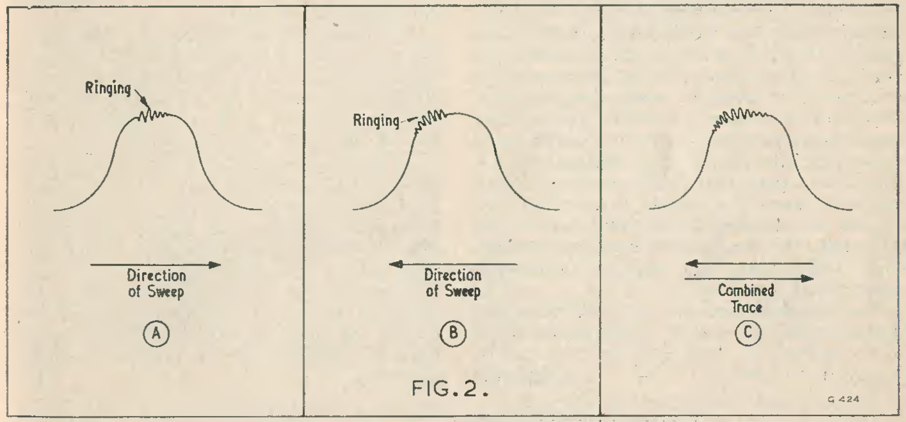

FIG. 2.

Fig. 2. Illustrating, in somewhat exaggerated form, how discrepancies between two curves result in a final distorted response when they are combined, as at (c)

After detection and amplification, the voltage appearing at the output terminals of the equipment under test is finally applied to the Y plates of the oscilloscope tube. The method of connection used here is normally phased such that the spot of the oscilloscope tube is deflected upwards when the detected voltage increases in amplitude.

The 50 c/s source employed for modulating the frequency of the wobbulator is next applied to the X plates, or to the X amplifier, of the oscilloscope. In consequence, the spot of the oscilloscope tube now travels horizontally, keeping in step with the changing frequency of the wobbulator. Since, at the same time, the spot is deflected vertically according to the amplitude of the detected voltage, a trace is obtained on the tube of the oscilloscope which corresponds to the response curve of the equipment under test.

Practical Details

There are a number of minor details which have not been mentioned in the explanation just given, and which apply to the layout of Fig. 1 when used in practical form. These points will now be dealt with.

The first concerns the fact that the frequency of the wobbulator oscillator is modulated by a voltage which is obtained from the 50 c/s mains supply, this supply also providing horizontal deflection in the oscilloscope. Since the 50 c/s modulating voltage is present all the time, we may then obtain the situation wherein the frequency of the wobbulator is altered first in one direction, and then in the reverse direction, as successive half-cycles of a.c. are passed to the modulating circuit. At first sight there appears to b nothing wrong with this state of affairs, since the paths traced out by the oscilloscope spot in both directions should be identical, and would coincide to give a single response curve on the screen. In practice, nevertheless, difficulties can arise due to the presence of small discrepancies between the forward and the reverse traces, these sometimes resulting in the presentation of two slightly different curves on the tube. When such differences become large, the trace may become fuzzy and ill-defined, or may even break up into two separate, discrete lines. The reasons for the discrepancies between the two curves are mainly small phase shifts in the equipment under test, and in the Y and X amplifiers of the oscilloscope. Phase shifts may also occur in the frequency-modulation arrangements

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* Some television wobbulators employ a sawtooth modulating voltage obtained from the X timebase of the oscilloscope with which they are to be used. Others may function either from an oscilloscope sawtooth waveform or from a 50 c/s mains source, as desired. This article describes wobbulator techniques using the 50 c/s sinusoidal source, as this now appears to cover most practical instances.

† Small alterations in amplitude may occur during the sweep with practical wobbulators, but these should be small enough to be ignored.

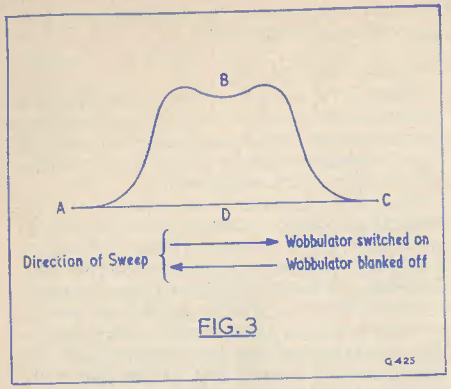

FIG. 3

Fig. 3. The waveform obtained when a blanking circuit is employed in the wobbulator

employed in the wobbulator, these being possibly at their worst when a mechanical device, such as a mechanically driven variable condenser, is used to vary the oscillator frequency. Another possible discrepancy would be ringing in one or more of the tuned circuits in the equipment under test. If ringing at a particular frequency were present the effect would be evident in one direction for the first scanning period, and in the other direction for the reverse scanning period. Fig. 2 illustrates this effect in somewhat exaggerated form.

The simplest method of overcoming the discrepancies between the two traces consists of removing one altogether, and this can be achieved by cutting off or "blanking" the output of the wobbulator during alternate half-cycles of the control voltage. During the time in which the blanked-out curve would otherwise appear, the output of the wobbulator is zero. The blanking process is normally achieved in the wobbulator itself, a simple valve switching circuit sufficing to remove the output during the required period. The result of this arrangement is to cause the oscilloscope tube to display a response curve of the type shown in Fig. 3. In this diagram the line ABC represents the response curve of the equipment under test, and is given during the period when the wobbulator output is switched on (i.e. not blanked). At point C the direction of change of wobbulator frequency and of spot movement reverses. At the same instant, however, the output of the wobbulator is blanked off; whereupon the spot traces a straight line CDA before it reaches point A again, this line corresponding to zero voltage at the input terminals of the equipment under test.

At point A the movement of the spot and the direction of frequency alteration once more reverse, and the blanking circuit in the wobbulator switches in the output once more. The spot on the tube now commences to retrace the curve ABC as before.

(It should be noted that, although we have described the response curve as being traced by a spot moving from left to right in this particular instance, we would obtain an equally useful result if the spot had moved from right to left, the blanking period occurring during its return to the right. The direction in which the spot moves whilst tracing the response curve is unimportant so long as blanking occurs during its return journey.)

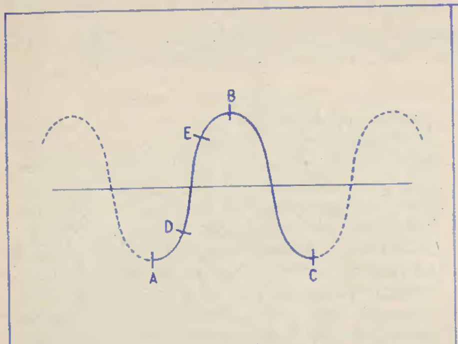

FIG. 4

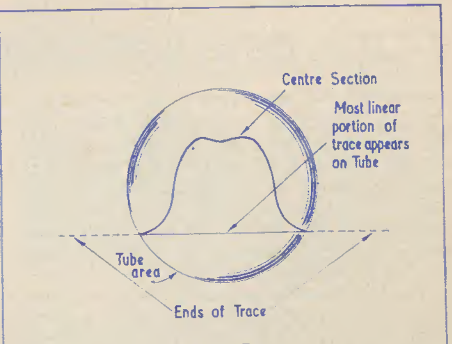

FIG. 5

Fig. 4. Analysis of the sinusoidal modulating voltage, showing that its most linear section lies at its centre. Fig. 5. When a sinusoidal sweep is employed, a more linear trace may be obtained by widening sweep and deflection, as shown here

It will be noticed that the curve illustrated in Fig. 3 now has a base line, this occurring during the blanking period, or "retrace," whereas that of Fig. 2 (*c*) did not. Amongst other things, the base line performs a somewhat useful purpose insofar that it enables the person using the wobbulator and oscilloscope to obtain an idea of what part of the trace corresponds to zero input to the equipment under test. Another rather useful factor is that its presence enables the average voltage passed to the Y plates of the oscilloscope to remain more steady with relation to the response curve for changes in shape of the latter. This point will be dealt with in more detail later.

Blanking circuits are fitted as "standard" on most wobbulators intended for television alignment and using sinusoidal modulating voltages.

Linearity

As we have already mentioned, the modulating voltage applied to the wobbulator oscillator, and the scanning voltage applied to the X plates of the oscilloscope, is normally obtained from the 50 c/s mains supply. Such a voltage is, of course, sinusoidal, with the result that the trace exhibited by the oscilloscope will be non-linear in the horizontal direction. This fact is of some importance because, although we do not require perfect horizontal linearity on a response curve display, a reasonable degree of linearity is obviously worth aiming for. Fig. 4 illustrates a cycle of the 50 c/s control voltage, and we may assume that we shall be employing the half-cycle which lies between points A and B for examining our response curve. (The section between B and C will then correspond to the blanking period.) If we examine the half-cycle between points A and B closely we can see that, due to its shape, its non-linearity becomes worse as we approach its ends. On the other hand, the centre part of the sine wave is reasonably linear. We would, therefore, be improving the horizontal linearity of our trace if we worked between two points on either side of the centre of the half-cycle. We could, for instance, examine the response curve between the limits D and E.

It is possible to employ a technique of this type for improving linearity by the simple process of selecting a wider frequency sweep in the wobbulator and greater horizontal deflection in the oscilloscope than is really required for the response curve proper. A typical example is illustrated in Fig. 5. In this diagram, the horizontal deflection of the oscilloscope is widened such that the outer limits lie outside the area of the tube face. Similarly the sweep of the wobbulator is increased so that the response curve now occupies a smaller part of the total overall trace. Despite these changes the response curve still appears on the face of the tube and, since it is now being displayed over the more linear part of the modulating and deflection voltage, its horizontal presentation is more linear. The dotted lines of Fig. 5 represent the two ends of the trace which lie outside the area of the tube and which are, in consequence, lost. (They would, of course, be visible if the tube area were larger.) Their loss is unimportant as they contain no information which is of use to us in the present field of interest.

The amount by which the trace has to be widened to enable the response curve to appear on its more linear centre section need not necessarily be as great as that shown in Fig. 5. It should also be pointed out that physical limitations are set by the frequency sweep available from the wobbulator. It is fairly safe to say that reasonable horizontal linearity will be obtained if the response curve occupies less than some two-thirds of the total overall scan. It must be borne in mind, however, that lack of linearity in the oscilloscope presentation does not present any disadvantages that are excessively serious. Even if due to, say, frequency sweep limitations, a particularly wide response curve were to occupy almost all of the scan period available, as it does in Fig. 3, the resulting heavy non-linearity would not prevent the equipment being used for purposes of alignment. The person using the gear would merely have to bear in mind that the non-linearity was greatest at the ends of the trace; these tending to be compressed in the horizontal dimension.

Phasing

A practical difficulty affecting the design of wobbulators is raised by the necessity of ensuring that the frequency modulation of the wobbulator oscillator, the deflection of the spot on the oscilloscope tube, and the action of the blanking circuit are all accurately phased in relationship to each other.

Fig. 6 illustrates several half-cycles of the 50 c/s supply which is used to control these three circuits. As we know from Fig. 4, we can employ the period from point A to point B to modulate the wobbulator oscillator.‡ Assuming that no phase shifts occur we may also use this period to deflect the oscilloscope spot horizontally. All being well, the frequency modulation and horizontal deflection will then both remain in step with each other.

A snag becomes apparent, unfortunately, when we consider applying this same 50 c/s

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‡ This assumes that the modulating circuit employs a reactance valve or an equivalent "electronic," as opposed to a mechanically driven, device.

voltage to the valve which carries out the blanking function. A typical method of blanking consists of applying a proportionately large 50 c/s sine wave to the grid of the blanking valve, using a circuit similar to that shown, in simple form, in Fig. 7. On positive half-cycles the valve of Fig. 7 conducts, whilst on negative half-cycles it cuts off. The waveform appearing at its anode is, as a result, a square wave; and this can be employed to control a second circuit which switches the wobbulator output on or off, as desired. Alternatively, the conduction, or otherwise, of the valve may itself control the wobbulator output.

oscillator may also deflect the oscilloscope spot with good synchronism, difficulties are caused in practice by phase shifts in either or both of these circuits. (See also footnote ‡.) Because of the presence of such shifts, some wobbulators have a second phasing control (fitted normally to the deflection circuits) to enable exact synchronism to be obtained.

A.C. Voltage

We referred earlier to the fact that the use of a blanking circuit in the wobbulator enables a more steady average voltage line relative to the response curve to be obtained for changes in the shape of the latter.

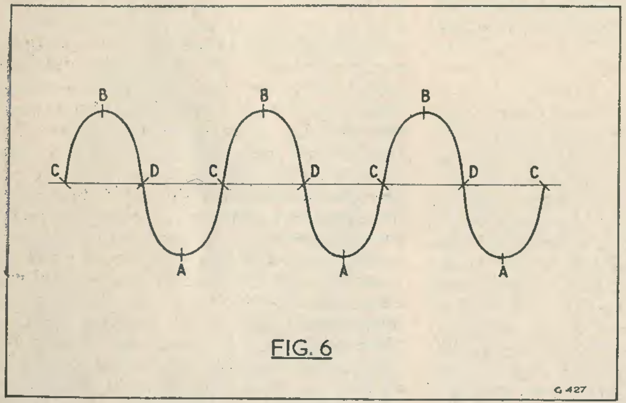


FIG. 6

Fig. 6. Several cycles of the modulating voltage, demonstrating the 90 degree phase difference needed between the modulating and blanking voltages

The reason for discussing the circuit of Fig. 7 in some detail is to point out that the blanking circuit can only function on half-cycles which are enclosed within the points C and D of Fig. 6. However, these points are 90 degrees out of phase with the half-cycles enclosed between points A and B, with the consequence that, if the blanking period is to be kept in step with the frequency modulation and deflection periods, the 50 c/s control voltage applied to it must be 90 degrees out of phase with that applied to the other two circuits.

The requisite 90 degree shift for the blanking circuit may be obtained in the wobbulator by means of fixed phase shift networks. However, it often happens that the wobbulator is provided with a panel phasing control which enables final adjustments to be made. Setting up such a phasing control normally necessitates ensuring that blanking occurs only at the ends of the trace and does not cause any of the response curve proper to be cut off.

Although, as was mentioned above, the a.c. control voltage modulating the wobbulator

This particular fact may be better understood if we consider once more the fact that the detected output given in the set-up of Fig. 1 consists of an alternating voltage. We then amplify this voltage in something of the same manner as we do an a.f. voltage, using conventional a.c. couplings. As a result, the detected signal applied to the Y plates of the oscilloscope has lost its d.c. component. Because of this, the only part of the trace which will remain steady on the tube in the vertical direction will be that which corresponds to the average voltage of the signal.

Fig. 8 (*a*) and (*b*) illustrate two response curves without blanking period base lines. The area enclosed by the response curve of Fig. 8 (*a*) is large, whereupon the average voltage of the waveform will have the position shown approximately in this diagram. The area enclosed by the response curve of Fig. 8 (*b*) is small, and the average voltage will be lower on the curve, as shown. If, during alignment, the curve at (*a*) should become altered to that at (*b*), the whole trace would move upwards on the screen of the oscilloscope tube (the average voltage remaining

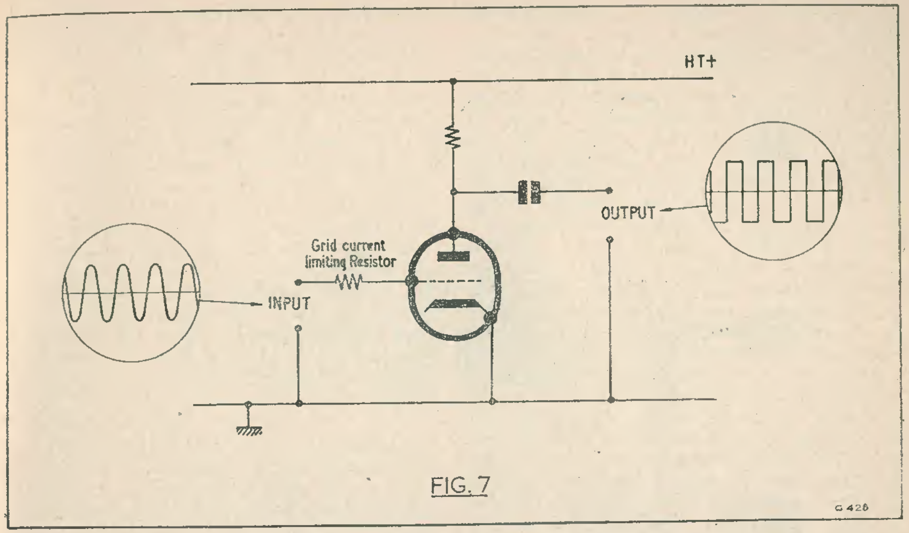


FIG. 7

Fig. 7. A simple circuit illustrating how a square wave may be obtained from the sinusoidal modulating voltage. A small-value condenser is sometimes connected across the series grid resistor to sharpen up the edges of the square wave

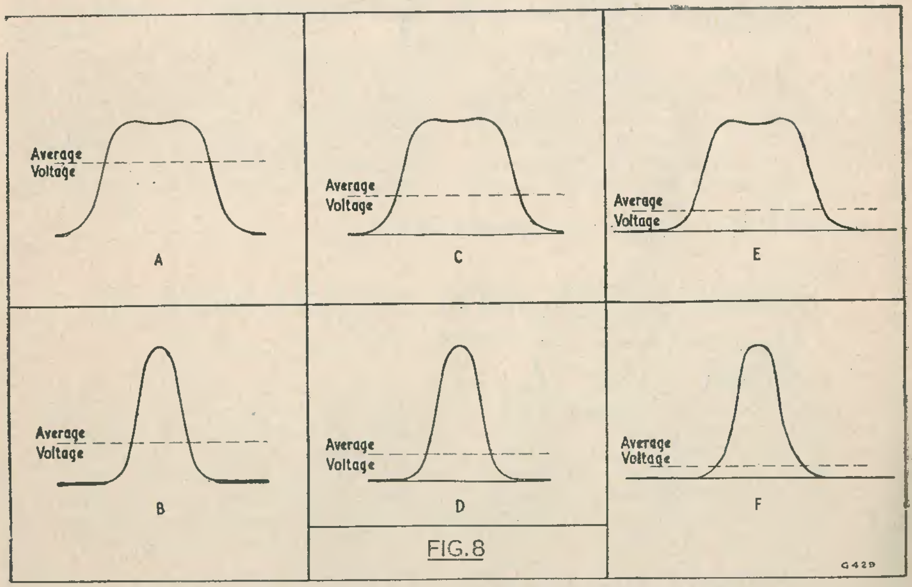


FIG. 8

Fig. 8. The position of the average voltage of a trace may be made more stable by the addition of a base line as in (c) and (d). Widening out the trace, as in (e) and (f), gives even further stabilisation

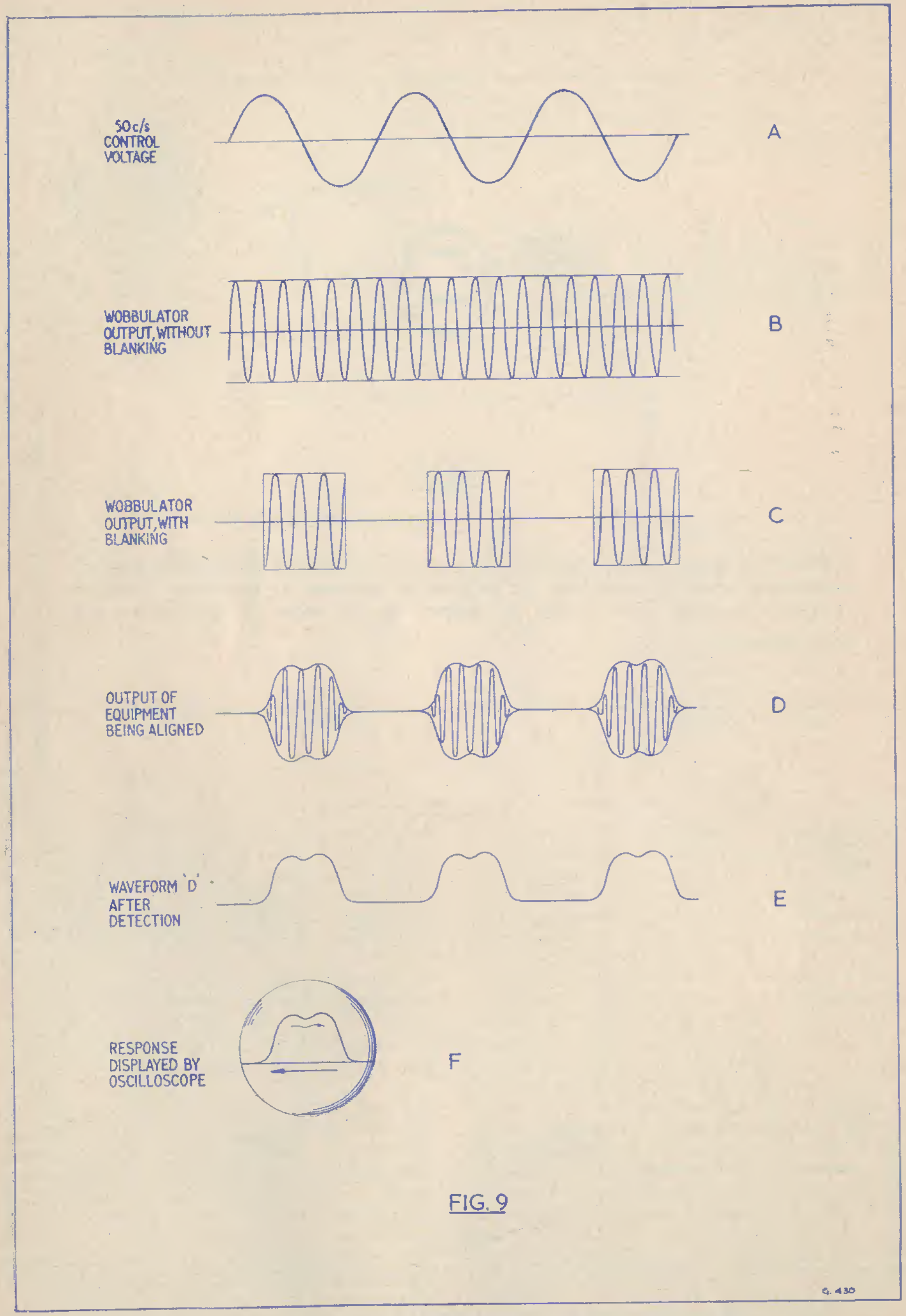


Fig. 9. Successive steps in the process of displaying a response curve on the tube of an oscilloscope

fixed). This effect can sometimes be very irritating, especially if the movement is sufficiently large to cause the top of the curve to fall outside the tube area. Fig. 8 (*c*) and (*d*) represent the same two curves respectively, with the difference that, this time, a base line has been added by the use of a blanking circuit. Due to the presence of the base line the average voltages of each response become lower and, whilst a difference still exists between them, this is smaller than occurred in Fig. 8 (*a*) and (*b*). The final result is that there is less vertical movement of the trace on the oscilloscope tube. Even better vertical stabilisation would be given if the sweep and deflection were widened out, as they are in Fig. 8 (*e*) and (*f*). In this case the average voltages for each curve are even lower, and the vertical difference between them still less again.

The fact that smallest vertical movement of the trace on the oscilloscope tube occurs when a trace such as that shown in Fig. 8 (*e*) and (*f*) is used also covers the situation where changes in wobbulator output level are made whilst alignment proceeds.

The Detector

The set-up shown in Fig. 1 illustrated a detector following the equipment under test, its purpose being to convert the r.f. appearing at the output terminals into a form suitable for amplification by the oscilloscope Y amplifier.

It should, of course, be mentioned that many items of equipment liable to be aligned contain their own detector circuits, whereupon an external detector circuit is not required. A typical example would be given by a vision i.f. strip, wherein the oscilloscope Y amplifier could be connected to the video diode load.

Summing Up

In order to leave a final clear picture of what occurs when a wobbulator is employed with an oscilloscope, it might be of value to examine the successive steps described in the article with the assistance of a diagram showing the various waveforms encountered. Such a diagram is given in Fig. 9. In this figure all the waveforms shown are drawn against amplitude and time.

Waveform A shows the 50 c/s voltage which controls the frequency modulation and deflection circuits. Waveform B illustrates the output obtained from the wobbulator before blanking is provided This waveform appears as an r.f. of constant amplitude, it being assumed (ideally) that the output level is constant over all periods of the sweep. Waveform C illustrates the wobbulator output after a blanking circuit has been provided. Waveform D demonstrates what appears at the output of the equipment under test. As may be seen, this consists of an amplitude modulated carrier with blanking periods. Waveform E represents the detected signal, this consisting of a number of individual response curves, each separated by a blanking period.

Waveform F illustrates the trace displayed on the oscilloscope tube, this consisting of the response curve sections superimposed on each other, to form a single curve; and the blanking periods superimposed on each other in the reverse direction to form a single base line.

Next Month

In next month's article, the advantages and disadvantages of wobbulator techniques will be discussed, as will also any hints which may be of advantage to the home-constructor. The question of injecting frequency markers will also be dealt with.

TRANSISTOR SETS FOR THE BEGINNER

PART 2

by **JAMES S. KENT**

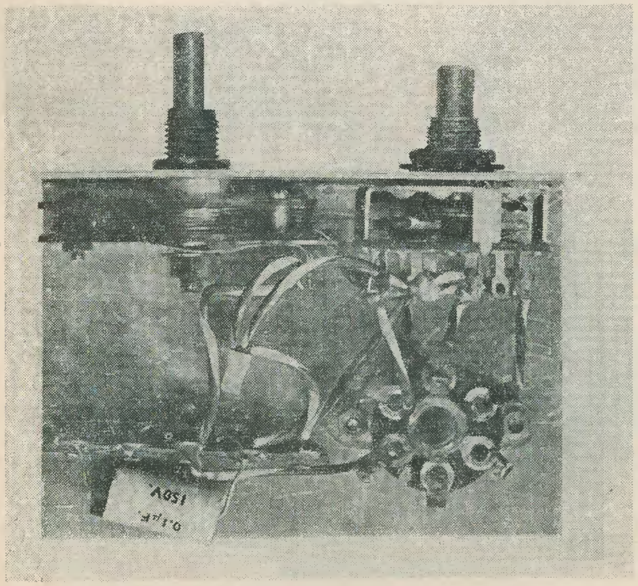
LAST MONTH TWO SIMPLE RECEIVERS WERE described, with which the beginner to transistors could construct, experiment, and have fun generally. In this instalment it is proposed to describe two more simple circuits, using much the same components as were used in the two receivers previously featured—thus ensuring that, for a minimum outlay in cash, the experimenter can gain more practical knowledge of transistors.

The first unit to be described is that shown in Fig. 1, where it will be seen that it is a simple Long and Medium Wave Feeder Unit. As such it is eminently suitable for feeding either an amplifier or a tape recorder, although the output circuit may have to be modified somewhat in order to suit the input impedance of the particular unit to which it is coupled.

The circuit is simplicity itself, and is designed around a Repanco type DRR2 coil, variable tuning capacitor, Yaxley type switch, transistor and a few other small items (see Component List). The aerial coupling and band switching is effected by a 3-pole 2-way switch, which also connects an appropriate tapping on the tuned circuit to the transistor base. The transistor is operating in the earthed emitter mode (roughly analogous to the triode), the collector load resistor being of such a value as to obtain optimum voltage gain. The output is taken via a 0.1μF condenser from the collector in the customary manner. This value is suitable where the next audio stage has a high input impedance, but would be raised to several microfarads if the next stage had a low input impedance, as, for example, a further grounded emitter transistor audio amplifier.

The h.t. voltage applied will affect the output obtained, and some experiment here would be worth while. In any event, do not forget that the polarity of the h.t. supply is opposite to that of ordinary valve circuits.

A study of the accompanying photograph will show the actual method of construction used. A small piece of aluminium, 3½in. by 4½in, is cut and bent so that the base is 2½in wide, and the various components are then mounted. The drilling locations, which are not critical, can be seen from the illustrations and, in any event, depend on the actual size of the individual compo-



The MW and LW transistor feeder unit

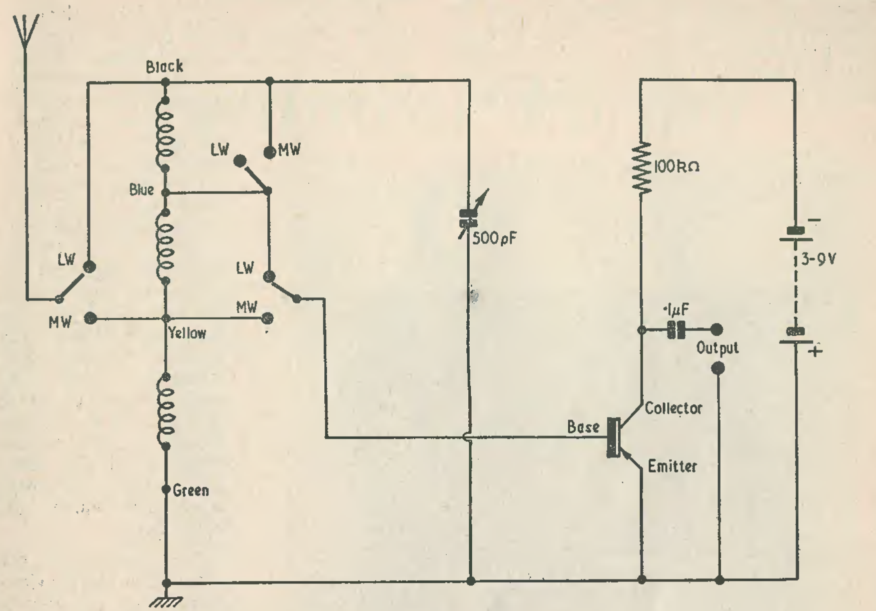


Fig.4
Long & medium wave transistor feeder unit

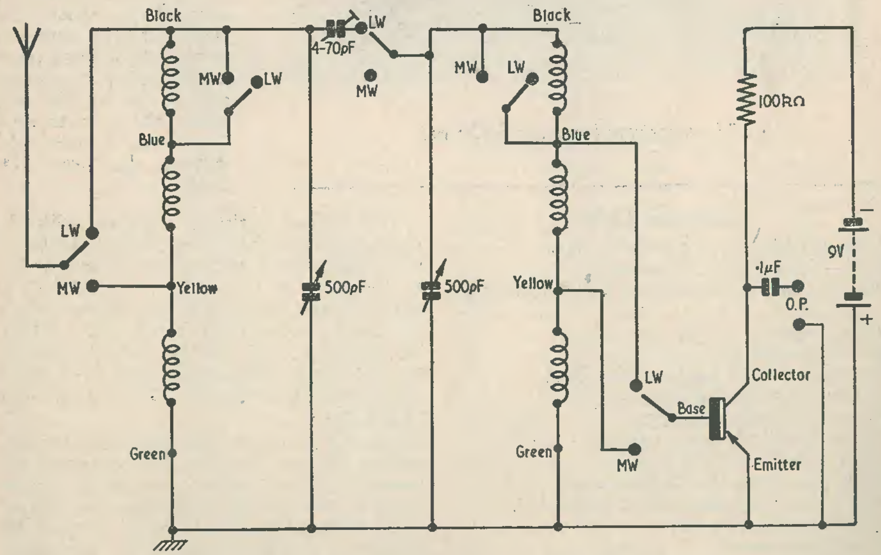
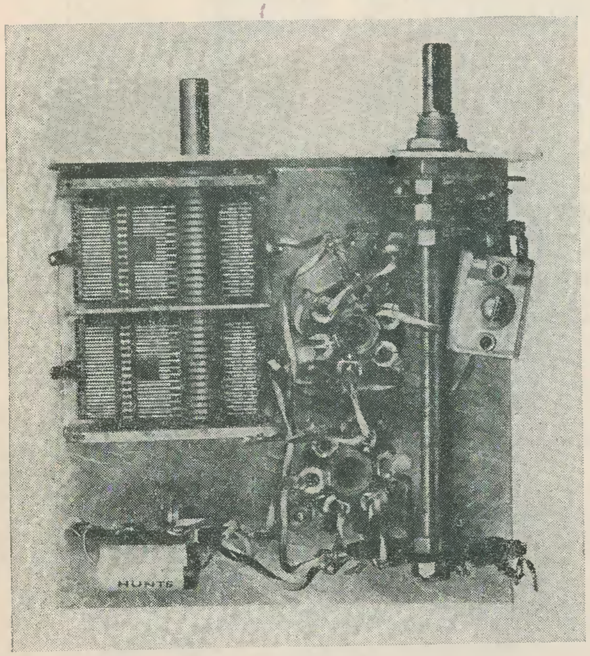


Fig.5
Bandpass feeder unit

E423

nents used. A 5-way tag strip, of the type having the centre tag earthed, is used for external connections such as the aerial input and the feeder unit output, etc. The whole unit is reasonably compact and simple, and should take only a short time to construct.



The transistor bandpass feeder unit

Component Lists

Long and Medium Wave Feeder Unit
Coil—Type DRR2 (Repanco)
500pF Variable Condenser (solid dielectric) J.B.
100kΩ resistor ¼ watt
0.1μF condenser
Transistor—Red Spot or Blue Spot
3-pole 2-way Yaxley switch
Panel and base—Repanco
5-way Tag Strip, centre earthed

Band Pass Feeder Unit
Coils (2)—Type DRR2 (Repanco)
500pF variable condenser (2-gang) J.B.
100kΩ resistor ¼ watt
0.1μF condenser
Transistor—Red Spot or Blue Spot
4–70pF trimmer
5-pole 2-way Yaxley switch
Panel and base (Repanco)
5-way Tag Strip, centre earthed

Bandpass Feeder Unit

This is shown in Fig. 5, and from the circuit it will be seen that, in this case, two type DRR2 coils are used, each being tuned by a section of a 500pF variable 2-gang condenser. The degree of inductive coupling between the two tuned circuits will be affected by the distance between each coil, in the prototype shown (see accompanying photograph) this being 1¼in. The 70pF trimmer condenser provides capacitive top coupling and, in operation, this will need some adjustment to provide optimum signal strength. Little more need be said about the circuit as it is extremely simple. The remarks made previously about h.t. voltage and output condenser value also apply here.

The method of construction is clearly visible from the photograph, from which it will be seen that the whole assembly is again mounted on a small piece of aluminium which has been bent in order to form both a front panel and base. The aluminium size is 6in by 4in; this being bent upwards some 2¼in from one end, leaving the base 3¾in by 4in.

The 100kΩ resistor, together with the output coupling condenser, is mounted and wired on to the 5-way tag strip shown bolted to the base of the unit, the transistor, of course, being suspended with its own wiring as shown. Once constructed, and properly adjusted for best results, the unit should prove to be a useful radio tuner for either a valve amplifier or even a transistor a.f. stage or stages.

It is to be hoped that this short series of articles on transistors, both theoretical and practical, has not only proved to be of some value to the transistor beginner but also of some interest to those about to take the plunge in transistorising their equipment. The whole subject is fascinating, to say the least; and, although the transistor is now in its infancy, there is no doubt at all that it will, in the future, come to be used more and more by the radio enthusiast.

Technical Forum

Intermittent Faults

A READER RECENTLY WROTE TO US describing a defect which had developed in his television receiver. It appears that each time the set was switched on nothing happened for about 15 minutes, when a judicious tap or two on the side of the cabinet suddenly corrected the trouble, and the receiver operated normally. Being a busy individual he was unable to investigate the fault for nearly a year, but during the whole of this time a carefully placed tap on the cabinet after the set had warmed up always brought results. Defects of this nature develop occasionally in electronic equipment, and from the writer's experience may usually be traced to either a valve or a resistor. Intermittent faults are always a headache to the service engineer because they so often behave in a manner similar to toothache: they are most troublesome when the remedy is far away, but tend to disappear when repair action is about to be taken. We have known service engineers to run sets for hours waiting for an intermittent defect to appear, in some cases to find that it disappears again when the receiver is being moved to the bench. However, some knowledge of the causes of these troubles can frequently save much valuable time.

Resistors

In the case of the television receiver mentioned above, it was found that a carbon resistor used in the h.t. decoupling circuit had overheated and become intermittent. This is not a fault which is inherent in these components, but it does sometimes occur, and when it does its location may cause some trouble. The best approach is first to decide the most probable part of the receiver to house the defective resistor, and then to examine in turn each one in that section. For example, if a television set developed intermittent collapsing of the frame timebase, leaving a thin horizontal line across the picture tube, those resistors in the frame timebase would first be examined, in particular any which may show signs of overheating. Overheating may not be necessarily the prime cause of failure, but may well be the result of it. Should the carbon crack, the resistance may increase appreciably, and thus the I^2R loss (wattage) across the fracture can be high. Whether or not overheating is present largely depends upon whether the resistor is in such a position in the circuit to permit it to pass sufficient current. A quick check for a fracture is obtained by applying a gentle but firm side or end pressure on the resistor. The direction is shown by the arrows in Fig. 1, which also indicates a typical hair-line break in the carbon body of the resistor. A gentle pull on the lead out wires will also show whether they are firmly anchored to the main element of the resistor. These tests will usually reveal a faulty resistor, but should they fail recourse must be made to resistance measurement.

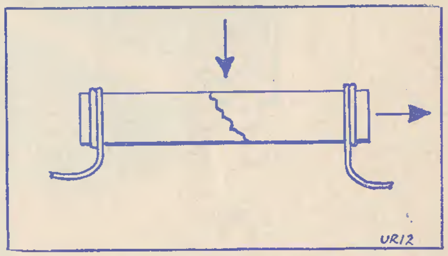


Fig. 1. A fracture in a carbon resistor may be detected by gentle pressure

Valves

Intermittent faults in valves occur due to several different causes, and can in general appear any time during their useful life. The most likely reason for a short is a particle of foreign matter such as a piece of getter material or speck of dust which has become carbonised, and is thus conductive, falling between two of the electrodes or electrode connections. Valve manufacturers take elaborate precautions these days to prevent these particles from reaching the electrode assembly during production, but it is virtually impossible to eliminate every piece. A valve which has developed this defect can sometimes be permanently repaired by simply dislodging the offending particle and allowing it to fall on to the bulb where it will not cause trouble. The best plan is to tap the valve on a table with the base downward in the hope that any loose particle will become dislodged and fall to the bottom of the bulb.

Another cause of short circuits which is much less prevalent in these days of improved manufacturing technique is the sagging of one of the grids so that it contacts its neighbour.

As a precaution against this happening, it is generally recommended if valves have to be mounted horizontally that they are rotated to such a position that the major axis of the grids is vertical. This is shown in Fig. 2.

Yet another reason for the intermittent operation of a valve is a broken weld which probably only makes contact after the valve has warmed up, and allows the metal to expand and remake the connection. Valve defects of the type mentioned are usually susceptible to vibration and the offending component can usually be located by gently tapping each in turn.

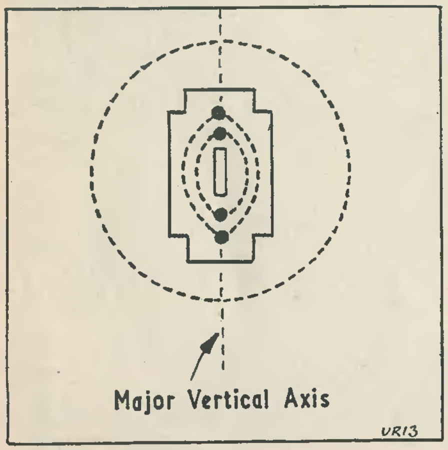


Fig. 2. Cross-section of a tetrode valve indicating the plane in which the assembly should be mounted

There is a particular fault which is peculiar to superhet receivers and causes them to become silent at certain times, usually when the mains voltage is low. This is due to the temporary stopping of the local oscillator, usually because the oscillator valve emission is low so that it will only oscillate when the supply voltage is fairly high. The obvious cure is to test and renew the oscillator valve (usually the frequency changer), but before doing so, check l.t. and h.t. voltages, and compare them with the valve maker's recommended figures. The l.t. is the most critical and should be within ±7% of the correct value.

This type of fault is particularly troublesome in the battery portable class of receiver where premature failure is often taken as an indication that the batteries require renewing. The battery voltage will fall gradually during life, and if all is well in the receiver the frequency changer should continue to function until the l.t. has fallen from 1.5V to about 1V. However, if oscillation ceases before this value is reached, the valve should be tested. Another contributory factor of this trouble is insufficiently tight coupling between the turns of the two windings comprising the oscillator coil. Coils made specially for use in battery receivers have the maximum possible coupling which is obtained by placing the windings one above the other.

Fuses

Intermittent faults are often blamed for the sudden, and on the face of it, inexplicable blowing of fuses from time to time. Whilst in many cases this is so, and some of the faults mentioned may well blow a fuse, there are instances when a fuse will open without any overload current. This may be expected to occur when a standard fuse is employed to carry a steady current near its rated value. It is usual to employ a fuse with a rated current value which is at least twice that which it is normally expected to carry. If this gives inadequate protection to the equipment, then one of the special thermal cut-outs as made by Belling & Lee should be employed.

In this short resumé of the major cause of intermittent operation, no mention has been made of capacitors or transformers. Capacitors may be checked for mechanical connection in the same way as resistors, although they seldom exhibit this type of fault. Transformers rarely go intermittent; usually turns become permanently shorted or the wire parts and they become open circuit. In the writer's opinion the defects listed are those which are most likely to give trouble, and to be aware of them goes a long way towards their speedy rectification.

The article on the Collaro tape deck has had to be unavoidably held over.

Radio and Electronic Component Show

TICKET ARRANGEMENTS

The R.E.C.M.F. has discontinued the lapel badge system of admission for visitors to the 1957 Radio and Electronic Component Show, to be held in London from 8th to 11th April. This year double tear-off tickets will be issued which will admit to both sections of the show, at Grosvenor House and at Park Lane House. These tickets will be issued from the R.E.C.M.F. offices and all prospective bona fide visitors should apply in writing direct to The Secretary, Radio and Electronic Component Manufacturers' Federation, 21 Tothill Street, Westminster, S.W.1.

The "MINI-MAX"

TRANSISTOR POCKET RADIO

for Local Station Reception

PART 1

by **I. F. GREGORY**

SINCE LAST YEAR'S NATIONAL RADIO SHOW there has been an increasing interest shown in transistors; though unfortunately, apart from the Red and Blue Spot types, r.f. junctions are only now slowly becoming available to the constructor. The Red and Blue Spot junctions are capable of a good performance on the medium waveband, but despite this the construction of a pocket superhet is a matter of considerable difficulty. At the time of writing a small 2-gang condenser, the J.B. type "O," and a range of small i.f. transformers and oscillator coil to suit, are obtainable; but these are not really in the sub-miniature class, and there are no indications of any such items comparable to those available in the States being on the way—though there have been one or two rumours.

The Pocket Radio described here has been designed to produce a really small-sized receiver, and yet one capable of giving a reasonable volume of sound despite its physical dimensions—and this on a "speaker." The quality is, naturally, not in the Hi-Fi class; however, if the receiver is to be small and not too expensive to build, this is unavoidable.

The Circuit

Fig. 1 shows the circuit diagram of the receiver, the r.f. section of which consists of a single tuned circuit consisting of a ferrite frame aerial tuned by a variable condenser, feeding a germanium diode detector. This is followed by a step-down transformer to match the output of the detector into the base of the first transistor audio stage. Then follow a further four stages of audio amplification, using Mullard OC71 transistors or their equivalents.

The power supply consists of three Mallory (obtainable from Boots the Chemists) mercury hearing-aid cells, giving a total of some 4V. The "speaker" used is an ex-W.D. balanced armature earphone, which is easily obtainable.

The receiver will give an output of about 40mW in areas of good signal strength.

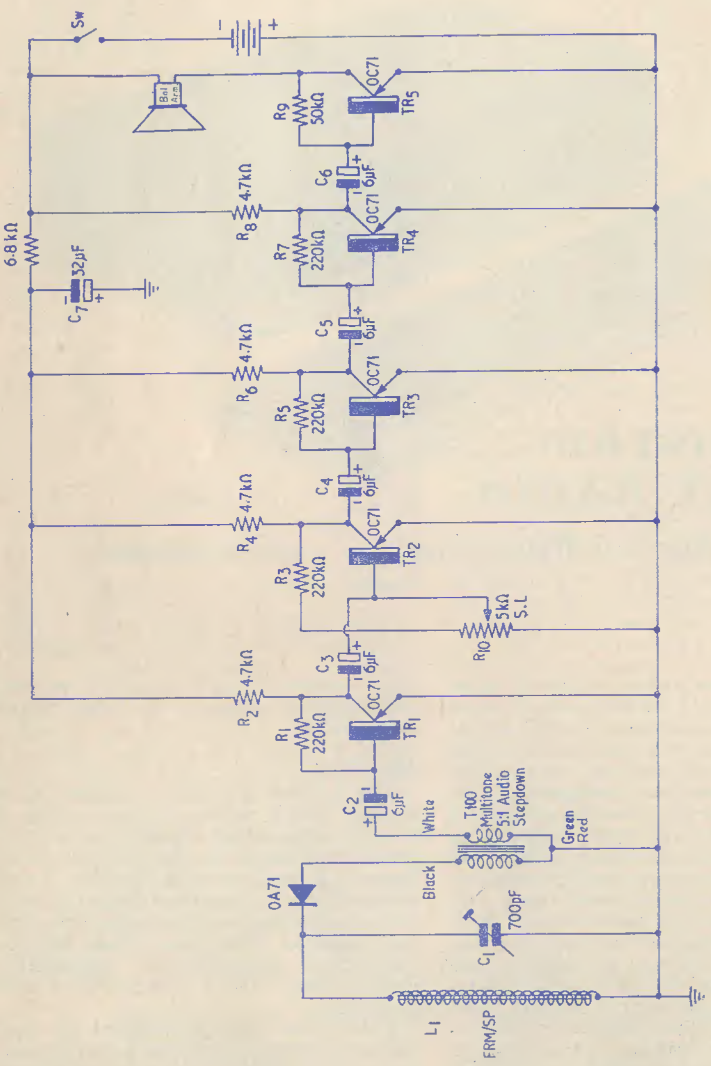
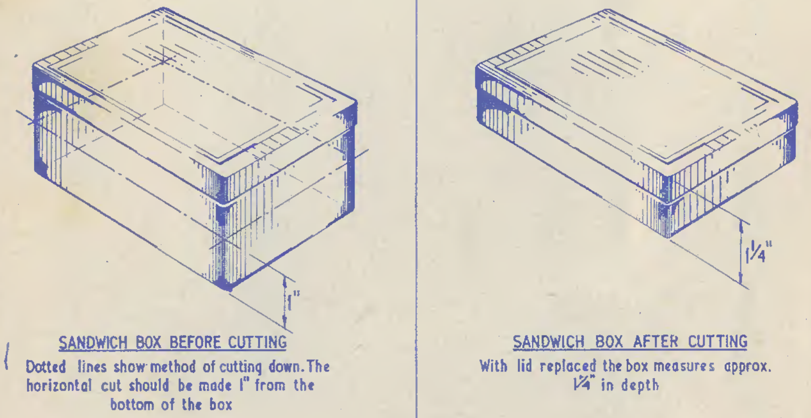


FIG.1 CIRCUIT DIAGRAM OF TRANSISTOR RECEIVER

The Case

After a very extensive search for a suitable plastic case in which to build the receiver, the writer finally decided to use a cheap sandwich box, sold generally under the name "Elevenses Pack" and illustrated here. It should be stressed that the set has been designed to fit this particular box, after the latter has been modified, and construction would be greatly facilitated by its use.



SANDWICH BOX BEFORE CUTTING
Dotted lines show method of cutting down. The horizontal cut should be made 1" from the bottom of the box

SANDWICH BOX AFTER CUTTING
With lid replaced the box measures approx. 1¼" in depth

FIG. 2

Preparation of Box

The plastic box when bought is nearly 2½-in deep, and as a final depth of 1¼-in only is required it can be cut horizontally as shown in Fig. 2. Great care should be exercised during this operation, as this type of plastic fractures very easily. It is, therefore, suggested that a very fine-toothed saw of the Dovetail type be used, and that the cut be kept wet whilst sawing.

On completion of this stage it may be found that the lid is now a little too tight; this is, however, all to the good as a very tight final fit is essential. The lip on the lid may be lightly filed until the desired fit is obtained. The box will require still further modification, but this is dealt with later in the article.

The Chassis

Paxolin sheeting of approximately one-sixteenth inch thickness provides a very suitable material for the chassis, as it can be easily cut and offers sufficient strength. A sheet measuring 6in by 6in will be needed as a second piece is required for the front of the box, described later in the article.

The chassis should be cut to fit closely into the box, with all four corners rounded to conform with the shape and give it maximum size.

Figs. 3 and 4 show respectively the underneath and top layouts with the main components identified.

The Transformer

Mounting the transformer presents some problems, and the following observations may be of assistance. Mounting directly on to the chassis was found to result in a howl owing to vibrations from the speaker being picked up. This trouble can, however, be completely eliminated (except when the gain control is fully advanced) by insulating the transformer by means of a rubber seating. A hole should be cut in the chassis of a size somewhat larger than the transformer (a ¼-in clearance each way should be sufficient). Now place the transformer, leads downwards, upon a piece of rubber strip, and sink the laminations and leads into the strip. Cut the latter considerably oversize, and secure this assembly to the

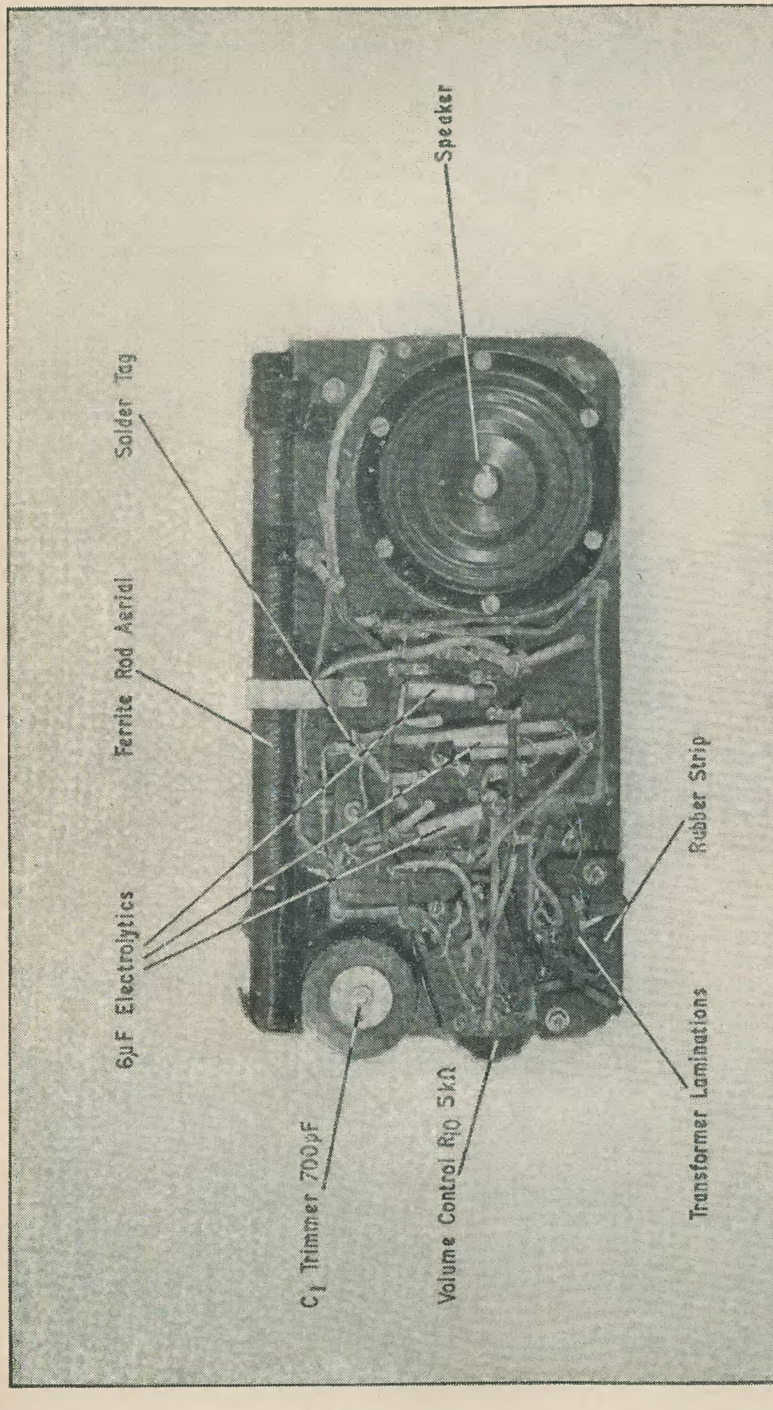


FIG.3. UNDERSIDE OF CHASSIS SHOWING MAIN COMPONENTS ASSEMBLED

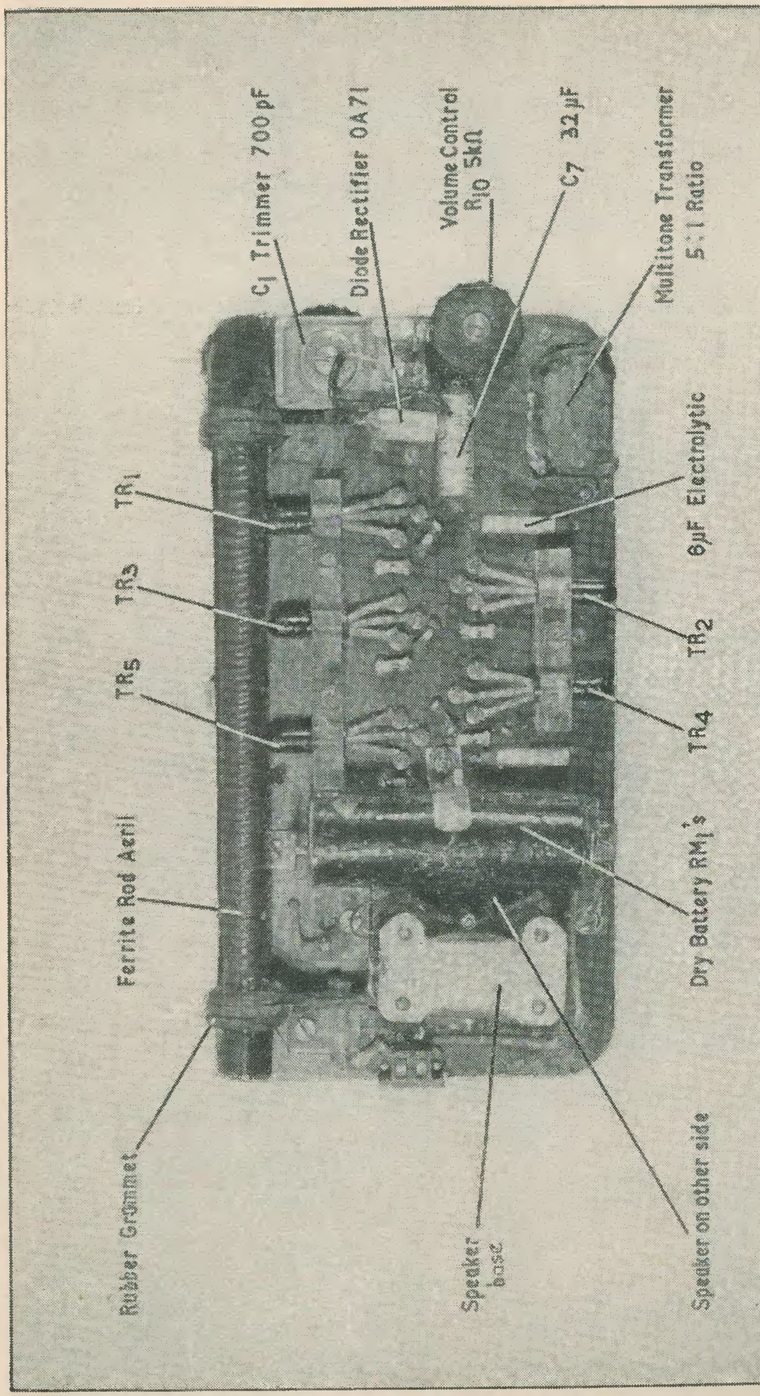


FIG.4. TOP VIEW OF CHASSIS SHOWING MAIN COMPONENTS ASSEMBLED

chassis by means of two small screws and nuts. It is suggested that a small quantity of 12-BA screws and nuts be purchased from a model shop, as these are required as anchorages elsewhere, and can also be used for mounting the transformer.

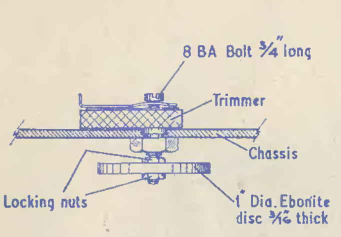


FIG. 5 MOUNTING OF TRIMMER—SHOWING MODIFICATIONS

Tuning Condenser

The 700pF trimmer is mounted as shown in Fig. 5. The adjusting screw must be replaced by one of similar thread and having a length of $\frac{3}{4}$-in, to enable a tuning disc (knob) to be fitted and also to allow sufficient space for locking nuts for this disc and the mounting nuts for the whole assembly. It may be found necessary to shorten the threaded mounting sleeve on the trimmer to give more room for these modifications.

(*to be continued*)

Components used in Prototype

TR_1, TR_2, TR_3, TR_4, TR_5	Mullard OC71 (or Henry's Red Spot)
T_1	Interstage Multitone T100 (or similar)
C_1	700pF ceramic trimmer Henry's Radio
C_2, C_3, C_4, C_5, C_6	6μF 1.5V T.C.C.
C_7	32μF 1.5V T.C.C.
R_1, R_3, R_5, R_7	220kΩ $\frac{1}{4}$W
R_2, R_4, R_6, R_8	4.7kΩ $\frac{1}{4}$W
R_9	50kΩ $\frac{1}{4}$W
R_{10}	5kΩ S.L. V/C with switch, Ardente V.C.1126
Crystal Diode, Mullard OA71 or similar	
L_1	Teletron ferrite frame type FRM/SP
Solder tags, Sub-miniature, G. W. Smith, Lisle Street	
Speaker, Balanced Armature Earpiece, ex-W.D.	
Batteries, 3 Mallory Cells R.M.1 (Boots the Chemists)	
12-BA Screws and Nuts, Bonds o' Euston Road, 357 Euston Road, N.W.1	

The Television Society Exhibition, 1957

Place: The Royal Hotel, Woburn Place, London, W.C.1.

Dates: Tuesday, 5th March, 11.30 a.m.–8 p.m. (members only); Wednesday, 6th March and Thursday, 7th March, 12.0 a.m.–8 p.m. (ticket holders only).

Tickets are available, free, from the Television Society, 164 Shaftesbury Avenue, London, W.C.2.

Exhibitors: At the time of the issue of this press notice the following exhibitors will be taking part:

Automatic Coil Winder & Electrical Equipment Co. Ltd.
C. H. Banthorpe Esq.
Belling & Lee Ltd.
B.R.E.M.A.
British Broadcasting Corporation
Bush Radio Ltd.
A. C. Cossor Ltd.
Cinema-Television Ltd.
Edison Swan Ltd.
E.M.I. Electronics Ltd.
The Ever-Ready Co. (Gt. Britain) Ltd.
J. S. Fielden
General Electric Co. Ltd.
Hallam, Sleigh & Cheston Ltd.
Leyland Instruments Ltd.
Livingston Laboratories Ltd.
Marconi's Wireless Telegraph Co. Ltd.
Mullard Ltd.
Murphy Radio Ltd.
Philco Ltd.
Standard Telephone & Cables Ltd.
Telegraph Construction & Maintenance Co. Ltd.
Thorn Electrical Industries Ltd.
20th Century Electronics Ltd.
W. Vinten Ltd.

Exhibition: The outstanding exhibit this year will be the first demonstration at an exhibition of colour television to N.T.S.C. standards. Colour signals will be generated from a flying-spot colour slide scanner, encoded and monitored on various colour receivers.

Many examples of new transistorised equipment will be shown with particular reference to television applications.

Test gear, new components, cathode ray tubes, studio monitors, studio apparatus, colour burst generators and many other items will be demonstrated.

THE "VERSATILE" AMPLIFIER

by **J. G. RANSOME**

THE "VERSATILE" WAS DESIGNED FOR USE IN conjunction with various radio tuner units, each having its own self-contained power supply. It may, however, be argued that many of the tuner units now on the market do not possess such a feature, and that provision for their supplies must be made in the amplifier. To take care of this point, an alternative power supply is given which will, in addition to the supplies for the amplifier, give 250V at 30mA and 6.3V at 1.5A for the tuner unit. The alternative power pack also has the advantage of being isolated from the mains, and the chassis may therefore be directly earthed. With the supply shown in Fig. 1, the chassis is "live" and the usual safety precautions should be taken.

With the valves specified, some 3–4 watts of good audio can be obtained, and this is sufficient to load an 8-in speaker. Distortion is of a low degree. Negative feedback was considered, and tried, but it gave so little improvement that, in this case at any rate, it was decided that the additional complication and expense was not justified.

The first stage uses a Mullard EF40 low microphony pentode, and provided that reasonable precautions are taken there should be no trouble with instability. The input lead to the potentiometer should be screened, as should the case of the potentiometer itself. The lead from the control to the grid of V_1 could also be screened, but if this is thought to be impracticable then it should be kept as short as possible and well away from the heater leads.

The gain of the first stage is about 100, with the valve specified. This may be too great a gain for some tuners, which is why the volume control has been incorporated in the grid of V_1 and not, as more usual, in the grid of V_2.

The EF40 is a miniature B8A-based equivalent of the well-known EF37A, and there is no reason why the latter valve should not, if it is more convenient, be used instead. No alterations to the circuit are required other than, of course, the replacement of the B8A holder by an octal holder, and the appropriate wiring-up of the latter.

The overall gain of the amplifier is such that it is adequate for use as a gramophone, baby alarm, intercom amplifier, etc.

The output stage is quite straightforward, and only one comment is needed. It was suggested that it might prove more versatile if, by choosing a suitable value for the bias resistor, R_6, the user could obtain the choice of employing, without alteration, an EL42 for normal use or an EL91 for occasions where higher power was required. This is not practicable, however. The EL42 needs a bias resistor of 360Ω, and this is fairly critical. If a value such as this was used for the EL91 its output would be no greater than that of the EL42, if as much.

It should be noted that the "Versatile" has a high impedance input. Some tuner units (and some microphones and other apparatus which might be fed into the amplifier) have low impedance outputs. In this case a suitable matching transformer will be required, and this should preferably have a mu-metal case—it should be screened, in any event, and the screening taken to chassis.

Warning

If the power supply shown in Fig. 1 is used, then the chassis will be "live" and, therefore, dangerous under certain conditions. Readers building this version are advised to read the comments on safety precautions which appeared in "Television for the Home Constructor" in the last issue of this magazine.

It should not be forgotten, in this connection, that the chassis of a tuner unit or any other apparatus used with the amplifier will also become "live." This may be avoided by coupling the two items via a 1 : 1 isolating transformer; or in the case where the matching input transformer is employed, it will be achieved automatically provided it is a true transformer—and not an auto-transformer—and also provided that neither side of the

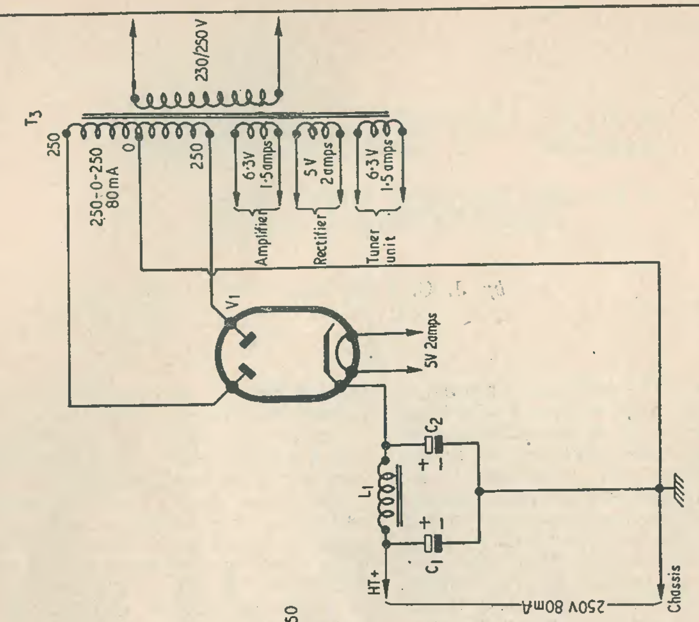


Fig. 2
Alternative power supply
Break circuit at ⊗ on Fig. 1 & connect as in diagram

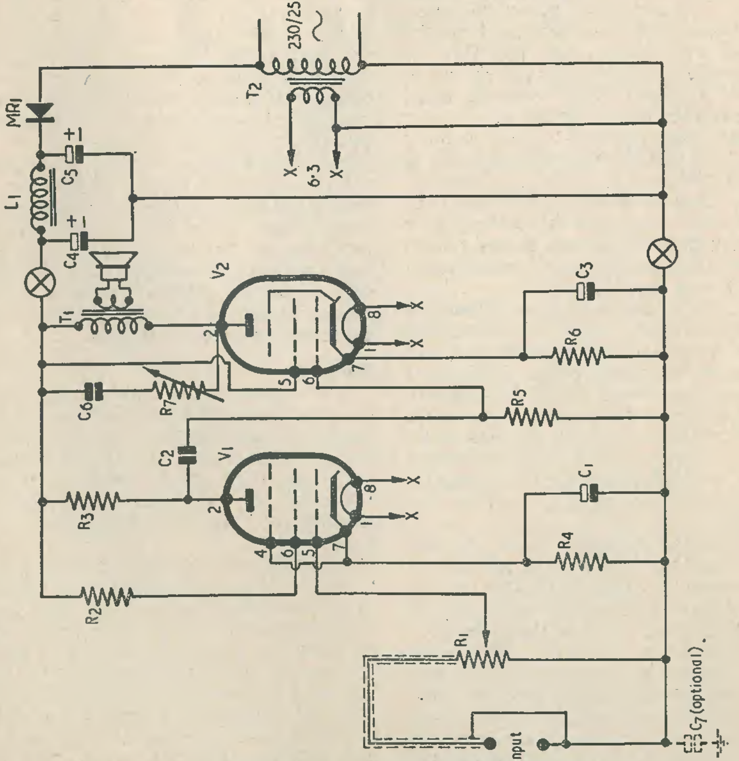


Fig. 1
The "Versatile" amplifier

primary winding is connected to the amplifier chassis. The amplifier should be housed in a wood cabinet, with all screws covered over so that no contact can be made, even accidentally, with the chassis.

All the above complications may be avoided by employing the power supply given in Fig. 2 at very little extra cost; but even here the trouble can occur, should the amplifier be used (without an isolating transformer) with a unit which itself happens to be fitted with a self-contained power supply which renders its own chassis "live."

Life can be tedious—but it's still better to be alive!

Component List

Resistors

R_1	250kΩ pot.
R_2	220kΩ
R_3	100kΩ
R_4	1.5kΩ
R_5	500kΩ
R_6	220Ω 1 watt
R_7	25kΩ pot.

Condensers

C_1	25μF 25V
C_2	0.1μF 350V
C_3	25μF 25V
C_4, C_5	16 and 8μF 350V
C_6	0.005μF 350V
C_7	0.1μF 750V

Miscellaneous

V_1	EF40
V_2	EL91
MR_1	any metal rectifier capable of handling 60mA at 250V
L_1	Smoothing Choke, 10H, 60mA
T_1	50 : 1 for 3Ω; 30 : 1 for 8Ω; 22 : 1 for 15Ω. Z = 9kΩ
T_2	Secondary 6.3V at 1.5A

Alternative Power Supply

C_1, C_2	16 and 8μF 350V
L_1	10H, 90mA
T_3	Secs: 250–0–250V at 80mA, 6.3V at 1.5A, 6.3V at 1.5A, 5V at 2A
V_1	EZ40 or similar

Can Anyone Help?

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

E. D. FARNSWORTH, 65 High Street, Carrville, Durham City, wishes to buy or borrow the Manual or circuit diagram of the ex-Admiralty AVO Valve Tester pattern 55046, serial no. 10374–646. This instrument is basically the pre-war AVO design with separate valve panel.

* * *

W. CAMPBELL, 22 Burnmouth Road, Barlanark, Glasgow, E.3, is in need of and is willing to purchase a Manual, circuit diagram or any other data on the Eddystone B34 (358X) receiver. All letters will be answered.

* * *

J. J. G. CLAYTON, Crookham Lodge, Church Crookham, Hants, wishes to buy or borrow the handbook on, or details for converting, the U.S. Army Signal Corps receiver type BC–683–A (28–39 Mc/s). It is required to convert to Band 2.

* * *

PHILIP GOH, 721 Geylang Road, Singapore 14, Malaya, wishes to buy, borrow or hire a circuit diagram for the "Erres" model KY750 receiver.

* * *

W. STEPHENS, 48 St. Marys Road, Oatlands Park, Weybridge, Surrey, would like to borrow or purchase the circuit diagram of the Philips radiogram type 539A.

J. BROMILEY, 333 Bolton Road, Westhoughton, near Bolton, is in need of information on the valve line-up in the driver and final stages of a Marconi C.N.Y.2. Can any reader assist?

* * *

R. MCLEOD, 50 Oakleigh Road North, London, N.20, wishes to buy or borrow a manual or handbook on the Pilot 85 receiver AC4810, and particularly wishes to know the wiring of the wavechange switch $S_{1, 2, 3, 4}$.

* * *

R. E. G. COPP, G2DUV, 14 Carolina Road, Thornton Heath, Surrey, wishes to borrow or purchase the service sheet or circuit diagram of the Murphy V204 television receiver with converter type C.2.

* * *

A. MAYHEW, 1 Windsor Gardens, Hayes, Middlesex, wishes to purchase coils or winding data of the G.E.C. V.H.F. Unit BCS 1350.

* * *

P. G. MARTIN, 4 Beech Road, Princes Risborough, Aylesbury, Bucks, wonders if anyone has a service sheet for the Murphy V114 television receiver for sale; or would exchange for "Handbook of Wireless Telegraphy," Admiralty, Vol. II, 1944 reprint.

Radio Miscellany

A number of interesting letters covering quite a range of topics have come to hand this month, and once again I have not had time to answer them all individually. Nonetheless they are greatly appreciated, and where necessary have been passed on to the suitable quarter for either noting or action.

F.W.D. of Southfields, S.W.18, writes, "You recently took up the question of the difficulties encountered by readers living in rural parts in getting components—especially the small items. Believe me, it isn't only rural readers who have this trouble. Even the London shops stock only the easy-selling lines. Try to get a small item and you usually find that unless it shows a high margin of profit or sells without the bother of cutting or counting, etc., they are not even interested in getting it for you. Recently I wanted some self-tapping screws, which are, of course, widely used by radio manufacturers, etc. I tried nearly a dozen radio and tool shops, etc., and I am still looking for them! Not one offered to get them."

Oddly enough, about eighteen months ago I was in need of self-cutting screws myself, and needing them quickly found very much the same difficulty. Eventually I found that a branch of a well-known motor accessories firm (Branches Everywhere) carried a small stock of a limited number of sizes—mostly countersunk, which I didn't want. I had to make do with the nearest size available.

These screws are also widely used in the motor trade, but by far the best plan is to stock up whenever you get the opportunity. They are useful for all sorts of jobs. Experience teaches that they work out just about as dear as buying nuts and screws, but they are invaluable for jobs where it is awkward, or impossible, to get a nut on the back (Messrs. K. R. Whiston, New Mills, Stockport, Cheshire, have huge stocks of almost any screw or nut likely to be wanted, and will send a list on request.—Ed.)

The Wide World

Another interesting letter comes from Mr. V. Savage of Christchurch, New Zealand, who mentions that his copies of *R.C.* are eagerly awaited each month. I hope the journal you wanted has reached you safely, old man, and if you write again don't forget we always welcome news and views of overseas constructors and like to hear something of their experiences. The only thing that most home readers know about radio in New Zealand is that prices are somewhat dearer than they are in Gt. Britain, and that you see more of American gear than we do. What about it, you readers in other parts of the world?

Protection

The next comes from G.E.S. of Reading, who writes: "A couple of years ago you gave some tips on anodizing for weatherproofing dural aerial elements. I tried it, but do not consider even this gives sufficient protection. What about the fancy dressing motorists have recently taken to using to protect the exposed chromium parts of their cars?"

A very good question, and I feel that G.E.S. may have got something there. Who can have failed to have seen the colourful lacquers so generously daubed over all the bright parts of so many cars. Incidentally, I have tried some myself and found it easily obtainable in the transparent form. It is really weatherproof, too, but just how the "remover" is going to work when the sun returns has yet to be seen.

When one comes to think of it, it is rather incongruous that chromium plating, which at first was intended to protect bare metals, should itself come to be in need of protection. But there it is. These lacquers, which are simply painted on with a brush, certainly give full protection from rain. Presumably dural aerial rods would be equally well protected against moisture, but whether it would retard chemical deterioration as well is a question some of our readers more versed in chemistry than I am might answer.

Round the Workshops

While on the subject of ideas, I recently saw some excellent examples of metal renovation carried out by one of our old-timers. He had several ex-W.D. receiver and instrument cases which had stood empty and idle since the first R.S.G.B. Disposal Scheme. They were sadly battered, and at least one corner had completely rusted away. Needing to put them into use, he set about restoring them. After all the old paint was scratched off with a wire brush, the dents were beaten out as well as possible. With the aid of a filling marketed under the name of "Bondafiller" made up into a putty-like mixture, the dents and holes were filled in. Bondafiller is made of glass fibre, resin and a powder. It dries hard in about a half an hour, when it can be sanded or filed to give a good painting surface. Primarily made for the home repairing of splits and dents in car wings, it is also ideally suited to such jobs as that undertaken by our friend. While I have not yet had occasion to try this preparation out for myself, judging from the results achieved, I should imagine any handyman ought to be able to get a near-professional finish with the minimum of practice.

CENTRE TAP *talks about* *Items of General Interest*

Self-Help

With this month's correspondence also comes an appreciative letter from Bill Harris, Hon. Sec. of the Radio Amateurs Invalid and Bedfast Club, regarding my comments on the cheerful, help-one-another spirit with which our less fortunate fellow hobbyists overcome their various handicaps. As I have already pointed out, this club does not publicly appeal for help. True, they have received help from well-wishers—helpers whose first gesture came as a friendly action towards a fellow-enthusiast and who now willingly lend a hand when they see the difference a cheerful word, or a little encouragement could make. Yet most of the good work has come as the result of their own efforts despite their various physical handicaps, often in the face of financial strain.

We who are blessed with good sight, health and a full complement of limbs, are only too apt to take these things for granted. My own consciousness of incapacity was of a temporary nature during the war. For a while I was "one-armed," and if you have not yet appreciated just what effect this has on the thousand and one things of daily life, try cutting up the meat on your plate with one hand. Of course, you could try drilling a chassis, assembling components and soldering connections with one hand only if you remain unconvinced. You may well then wonder whether you have the character and fortitude, not only to remain cheerful in overcoming such a difficulty, but in getting round to helping someone whose plight is perhaps worse than your own.

Bill tells me that a Mr. Dawson of Stoke-on-Trent was first in the field with an offer of help. I hope many others have followed his example.

Where There's a Will

He also pays tribute to the grand work put in by their local reps. I know many of them perform their good services in face of physical difficulties. But what of Bill himself? I have not had the good fortune to meet him, as he has been bedridden for a good many years; and last June he had the misfortune to lose the sight of his one good eye—the other has long since been virtually useless. Yet he underwent training in order to use a special typewriter, so he could carry on with his secretaryship.

It is heartening to feel that in these days when there is a deplorable tendency for people to expect the Welfare State to do everything for them, that those who have a better right than most to look for help from others, should have the spirit to do so much for one another. By the way, any reader who has no modern gear he could send can still show his sympathy in a practical form. What about a supply of duplicating paper for their excellent monthly news-letter, *Radial*, or a book of stamps to help with its circulation?

It is hoped that a regular 40-metre "Net" can be planned by their members holding transmitting licences in the early future. Full details are obtainable from Bill Harris, 25 Playford Lane, Rushmere, Ipswich.

Lament

So the long-threatened extra hour of T.V. (between six and seven in the evenings) is at last upon us. Not only is it a backward step regretted by many (amateurs, parents, teachers, most thoughtful viewers and those who would enjoy some peace), but it is to be feared that a threat of round-the-clock T.V. may well lurk behind it. Remember steam radio started off with two hours a day and gradually grew to the almost incessant din which haunts us all day—and most of the night.

(*continued on page* 562)

MULTIVIBRATOR DESIGN

Using C-R Curves to Simplify Calculations

by HUGH GUY

Coupling Circuits

VIDEO AND PULSE TECHNIQUES DIFFER FROM audio and radio frequency techniques principally in the types of waveform encountered. Whereas those of r.f. and a.f. circuits are nearly always sine waves, video and pulse waveforms are usually anything but. As a result, simple circuit elements need more careful consideration and are sometimes more involved when they occur in circuits required to handle pulses and square waves. A good case in point concerns resistance-capacitance coupling.

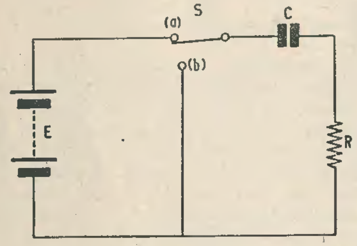


FIG. 1a.

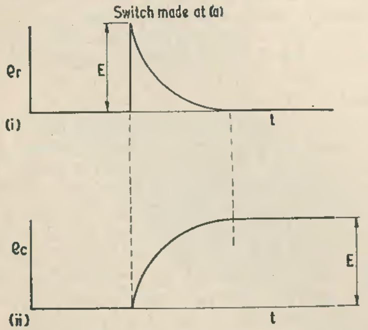


FIG. 1b.

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A bad choice of components in a resistance-capacitance coupling usually results in nothing more serious than an attenuation in signal and undue phase-shift, if such compents comprise a.f. or r.f. couplings. A similar unfortunate choice in components used, say, in a video coupling, however, can make a square-wave recognisable.

Unwanted phase-shift in a.f. and r.f. circuits is, of course, not permissible if negative feedback is to be applied, otherwise distortion may occur; but except for this case, incorrect components in such circuits cannot produce distortion of sine waveshape. This is not true in the case of square waves, or in fact of any waveshape other than the sine wave.

The fact that simple R-C circuits are capable of altering waveshapes is often utilised in pulse techniques; for example, a circuit which differentiates the output (i.e. one which produces an output which varies at the rate of change of the input) consists of exactly the same arrangement of condenser and resistor as does the coupling circuit.

It will be helpful here if we consider what happens in a simple voltage divider circuit consisting of the usual R-C coupling; that is, a condenser and resistor in series.

The circuit is shown in Fig. 1A. Here, a d.c. supply in the form of a battery E is connected in series with a two-positioned switch S to the condenser and resistor. In position "a," the battery supplies current to the divider, while in position "b" the divider is short-circuited.

If the operation of this elementary circuit is followed in detail, the approach to the design of R-C couplings will be readily understood.

For such a circuit Ohm's law still applies, despite the fact that a condenser is involved. If the switch is suddenly closed then electrons start to flow from the upper plate of the condenser, being attracted by the "positiveness" of the battery. These electrons constitute the charging current of the condenser C; and at the initial instant, there is no voltage across the condenser. The total voltage, therefore, appears across the resistor R, and the initial charging current i_c equals E/R. In Fig. 1B are drawn the waveforms appearing in the various parts of the circuit and in (i) the edge corresponding to the sudden application of the voltage E to the circuit is seen to produce the entire input voltage across R whilst no voltage appears across C.

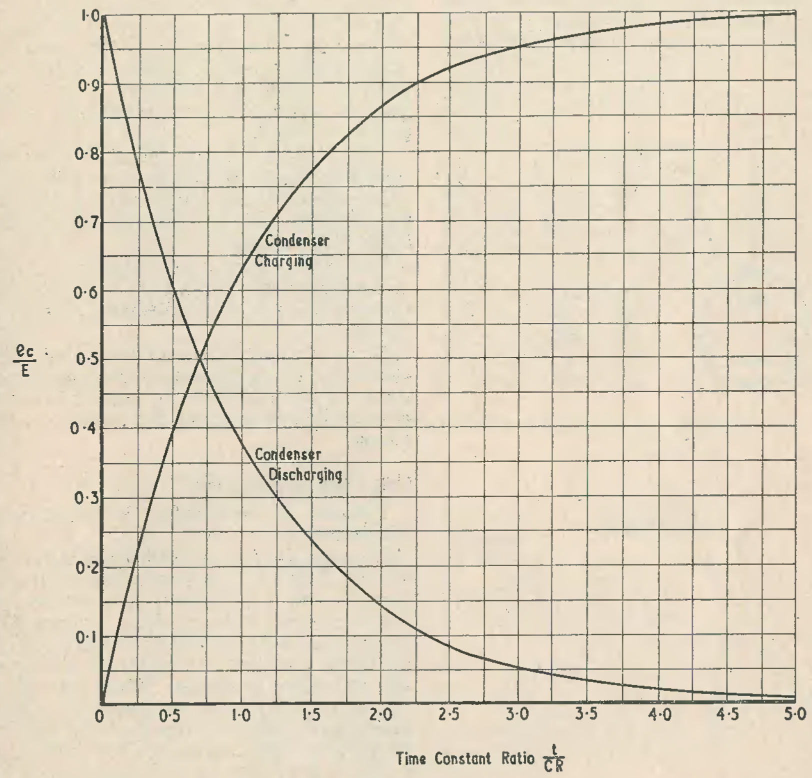


FIG. 2. CHARGE AND DISCHARGE CURVES.

C413

With the continued flow of current in the circuit the condenser starts to charge. The formula Q = CV shows us that the voltage across the condenser increases directly with the charge and hence the voltage across the condenser commences to rise. The total voltage E remains fixed, of course, and thus the voltage drop across the resistor will correspondingly fall. This voltage drop will nevertheless be produced by the product i_cR and, since R is fixed, i_c must decrease and the condenser charge less rapidly.

This process will reach a climax when the condenser is fully charged and the voltage E appears across its terminals. By this argument, therefore, the voltage across the resistor will be zero at this time (which theoretically occurs only after infinite time), and no current will flow. This is shown in Fig. 1B.

If S is now switched to position b, the condenser will now start to discharge. This time, however, the discharge current i_d will flow in the opposite direction resulting in a voltage drop of the opposite polarity to the charging voltage. The amplitude and shape of the waveform will be as before, however.

C-R Curves

There is a formula by means of which it is possible to determine the voltage appearing across the resistor or condenser at any given instant during the charge or discharge of the condenser. When, for example, the condenser is charging, the current at any instant is given by:

$$i_c = E/R.^{-t/CR}$$

When the condenser is discharging through R, the discharge current at any instant is:

$$i_d = -E/R.^{-t/CR}$$

Now although the charge and discharge currents are the same, apart from the minus sign, which in the latter expression indicates that the current flows out of, and not into, the condenser, the voltage appearing across the two components is not the same in the two cases because the circuit is different in each case.

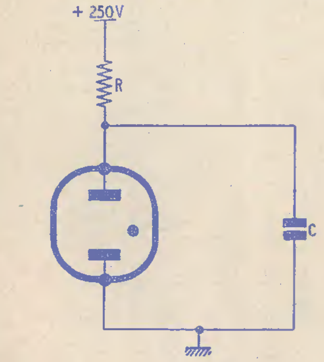


FIG. 3a.
SIMPLE TIME BASE.

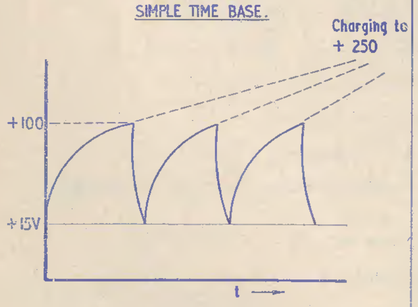


FIG. 3b.
WAVEFORM OF FIG. 3a CIRCUIT.

In the charge case, the condenser and resistor are in series across a supply of E volts. Thus the resistor voltage equals i_cR and the condenser voltage is the difference between the supply voltage and the resistor voltage.

In the discharge case, the two components are in parallel and hence the voltage across each is common and equals i_dR.

The voltages across each component at any instant during either of the two conditions is given below:

R-C charging:

$$e_r = i_cR = E.\varepsilon^{-t/CR}$$
$$e_c = E - e_r = E(1 - \varepsilon^{-t/CR})$$

R–C discharging:

$$e_r = e_c = i_dR = -E.\varepsilon^{-t/CR}$$

Of these formulae, those dealing with the voltage across the condenser at any time t are the ones concerning us most.

None of these formulae is easy to deal with as they stand since they involve the use of exponential quantities, and the essential information is more readily available in graphical form, and therefore a more convenient version of them is plotted in the graphs of Fig. 2.

These graphs have common axes, the horizontal scales being graduated in the ratio t/CR, where t is the time in seconds after the transient has occurred in the circuit, and CR is the time constant.

The vertical scale is graduated in the value of the condenser voltage after t seconds, as a fraction of the total possible change of voltage.

When designing a circuit involving the knowledge of the formulae from which these graphs were drawn, one or other of the two ratios is known enabling the unknown to be solved.

Using the C-R Curves

The use of these curves is shown in a simple example.

Consider the fundamental timebase circuit of Fig. 3A. This shows a neon lamp in parallel with a condenser, the combination being in series with a resistor. Across this circuit there is an h.t. voltage of 250V. When the h.t. is initially switched on the condenser will commence to charge. When the voltage across the condenser reaches the striking potential of the neon lamp, the latter will fire, discharging the condenser very rapidly to within a few volts of zero, after which the process will be repeated.

The waveform produced by the circuit is shown in Fig. 3B, where it is seen to be repetitive, If this waveform were fed to the X plates of an oscilloscope, a trace would be produced across the face of the tube corresponding to the charging time of the condenser. The rapid discharge of the condenser through the low resistance of the now-conducting neon lamp would produce a flyback of the spot on the screen for the recommencement of the trace.

In practice, if such a circuit were used for producing a scan in this manner, the resulting trace would not be linear due to the curvature of the charging characteristic. However, the simple charging of a condenser through a resistor is the common basis of a great variety of scan generating circuits, many ingenious refinements having been devised to correct for the non-linearity of the characteristic.

How, then, do we proceed to calculate the values of condenser and resistor?

First we must know the duration of the scan, or scan time. Let us say that, for this example, we require 100 scans per second. If we assume that the flyback time is very much less than the scan time, then we can assume that the latter is 1/100 sec. This is the value of the symbol t in the ratio t/CR on the graph.

We next need to know the characteristics of the neon. Let these be: Striking voltage, 100V. Extinguishing voltage, 15V. Average conducting resistance 100 ohms.

In Fig. 3B we see the limits marked on the waveform. The condenser starts charging from 15V, this being the level at which recharging starts after the completion of the previous scan and flyback. The charge rises exponentially towards 250V, but ceases abruptly at 100V when the neon fires. The voltage e_c is, therefore, (100-15)V, i.e. 85V, and the voltage E is (250-15)V, i.e. 235V. Thus the ratio e_c/E is 85/235 or 0.362, and from the Charge curve this is seen to correspond to a t/CR ratio of 0.44.

From a practical point of view it pays to keep the value of condenser down, both from a size and from a financial consideration, and the value of resistor is therefore best found in the Megohms region. A second point which endorses this view concerns the flyback time. If the condenser is large, when the neon conducts the discharge path consists of a parallel path through the neon resistance and through R. The latter being much greater than the former means that the discharge resistance is virtually only the neon resistance. The larger the value of resistor R, the truer this is, and the calculation for the discharge time is made correspondingly simpler.

This, then, is a point in favour of a large value for R.

A second point is the desirability for a small value of condenser so that the time taken to discharge it through the neon resistance is negligible compared with the scan time. Now we know that the discharge resistance is the conducting resistance of the neon—about 100 ohms, we said. Let this be R_d. Then we know the discharge time constant CR_d once we have fixed the value of C. Looking at the waveform again, we see that the condenser discharges from 100V to 15V, and this decay finally gives us a value of 15V across the condenser for e_d. The voltage E is, of course, 100V, being the amount the condenser could discharge if it were permitted. Thus the ratio e_d/E on the discharge curve is 15/100 or 0.15, which in turn gives a t/CR value of 1.88. That is, t/CR_d must be 1.88.

From the two cases we have first, CR = 0.0227, and second, that t/CR equals 1.88, where t is the discharge time and R_d is 100 ohms. The discharge time is, therefore, 188 × C, showing that for a short flyback C

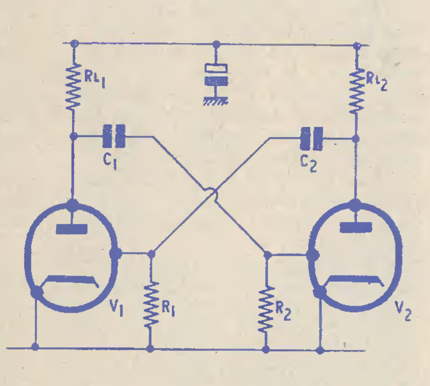


FIG. 4.
FREE-RUNNING MULTIVIBRATOR.

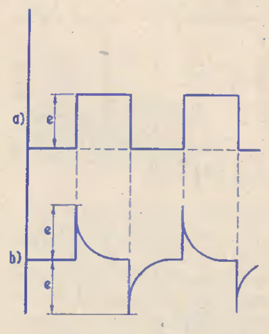


FIG. 5.
DIFFERENTIATION OF A SQUARE-WAVE.

Now t is known to be 0.01 secs., and hence CR is 0.01/0.44 or 0.0227.

Theoretically it would seem that any value of condenser and resistor, provided their product was 0.0227, would suit the design; but this is not true in practice, and although the example we are now considering is not a multivibrator this method of determining C-R combinations is applicable in all cases. In practice it is the flyback time which governs the choice of components.

must be small. If we make the value of C, say, $0.015 \mu F$, then by the first relationship R must be 1.5 Megohms. Also the discharge time is 1.88×0.015 µsecs; that is 2.82 µsecs.

Differentiation

At the beginning of this article it was mentioned that an R-C coupling can be used to produce an output proportional to the rate of change of input. The significance of this is best appreciated from Fig. 5. The waveforms before and after differentiation are shown one under the other, in Figs. 5A and 5B respectively, drawn to the same scale of time. The rate of change of the leading and trailing edges of the square-wave input is very high—infinite, in fact, in positive and negative directions, and hence the amplitude of the output waveform at these times is also high. At the flat peak and trough of the waveform, however, the rate of change is zero, and theoretically the output should also be zero. Electrically the nett effect of differentiation is produced, and the circuit is used to produce pulses for triggering other circuits at the leading and/or trailing edge of the square-wave.

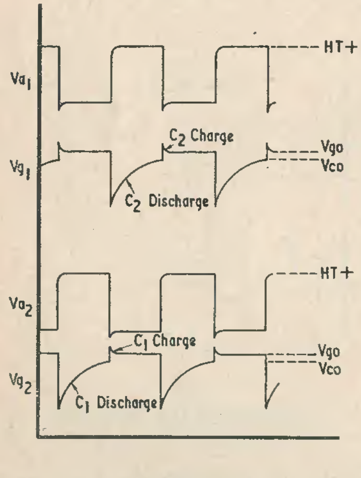


FIG. 6.
MULTIVIBRATOR WAVEFORMS.

When a square-wave is applied to an R-C coupling comprising a differentiator, the time-constant of the circuit is arranged to be short compared with the duration of each half of the square-wave. On the positive-going wave the condenser charges up to the peak value of the applied wave and the current through R decays to zero in this time. This process is repeated in reverse on the negative-going wave.

If, on the other hand, the time-constant is much greater than the duration of the transitions of the square-wave, then the condenser will hardly have commenced to charge when the next transition occurs. In this case the voltage change across the condenser is negligible and the square-wave is reproduced across the resistor almost unaltered.

These effects can be readily appreciated from the charge/discharge curve where for reasonable differentiation a t/CR ratio of 5 is seen to be adequate, whilst for good square-wave handling a t/CR ratio of 0.05 will result in only a 5% drop in the output.

Time of Rise

No electrically-produced square-wave has absolutely vertical leading and trailing edges. If a square-wave is produced at the anode of a particular valve, then the steepness of the wavefront is determined by the value of the load resistor and the stray capacities shunting it. These "strays" must be charged and discharged each time transitions of the waveform take place, and therefore, if examined closely, every square-wave will be seen to consist of an exponential leading edge, and a similar trailing edge. Of the current provided to produce such an edge, therefore, the more that is diverted to the condenser, the more exponential will be the characteristic of the waveform. It obviously pays to keep the stray capacities to a minimum by careful wiring and to use a low value of anode load, since the current flowing in the latter will be inversely proportional to its size.

Since the rate of rise or rise time of a wavefront determines its shape, it is necessary to be able to predict what the rise time T_r will be in a design.

The C-R charge curve shows that the time taken to reach the full value of applied voltage is very long, and so the rise time quoted in design practice is conveniently defined as being the time taken for the stray capacities across the load to charge from 10% to 90% of their full value. This is seen to correspond to a t/CR value of nearly 2.2, and, therefore, $T_r = 2.2CR$.

It is well worth taking the trouble to absorb what might seem to be a lengthy discourse on the mechanism of charging and discharging a condenser since it is the study of this type of transient phenomenon which is as basic to pulse techniques as the behaviour of sine waves is to a.f. practice.

The design of a simple multivibrator will illustrate this fact very well.

The Multivibrator

The simplest way of describing the multivibrator is to call it a two-stage R-C coupled amplifier whose output is fed back to the input. No frequency-conscious components are present in this positive feedback path, with the result that the output is not sinusoidal, but a square-wave.

The circuit is shown in Fig. 4.

On switching on, one or other of the two valves will start to conduct heavily due to the zero bias on its grid. Assume that V_2 is the valve in this case. Then the precipitate drop in anode voltage due to the heavy conduction through the anode load will be conveyed immediately to V_1 grid via the coupling condenser across which, remember, no instantaneous change of potential can occur.

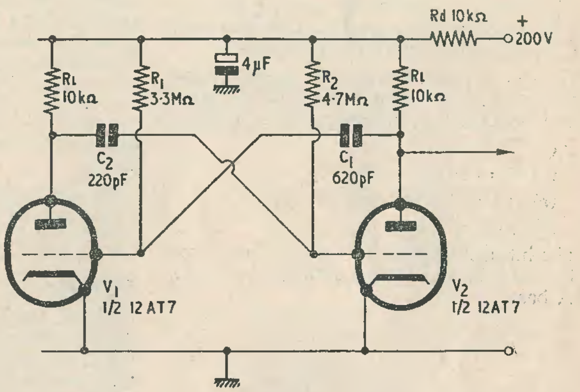


FIG. 7.
PRACTICAL MULTIVIBRATOR.

V_1 is thus well and truly cut off, but as the coupling condenser C_2 discharges so V_1 grid rises exponentially, as shown in Fig. 6, where anode and grid waveforms are given on the same time scale. When the grid potential has risen to within the cut-off bias (or grid base) of V_1, the latter starts to conduct with a consequential fall in anode potential. This drop like that just described is undergone by V_2.

The time intervals of the waveform are then dictated by the time taken to charge the coupling condensers through the series circuits comprising anode loads and following grid leaks. The number of square-waves produced per second and their mark-to-space ratio can be set by a knowledge of the valve characteristics and amplitudes of the pulses.

One minor refinement usually added in a practical design consists of returning the grid leaks not to earth but to the h.t. line. This is done to prevent "jitter" or uneven timing of the waveforms which results when a valve is cut-on near the limit of charge of the condenser when the voltage is changing only slowly across the grid leak. The cut-on or cut-off potential of a valve is rather ill-defined, varying slightly from one moment to the next. It is, therefore, important to make the transition from cut-off to cut-on rapid, and as the C-R charge shows, this is achieved best at a low e_c/E value. Hence E, the potential to which the condenser could finally charge, is made large. It is for this reason that the mode of connection in Fig. 7 is shown, this circuit being the one considered in the design example.

Design Procedure

The output required from the multivibrator should be specified in the following form:

(*a*) Rise time of leading edge (T_r) secs.
(*b*) Amplitude (A) volts
(*c*) Pulse recurrence frequency (prf)
(*d*) Mark-to-space ratio of waveform (M/S)

Using this information, the design then proceeds in the order set out below.

(1) The estimated stray capacities (C_s) in conjunction with (*a*) above fix the value of R_L, since $T_r = 2.2\ C_sR_L$.

(2) The current swing through the valve is determined from (*b*) above, since $A = I_aR_L$. This current is obtained at $V_g = 0$ and examination of the I_a/V_g characteristic of the chosen valve will show the anode-to-cathode voltage (V_{ak}) of the valve to produce this current at $V_g = 0$. To this V_{ak} is added the load voltage drop, and this gives the value of the necessary h.t. voltage.

(3) Voltage A will be conveyed to the opposite grid as a switch-off pulse. The rise of voltage across the associated grid leak will be controlled by the appropriate C and R. C should be small and R large so that the discharge time of C is short, and so that the value of R_L is negligible in comparison with R.

(4) The grid waveform is sketched and the potentials marked on as in Fig. 8A, and from this a value for e/E found. The grid voltage will rise exponentially towards the h.t. volt-

age, being caught when the valve starts to conduct. This point is reached when the grid voltage has risen to within the cut-off voltage (V_{co}) of the valve for the particular value of the h.t. in use. V_{co} is obtained from the valve characteristics.

Using the C-R charge curve, the corresponding t/CR ratio is found. Let this be t_m/C_1R_1, where t_m is the mark time.

(5) This procedure is repeated for the other valve resulting in a t_s/C_2R_2 value, where t_s is the space time.

(6) The total duration of the square-wave is given by 1/prf, and if the discharge times are made negligible, equals the sum of the mark and space times $t_m + t_s$. Hence these times may be solved from a knowledge of the prf and the mark/space ratio.

(7) Suitable values of C_1 and C_2 and R_1 and R_2 are then determined to conform to the C-R products deduced from t/CR ratios.

The design procedure is now applied to the design of such a free-running multivibrator, from which the output required is as follows:

(*a*) $T_r = 1\mu$sec.
(*b*) A = 60 volts
(*c*) prf = 1,000 pulses per sec.
(*d*) M/S = 2 : 1

The h.t. available is 200 volts. Valve used is 12AT7. This valve is a double triode on a B9A base.

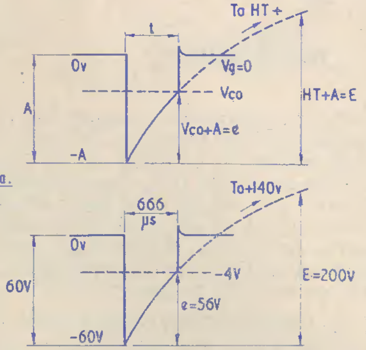


FIG. 8a.

FIG. 8b.

GRID VOLTAGES FOR DESIGN WORK.

(1) Estimated stray capacities = 50pF. Then $R_L = 10\text{k}\Omega$ for nearest standard value, to give T_r of 1μsec.

(2) I_a required for 60V pulse across $10\text{k}\Omega$ = 6mA. Valve curves show that 6mA anode current flows at $V_g = 0$ when V_{ak} is 80V. Thus required h.t. is 80 + 60 or 140V. This leaves excess of 60V to be dropped at 6mA across a decoupling resistor. R_d is thus $10\text{k}\Omega$.

(3) Sketch grid waveform as in Fig. 8B, and mark in potentials. For 12AT7, V_{co} at V_{ak} = 140V is − 4V. Thus e/E from sketch is 56/200 or 0.28. From C-R curve this gives t/CR as 0.32.

If equal amplitude pulses are required at each anode, then the values of each load will be the same and the design up to this stage is thus common to both valves.

(6) We now require the exponential rise of voltage across one resistor, say R_1, to take twice the time of that across the other resistor, R_2, for a mark/space ratio of 2 : 1. A square wave of prf 1,000 occupies a time of 1 millisecond, and a 2 : 1 division of this waveform gives a mark/time of 666 μsecs and a space time of 333 μsecs.

$$\text{Thus } C_1R_1 \text{ (mark)} = 0.00208$$
$$\text{and } C_2R_2 \text{ (space)} = 0.00104$$

and each R value must be large and that of C small.

Suitable values are found in:

$C_1 = 620\text{pF} \quad R_1 = 3.3\text{M}\Omega$
$C_2 = 220\text{pF} \quad R_2 = 4.7\text{M}\Omega$

Conclusions

Using the C-R curves obviously saves a considerable wastage of time by removing the "logarithmetic" from the design calculations, and, as the first example served to demonstrate, their use can be adapted to quite a wide variety of circuits so far as design is concerned.

Several refinements may suggest themselves to the constructor in connection with the multivibrator circuit: a useful modification, when a variable-prf output is required, consists of returning the two grid leaks to a common decoupled point at the slider of a potentiometer across a portion of the h.t. rail. This results in the ability to vary the exponential rate of rise of the grid waveforms, with consequent variation of the "off" period of the valves.

Variable mark/space ratios are obtained by connecting each grid leak to such a potentiometer arrangement individually.

It is also possible to synchronise the multivibrator waveforms to an external source, either by feeding in samples of the source at the cathode across a cathode resistor inserted for this purpose, or via a differentiating circuit of the type described earlier, to one or other of the grids.

Once the reader has digested and mastered the substance of this article, the way will be clear to the understanding of many more complicated pulse and video circuits.

Field Report on the
"EAVESDROPPER"
Miniature Transistor Local Station Receiver

by **W. G. MORLEY**

IN THE DECEMBER AND JANUARY ISSUES LAST of *The Radio Constructor*, full details were given of the "Eavesdropper," this being a miniature transistor receiver intended for local station reception. A number of "Eavesdroppers" have been successfully built by readers, and it is now possible to evaluate the performance of this receiver under the varying conditions in which it has been used.

In some cases, somewhat poor results have been obtained, and it is believed that this may be due—amongst other things—to spread in the characteristics of the transistors employed. Since the prototype was completed, performance figures have been taken with a number of different transistors of the type specified, with the result that a change in value of two resistors brings the design centre more accurately in line with the transistors available.

Several readers have asked for details of aerial input circuits capable of allowing large aerials to be employed without loss of selectivity. The question of output level and choice of reproducer has also been raised. So far as these last two points are concerned, experiments have been carried out with reproducers alternative to the crystal microphone insert employed in the prototype, thereby enabling fuller tonal response to be obtained. All these points are dealt with in this report.

It should be mentioned, at this stage, that a component which plays an important part in the successful functioning of the receiver is the diode D_1. This should be a Mullard OA71, as specified.

Modifications

Due to the spread in transistor characteristics just mentioned, it has been found that improved results will be given by the "Eavesdropper" if R_1 is changed to $220\text{k}\Omega$ and R_3 to $2.2\text{k}\Omega$.

When additional power output, plus some increase in gain, is desired, this may be achieved by replacing R_9 with an a.f. choke.

TABLE OF TEST READINGS OBTAINED ON THE PROTOTYPE

Supply Voltage: 14V on load.
Total Current: 2.9mA.
Voltage on TR_2 side of R_6: −2.4V.

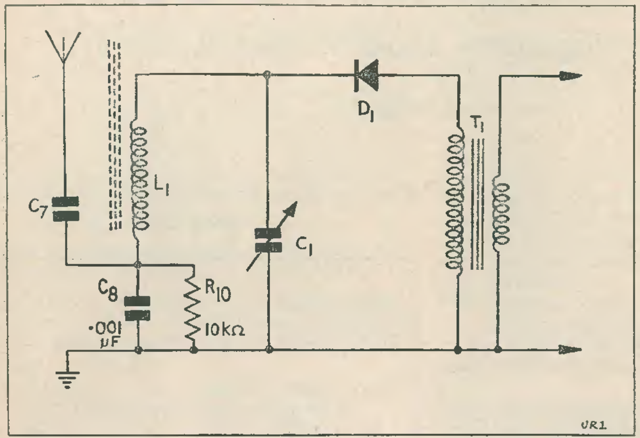
TR_1	Base Voltage	−0.1V
	Base Current, meter between R_1 and R_6	7μA
	Collector Voltage ..	−1.5V
	Collector Current, meter between R_3 and R_6 ..	0.5mA
TR_2	Base Voltage	−0.15V
	Base Current, meter between R_4 and R_6	8μA
	Collector Voltage ..	−1.2V
	Collector Current, meter between trans. and R_6 ..	0.5mA
TR_3	Base Voltage	−0.175V
	Base Current, meter between R_7 and h.t.−	60μA
	Collector Voltage ..	−4.9V
	Collector Current, meter between R_9 and h.t.− ..	1.8mA

A suitable miniature component is provided by a 250 : 1 transformer type OL.130 (available from Henry's Radio and other stockists). This transformer has its primary winding only connected into circuit, the secondary being ignored. The use of this choke incurs an increase in h.t. consumption of approximately 0.5mA.

An increase in tonal range can be obtained by employing a $1{,}000\Omega$ deaf-aid insert in place of the crystal insert. The deaf-aid insert should be connected as follows: one terminal to the h.t. + line and the other, via a series 25V wkg. electrolytic condenser having a value between 4μF and 8μF, to the collector of TR_3.

The negative side of the electrolytic condenser should be that which connects to TR$_3$ collector.

Good results were also obtained by employing an ex-W.D. balanced armature insert in the same circuit as that just specified for the deaf-aid component.



An aerial input circuit suitable for large and small aerials

Test Readings

Test readings obtained on the prototype after the modification to values of R$_1$, R$_3$ (i.e. with R$_9$ and not the a.f. choke as the collector load of TR$_3$) are given in the table which accompanies this report. These readings were taken with an AVO model 8, all voltage figures being with reference to the h.t.+ line. It must be emphasised that these readings are given for guidance only and may vary over quite large limits for individual transistors. This point applies especially to collector voltage readings, and it is preferable, wherever possible, to place reliance on collector *currents* instead.

Aerial Input Circuits

Whilst the "Eavesdropper" should give adequate local station reception on its ferrite frame aerial in localities of reasonable signal strength, an improvement can obviously be effected by the use of an aerial. An aerial input circuit has now been developed which meets this need, this having the advantage that it may accept both large and small aerials.

The input circuit accompanies this article. As may be seen, a capacitive tap into the tuned circuit is made by means of the 0.001μF condenser C$_8$. To maintain the d.c. circuit to the diode, this condenser is shunted by the 10kΩ resistor R$_{10}$. The presence of C$_8$ may necessitate slight re-tuning of the station selector trimmers when the pre-set version of the receiver has been constructed.

The value of the aerial series condenser C$_7$ is experimental. If a short aerial is used, say, 3 or 4 feet long, this condenser may be omitted, the aerial connecting directly to the junction of C$_8$ and L$_1$. For large aerials, C$_7$ should have a value which permits adequate sensitivity without loss of selectivity. Normally, the value of C$_7$ should lie between 25 and 250pF. An earth connection is desirable, especially when large aerials are employed, but is not essential.

New Edition of Mullard Pocket Data Book

This new edition includes details of entertainment valves, television picture tubes and germanium devices introduced since the previous edition published in 1954.

An improved format has been devised which presents the information in a simplified form. For example, base connections, type numbers, descriptions and characteristics are now given in a single line, thus enabling all the information about any particular valve to be obtained by reference to only one page.

A new section has been added which deals with Mullard Varite Thermistors, and there is a list of communications and industrial valves and tubes.

Comprehensive equivalents lists for entertainment valves and picture tubes are also included.

RIGHT—*From the Start*

PART 13

MEASUREMENT

by A. P. BLACKBURN

THE MAINTENANCE AND DESIGN OF RADIO equipment makes necessary a technique of measurement. Rules and micrometers are common enough to mechanical engineers, where the unit of length is of prime importance. To the radio man, however, there are four quantities which require some yardstick, in order that he shall know how, say, a particular circuit is performing. The four quantities are current (a.c. and d.c.), voltage, resistance (including impedance and reactance) and frequency.

Current

D.C. currents are usually measured nowadays with a moving coil meter. In this a coil, which is free to rotate, is placed between two poles of a strong permanent magnet, as shown in Fig. 1. The coil is restored after movement by a hairspring and the "shaft" attached to the coil is itself attached to the pointer. When a current is passed through the coil it rotates, and finally takes up a position dependent upon the applied current, the strength of the field, and the retarding force of the hairspring. The latter two conditions are fixed for any particular meter, so the current is the deciding factor on where the needle comes to rest.

This type of movement has two great advantages. It is sensitive, and its scale is linear, that is to say, the movement of the needle is directly proportional to the applied current. This, of course, means that given divisions on any part of the scale are equally spaced.

As a measure of sensitivity, commercially produced meters for reading 5μA, i.e. five-millionths of an amp, are readily available, and rather less rugged types may have a sensitivity 10 times as great as this. Very robust movements for currents of 100μA and above are the order of the day in radio work.

For very small currents, the moving coil type of meter is obviously extremely useful, and as we shall see later it is a simple matter to modify them to read larger currents. Before going on to that, however, there are other types of movement which are sometimes used.

Other Types

A type which is certainly very robust, but usually less accurate than the moving coil, is the moving iron movement. Once again this has a coil through which the current to be measured is passed, and the field produced moves a piece of soft iron which is attached to the needle. The scale is not linear, being cramped at both ends, but it may be used for a.c. or d.c. measurements. Note that in this type the coil is fixed.

The hot wire ammeter is sometimes used where high frequency currents are to be measured, but it may also be used for d.c. The instrument consists simply of a pice of resistance wire which becomes heated by the passage of the current. A spring attached to the centre of the wire pulls it downward as it expands, and the resulting movement at the centre of the wire is transferred to the needle.

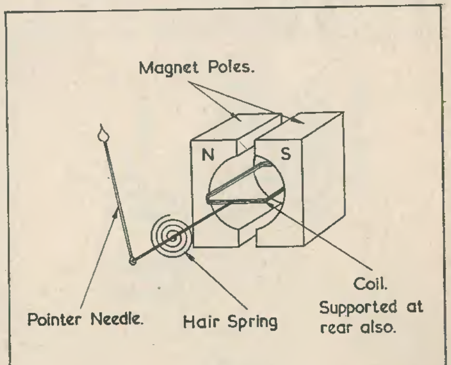


FIG.1.

Neither of these types are as sensitive as the moving coil, particularly the hot wire type, which is normally only suitable for measuring 1 amp or above.

After that brief digression we will return to the moving coil meter.

Heavy Currents

As mentioned already, the moving coil meter is very suitable for small currents. It may be wound with heavier gauge wire and a weaker magnet used, when it becomes less sensitive. Another method is to use an external shunt, which enables a given meter to be used for a number of ranges.

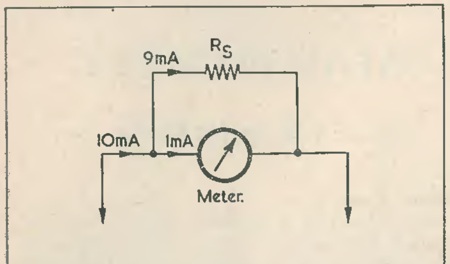


FIG. 2. M.402

Briefly, the principle is to divert some of the current from the meter. For example, if the current to be measured is 10mA and the meter has a full scale deflection of 1mA, 9mA has to be diverted as shown in Fig. 2. The diverting resistor R_s is called the shunt. By suitably switching this resistor, any number of ranges may be obtained.

The formula for calculating this resistor is easily obtained. The voltage across the meter is the meter resistance times the current, I_m, flowing through it. This voltage is also equal to the voltage across the shunt resistor, which is given by the shunt resistance R_s times the current I_s through it.

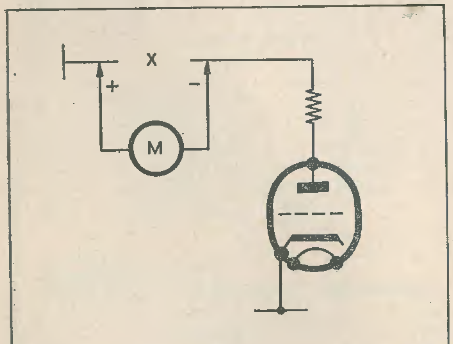


FIG. 3. M.403

Therefore,

$$I_mR_m = I_sR_s$$

but $I_s = I_T - I_m$, where I_T is the total current flowing into the circuit.

$$\therefore I_mR_m = (I_T - I_m)R_s$$

$$\therefore R_s = \frac{I_mR_m}{I_T - I_m} \quad \ldots\ldots\ldots\ldots (1)$$

If I_m is small compared to I_T,

$$R_s = \frac{I_m}{I_T}R_m \ldots\ldots\ldots\ldots\ldots (2)$$

Continuing the example of Fig. 2, if the meter resistance were 100Ω, what is the required value of R_s?

From (1) above:

$$R_s = \frac{1 \times 100}{10 - 1} = 11.1\Omega$$

If the meter were required to have a full scale deflection of 100mA, R_s would be

$$R_s = \frac{1 \times 100}{100 - 1} = 1\Omega \text{ approx.}$$

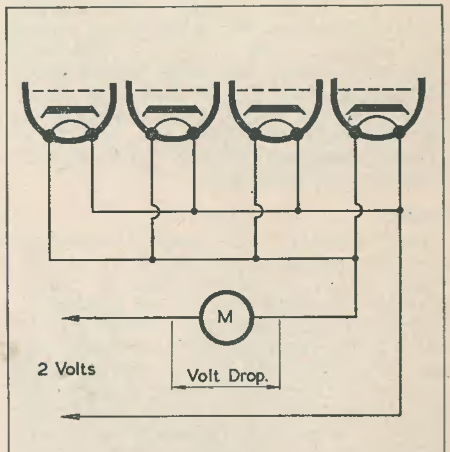


FIG. 4. M.404

It can be seen in this latter case that the denominator is scarcely affected by I_m, so formula (2) could have been used.

Where to Measure

When making a measurement of current it is important to take certain precautions. For example, when measuring the anode current of the valve in Fig. 3, the circuit could be broken as shown and the meter placed in series with the anode load. Now as we are only considering moving coil meters, we have to watch the polarity. The direction of deflection of the needle in this type of instrument depends upon the direction of the flow of current in the coil. In order to get the correct deflection it is necessary to connect the meter correctly as shown in Fig. 3—in this case with the positive terminal to h.t.+. Now the current flowing through the meter will cause a voltage drop across it, perhaps of the order of a volt or so. In the circuit shown this would obviously be unimportant. The meter resistance is so low compared to the anode load, 22kΩ, that it can be ignored. If, however, we wished to measure the filament current in a battery receiver using 2-volt valves, and 1 volt were dropped across the meter, only 1 volt would reach the valves. The resultant current as indicated on the meter would not be the same as when the meter were not in circuit.

For example, let us say that the filaments take 1 amp at 2 volts, and the meter had 1Ω resistance. The circuit would be like Fig. 4; the resistance of all the heaters in parallel would be 2Ω (1 amp at 2 volts) and the meter resistance when added to this makes 3Ω in all. The current flowing would, therefore, be:

$$I = \frac{E}{R} = \frac{2V}{3\Omega} = 0.6 \text{ amps,}$$

and the meter would indicate this. When the meter was removed, only 2Ω would remain in circuit and the current would be 1 amp.

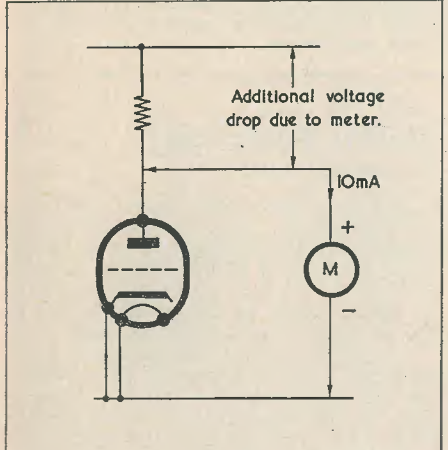


FIG. 5. M.405

So the meter has only indicated to an accuracy of 66%, which is hardly acceptable in the roughest measurement. Often the voltage drop is less than 1V, but this extreme value was taken to make the example clear.

Voltage

To measure voltage the same movement is normally used. We have already seen, however, that a meter with a full scale deflection of 1mA may have a resistance of 100Ω. The required voltage to produce full scale deflection is therefore:

$$E = IR = 0.001 \times 100 = 0.1 \text{ volts}$$

So basically such a movement will only measure up to 0.1 volts This could be overcome by decreasing the sensitivity, i.e. increasing the full scale current. This is undesirable because a large current drain into the meter might upset the circuit under test. For example, in Fig. 5 a voltmeter which takes 10mA at the reading obtained is measuring the anode voltage of a valve. This 10mA must flow through the 10kΩ resistor, therefore a voltage drop of 0.01 × 10,000 = 100 volts will occur across it. So if the true anode voltage were 200 volts, the meter would only indicate 100 volts; an error of 50%.

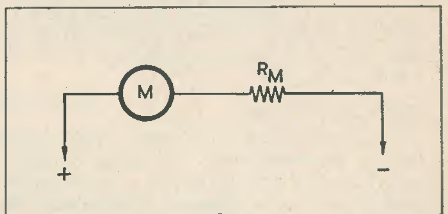


FIG. 6. M.406

Returning to our meter, then, the other thing to do if increasing the f.s.d. current is of no help, is to increase the resistance. This fortunately is very simple, as shown in Fig. 6. A resistor, R_m, called the multiplier is placed in series with the meter.

The calculation of this resistor is very simple. If we required to make our 1mA movement into a voltmeter with f.s.d.'s of 10V and 100V, we merely calculate the resistor from Ohm's Law.

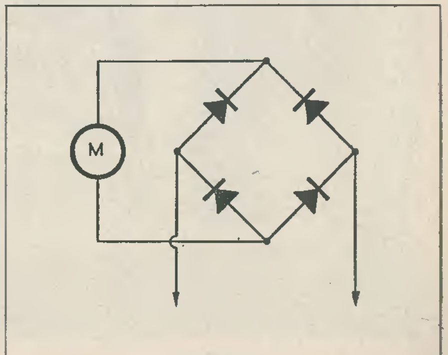


FIG. 7 M.407

i.e. for 10 volts $R_m = \frac{10}{0.001} = 10\text{k}\Omega$

and for 100 volts $R_m = \frac{100}{0.001} = 100\text{k}\Omega$

This ignores the voltage drop across the meter, which in this case was 0.1 volt, giving 1% error on 10V and 0.1% error on 100 volts.

The meter resistance would be important if we wished to make a 1 volt range. However, all that is necessary is to calculate as above?

$$R_m = \frac{1}{0.001} = 1k\Omega$$

and then subtract the meter resistance, in this case 100. The result is, therefore, 900Ω for 1 volt f.s.d.

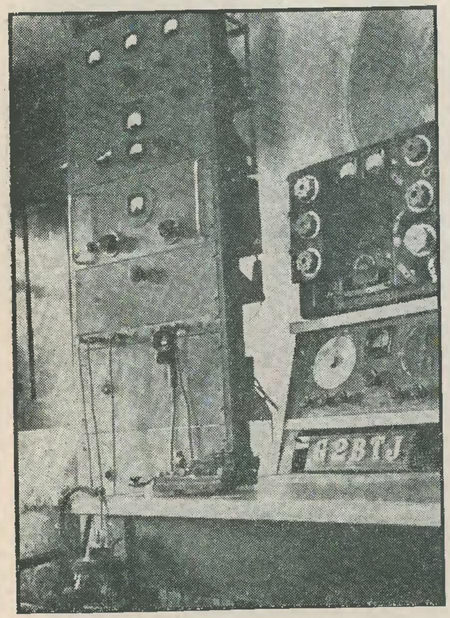
Alternating Current

The moving coil movement is only useful for d.c. measurements. The effect of applying a.c. is very little deflection. As the movement deflects in a direction according to the polarity of the applied current, an a.c. wave will tend to deflect it positively and negatively by equal amounts. If the frequency is too high to allow sufficient time for the coil to move, there will be no deflection of the needle.

The only solution is to rectify the a.c. before applying it to the meter. When measuring a.c. voltage a circuit like Fig. 7 is used. A bridge rectifier is used and the multiplying resistor is placed before the rectifier. By this means, a low voltage rectifier can be used for all voltage ranges.

An important point is that the meter will indicate the mean a.c. voltage, and not r.m.s., although most a.c. meters are calibrated in r.m.s. This is not important if the waveform is purely sinusoidal, but if a distorted waveform is being measured an error in the reading will result.

Unfortunately resistance and frequency, the last of the four quantities, has not been mentioned because space does not permit it. They will, therefore, have to be held over until next month.



The photo shows the shack of D. W. Robinson, G2BTJ, of Liverpool 15. *G2BTJ started with an AA licence in* 1939, *and reopened in* 1946. *The present Tx runs an* 829B *in the final, taking* 150 *watts input on (mainly)* 7 *and* 14 *Mc/s. The receiver is a Hallicrafters S.*20, *and the station is also equipped for CW/phone operation on Top Band. The photograph was taken by R. B. Swift, G3GYT, of Liverpool* 18.

Radio Miscellany

(*continued from page* 549)

Yet even this gloomy news contained a solitary laugh. One magazine proudly claimed that the dubious blessing of the extra hour came about as the result of its single criticism of the B.B.C. Which reminded me of the fly seated on the chariot inviting the world to behold what a dust he raised.

The final insult will come when the B.B.C. demands a further increase in the licence fee to pay for additional "service." Even the fact that the percentage of viewers deserting B.B.C. for I.T.V. still grows is hardly likely to shame them out of this for much longer.

Fortunately, an increasing number of intelligent viewers are beginning to realise that what is really wanted is fewer hours and better programmes. Many of the present programmes could very well do without the vision altogether. With the excessive number of hours of so-called light programmes, an even greater army of "entertainers" with no talent, but lots of self-assurance, are likely to smirk and posture their way on to our T.V. screens. Critical faculties must be becoming seriously blunted when comedians who make you squirm with embarrassment *for* them, and plunging-necklined, brassy-voiced, hip-waggling female crooners can so easily masquerade as entertainers for adult audiences. Few wish to see T.V. become a sort of evening-class-at-home, but I am beginning to wonder if even that wouldn't be preferable to a surfeit of non-stop programmes seemingly aimed at backward adolescents.

P.S. I find the outlook so depressing that I am quite unable to think of a funny Tailpiece this month.

A "THREE-PLUS-ONE" SUPERHET RECEIVER

by P. L. WINGROVE

Details of a receiver which represents an interesting departure from conventional practice

IN THESE DAYS OF ALMOST OMNIPRESENT television, "steam" radio still retains much of its popularity, and the necessity of providing suitable radio reception in the home remains nearly as pressing as it did in the days when sound was the only broadcast entertainment. To discuss the reasons for this fact would be to stray from the main purpose of what is intended to be a purely technical article. Nevertheless, it is still fairly safe to say that the attraction of the sound receiver has been diminished only slightly by the competition offered by its video offspring.

In this contribution a simple superhet receiver is described which has been designed to meet several principal requirements. From the purely functional point of view it is capable of holding its own quite comfortably, insofar that it will provide entertainment with good volume and good quality of reproduction. From the technical point of view it has the advantage that it may be built cheaply and easily. The greatest amount of gain is provided at audio, instead of at radio or intermediate, frequencies, with the result that the risk of instability is low. The simplicity of the design extends to its operation, inasmuch that pre-set tuning is employed.

Circuit Details

The circuit of the receiver is shown in Fig. 1. As will be noted, this has one or two unconventional features. These will be discussed in the general description which follows.

The aerial input to the receiver is applied to the coupling winding of coil L_1 via the condenser C_1. In the prototype, C_1 had a capacity of $0.001\mu F$, and the set functioned well with this value when it was employed in the London area with approximately six feet of aerial wire. If the receiver is used in areas of very strong signal strength, or in localities where interference is heavy, an improvement in performance may be obtained by reducing the value of C_1. The value of this condenser may also be reduced with advantage when a large aerial is connected to the receiver.

The coil L_1 is wound for medium-wave operation, two pre-set combinations of tuning capacity being connected across its tuned winding by means of switch $S_{1(a)}$. The capacity values shown for C_2 and C_3 are those for reception of the Home and Light programmes in the London area. Other values may be needed for these two condensers if the receiver is operated in other parts of the country or if other transmitters are required. The signal frequency voltage appearing across the input tuned circuit is applied between g5 and cathode of the frequency-changer V_1.

In the oscillator section L_2 functions as a tuned grid oscillator coil, it being tuned by whatever capacity is switched in by $S_{1(b)}$. With the prototype it was found possible to select the two programmes required without the necessity of having fixed condensers connected in parallel across either VC_3 or VC_4. In some cases it might be necessary to connect additional capacity across either one, or both, of these trimmers in order to select the stations desired.

It will be appreciated that there is no reason why $S_{1(a)}$ and $S_{1(b)}$ could not be three-position switches, with additional trimming circuits switched in by the third contacts. Such an arrangement would then enable a third pre-tuned programme to be received. Alternatively a conventional two-gang condenser can be used to tune the receiver, the required circuitry being that shown in Fig. 2. However, the pre-set arrangement has the advantage of considerable ease of operation, and it simplifies the

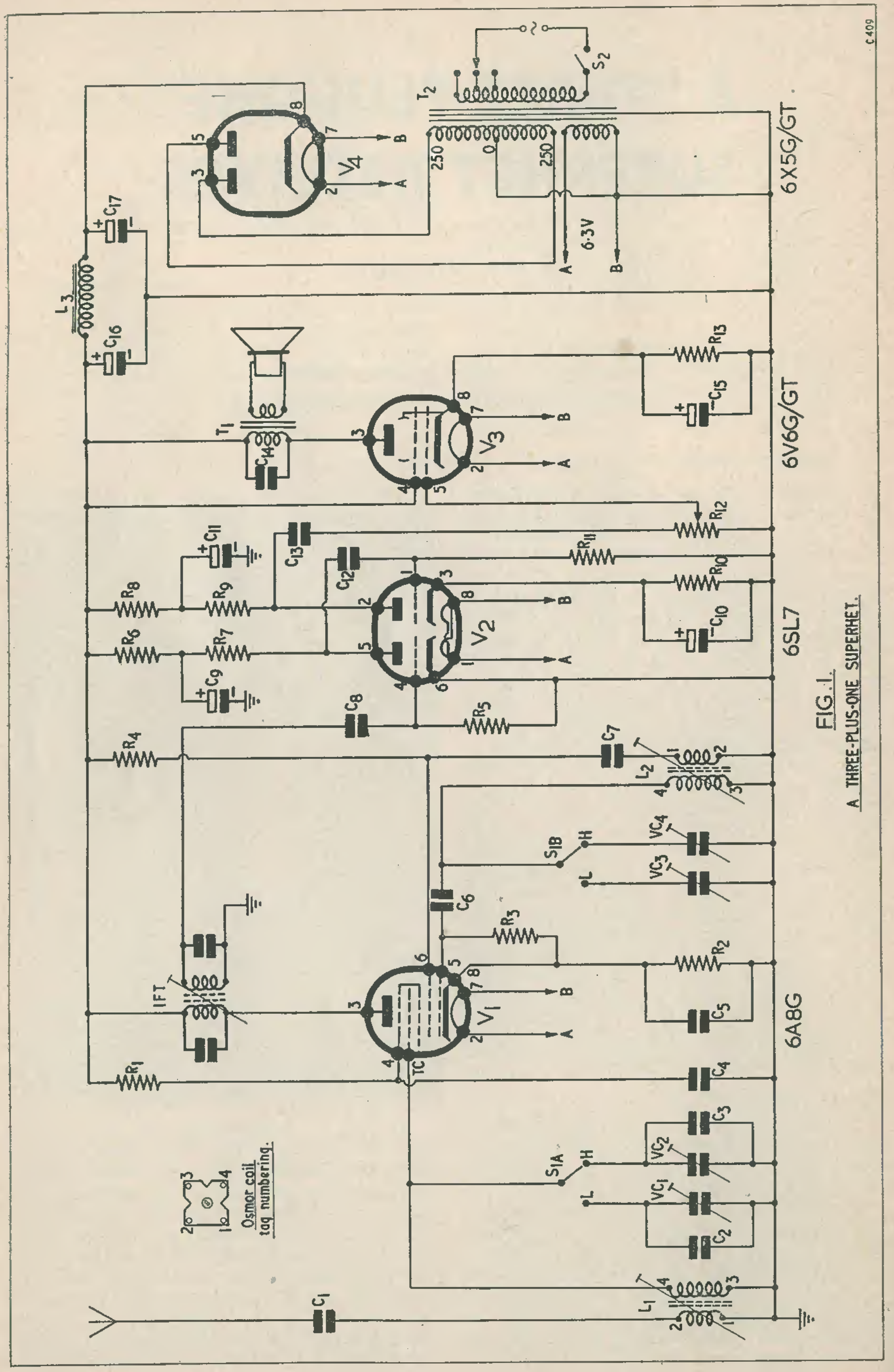


FIG. 1. A THREE-PLUS-ONE SUPERHET.

problems of layout and construction very noticeably.

The I.F. and A.F. Stages

The valve V_1 functions as a frequency-changer, the intermediate frequency which appears at its anode being applied to the primary of the i.f. transformer. Only a single transformer is employed in this receiver, and it was found that it afforded a surprisingly high degree of selectivity.

The secondary of the i.f. transformer is connected to the leaky-grid detector $V_{2(a)}$. The grid components (C_8 and R_5) used in the detector circuit have values such that the transformer secondary is not excessively damped. Due to the fact that only one i.f. transformer is employed, little risk of regenerative feedback at intermediate frequencies exists, and there is in consequence no necessity to provide filtering in the detector a.f. circuits. The detected a.f. appearing at the anode of $V_{2(a)}$ is applied, via C_{12}, direct to the grid of $V_{2(b)}$, where further amplification takes place.

The h.t. supplies to both $V_{2(a)}$ and $V_{2(b)}$ are decoupled; this being carried out by the components R_6 and C_9 in the case of $V_{2(a)}$, and by R_8 and C_{11} in the case of $V_{2(b)}$. Despite the high degree of gain given by the a.f. circuits a large amount of decoupling is not really necessary, that provided here being quite adequate.

A notable feature of the circuitry between $V_{2(a)}$ and $V_{2(b)}$ is that this does not include the volume control. At the volume levels handled by the two triodes there is little risk of overloading, and it becomes possible, therefore, to fit the volume control after $V_{2(b)}$. This particular arrangement is advantageous because it enables all components immediately connected to $V_{2(a)}$ and $V_{2(b)}$ to be wired closely around the valveholder, whilst the subsequent lead to the volume control, R_{12}, is less liable to pick up hum or cause instability.

The output stage is provided by V_3 and is quite conventional. The a.f. tapped off by R_{12} is applied to the grid of V_3, and the anode of this valve feeds into the output transformer primary. C_{14} is a tone-correction condenser.

The power supply follows normal practice also. There is, indeed, little here which needs comment save that a 6X5 is employed as rectifier in order to provide an economy in the number of heater windings required in the mains transformer. If the mains transformer employed has an electrostatic screen between primary and secondaries, this should be connected to chassis.

Setting Up

After the receiver has been completed and the wiring checked, it is ready for alignment.

Component List—set out for easy reference to Fig. 1

Resistors (¼ watt unless otherwise stated)

R_1	68kΩ ½ watt
R_2	300Ω
R_3	50kΩ
R_4	22kΩ ½ watt
R_5	1MΩ
R_6	10kΩ
R_7	47kΩ
R_8	10kΩ
R_9	33kΩ
R_{10}	2kΩ
R_{11}	1MΩ
R_{12}	1MΩ Pot.
R_{13}	270Ω 1 watt

Capacitors

C_1	See text
C_2	50pF, silver mica (see text)
C_3	170pF, silver mica (see text)
C_4, C_5	0.01μF, paper, 350V wkg.
C_6, C_8	100pF, silver mica
C_7	170pF, silver mica
C_9, C_{11}	2μF, 350V wkg.
C_{10}	20μF, 12V wkg.
C_{12}, C_{13}	0.02μF, paper, 350V wkg.
C_{14}	0.002μF, paper, 350V wkg.
C_{15}	25μF, 25V wkg.
C_{16}	16μF, 350V wkg.
C_{17}	8μF, 350V wkg.
VC_1, VC_2, VC_3, VC_4	100pF Trimmers

Valves

V_1	6A8G Brimar
V_2	6SL7 Brimar
V_3	6V6G/GT Brimar
V_4	6X5G/GT Brimar

Inductors

L_1	QA81 Osmor Radio Products Ltd.
L_2	QO8 Osmor Radio Products Ltd.
L_3	10H, 60mA

Transformers

I.F.T.	IFT11 Denco (Clacton) Ltd.
T_1	Output transformer, Z = 5,000Ω
T_2	Secondaries: 250–0–250V, 60mA; 6.3V, 2A

Miscellaneous

$S_{1(a)}$, $S_{1(b)}$	2-pole, 2-way Yaxley
S_2	On-off toggle, or combined with R_{12}

4 Octal valveholders
6in p.m. speaker, etc., etc.

If a modulated signal generator is available, this should be set to 465 kc/s and its output connected between the top cap grid of V_1 and chassis. The i.f. transformer should then be adjusted for maximum audio output, attenuating the signal generator as alignment proceeds. If a signal generator is not available, however, the i.f. transformer may still be satisfactorily aligned, the process being carried out with a received signal. This point is due to the fact that the transformer should be received from the makers aligned on factory test gear, whereupon it will still be approximately aligned to 465 kc/s after it has been connected up in to the receiver. The slight discrepancies introduced by the stray capacities in the receiver should not cause any serious shift off resonance. The final alignment of the transformer without a signal generator is described later.

second desired station may then be carried out with $S_{1(b)}$ in its alternative position.

If the i.f. transformer was not aligned with a signal generator, the process of adjusting the oscillator trimmers enables this component to be trimmed up also. The procedure here is to adjust the oscillator trimmer for maximum volume from any signal, then simply align the i.f. transformer until no further gain is provided for that signal.

Tuning the oscillator circuits in the manner described above assumes that sufficient signal is available for the frequency-changer with the signal frequency circuits off resonance. If it is found that the desired transmitters cannot be picked up in this manner the aerial should be temporarily connected, via a condenser of 0.001 to 0.01μF, direct to the top cap grid of V_1. Such a connection heavily damps the tuned winding of the input coil L_1, and causes

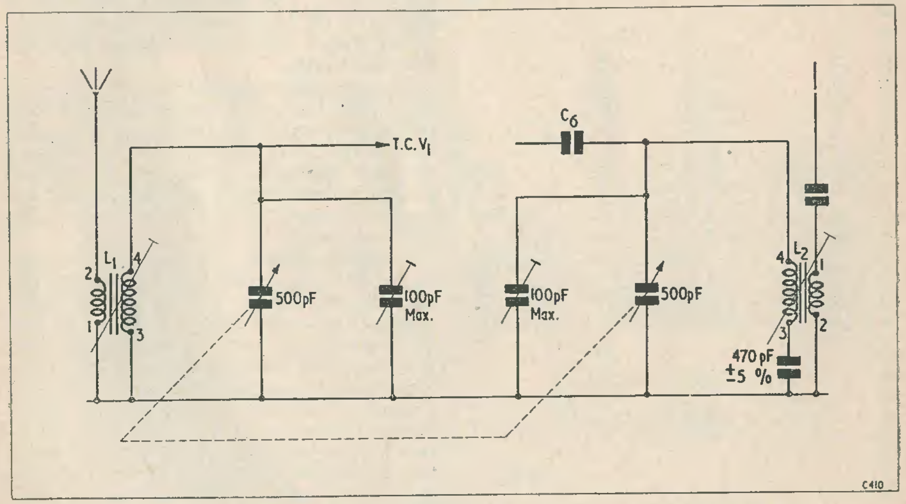


Fig. 2. Showing how a conventional gang condenser may be used instead of the pre-set tuning shown in Fig. 1

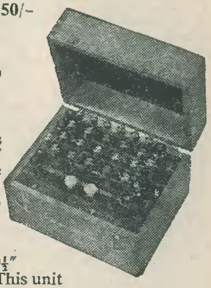
The next circuits to adjust are those in the oscillator section. A signal generator is not really necessary for this operation, as a reasonably good aerial will normally offer all the signal pick-up required. (In many areas a short aerial in the same room as the receiver may cope.) This aerial should be connected to the receiver; whereupon whichever oscillator trimmer is switched in by $S_{1(b)}$ should be adjusted until the required signal is heard. If the signal cannot be picked up in the range of the trimmer selected, additional capacity will need to be added across it experimentally. The oscillator trimming adjustment for the the stronger signals in the medium-wave band to be received quite readily. The process may result in second channel whistles appearing with some signals, but these should be ignored as they will disappear when the circuit is used in proper fashion.

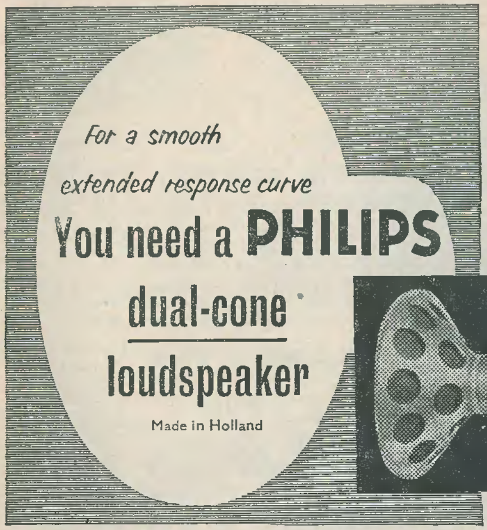
After the oscillator has been set up it becomes necessary to align the signal frequency tuned circuits. The trimmers switched in by $S_{1(a)}$ should be adjusted for maximum volume from the station selected by the oscillator trimmers, the aerial being connected up normally as in Fig. 1. As trimming proceeds it may be necessary to revert to a short aerial in order to reduce signal strength. This assumes that the receiver will be operated finally with such a short aerial. If a long aerial is to be used finally, the value of C_1 may be reduced accordingly. It should be mentioned again at this point that it will be necessary to add the requisite value of parallel capacity across either VC_1 or VC_2 when the required frequency is outside the range of the trimmer.

When the receiver uses the tuning arrangement shown in Fig. 2 the alignment process then becomes that used for conventional superhets. This necessitates trimming at the high frequency end of the band and padding at the low frequency end. Padding would normally be accomplished by adjusting the core of L_2 until the dial calibration was correct, and then adjusting the core of L_1 for maximum sensitivity. There should be no need to adjust the cores of either L_1 or L_2 when the pre-set arrangement of Fig. 1 is employed.

Layout

Due to the inherent simplicity of the receiver, the question of layout does not cause many headaches. The main point to observe here is that the circuitry around V_1 is kept reasonably well spaced away from that around V_3. Normally, V_2 and its wiring will lie between these two valves whereupon the necessity of keeping V_1 and V_3 spaced is automatically achieved.

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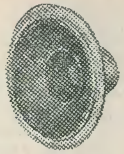

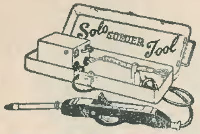

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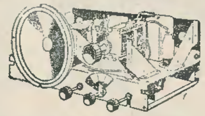

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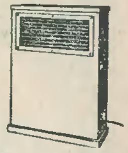

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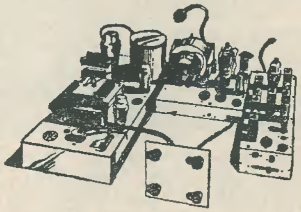

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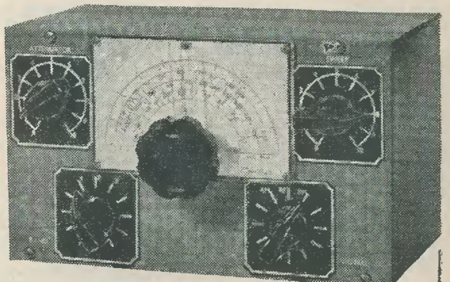

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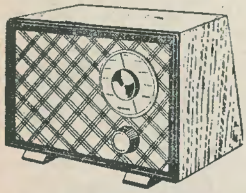

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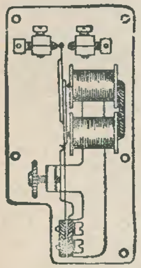

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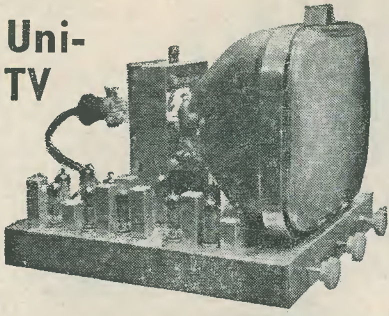

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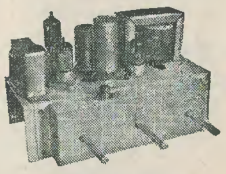

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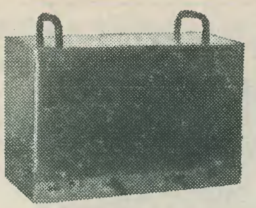
continued on page 575



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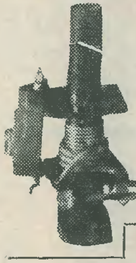

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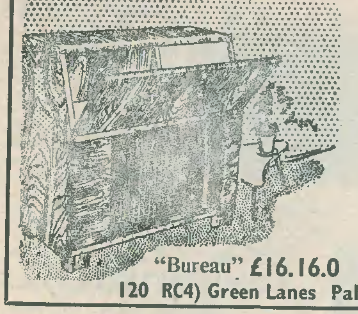

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continued from page 573

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continued on page 576

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Errata

High Quality Broadcast Receiver. In the diagram Fig. 2, p. 475 February issue, the coil shown as QM8 should have been marked QA8—the component list is correct.

Right—From the Start. On p. 457 of the same issue, it is stated that in Fig. 6 wave b is shown as being 180° out of phase with wave a. This is incorrect, the difference being only 90°.

SMALL ADVERTISEMENTS

continued from page 575

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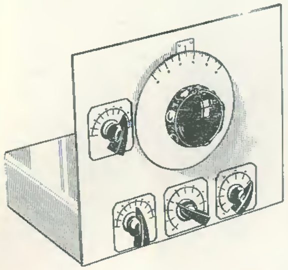

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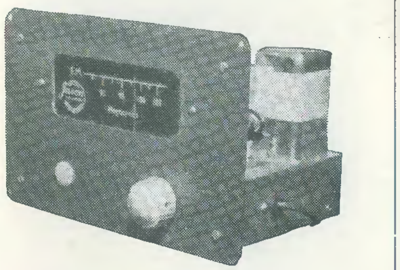

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