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NUMBER 6
JANUARY
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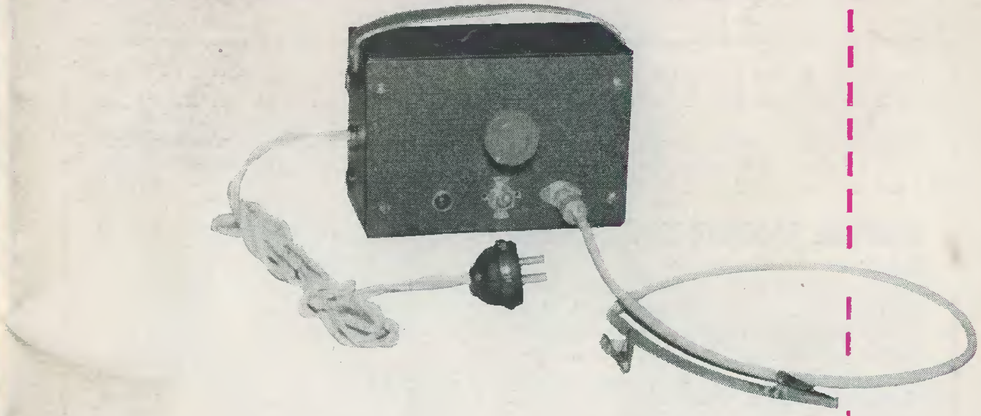

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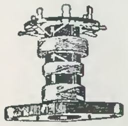

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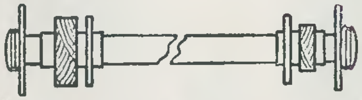

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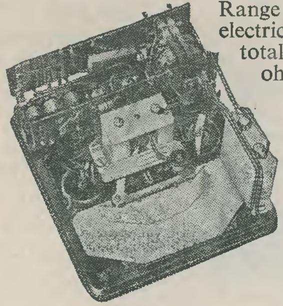

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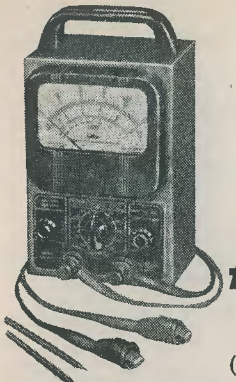

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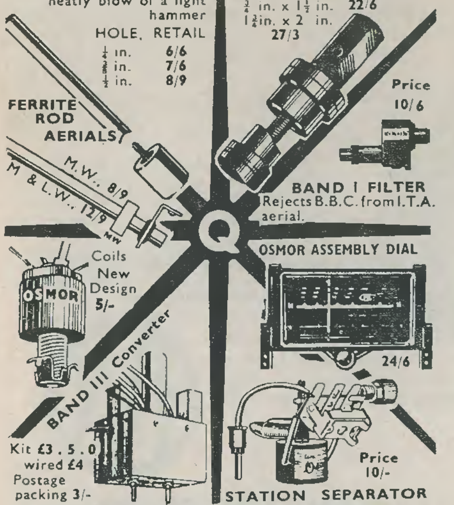

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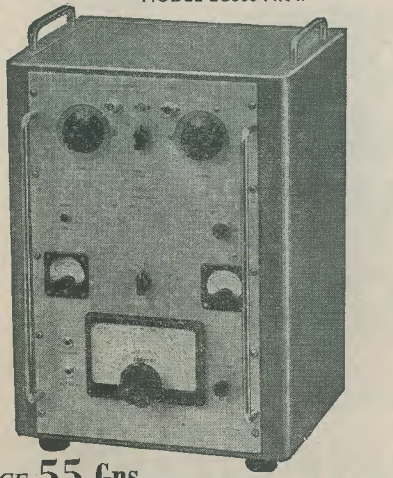

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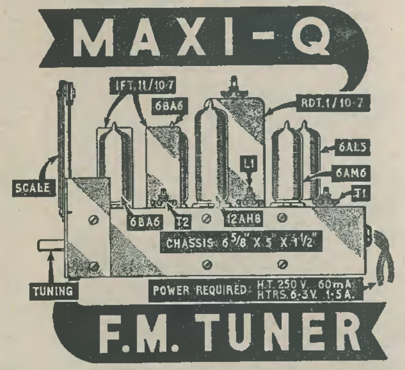

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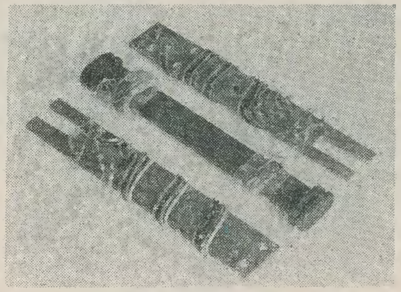

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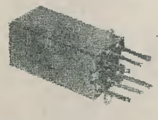

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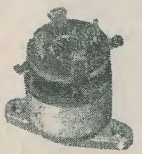

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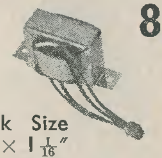

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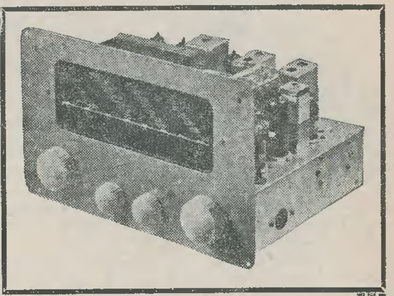

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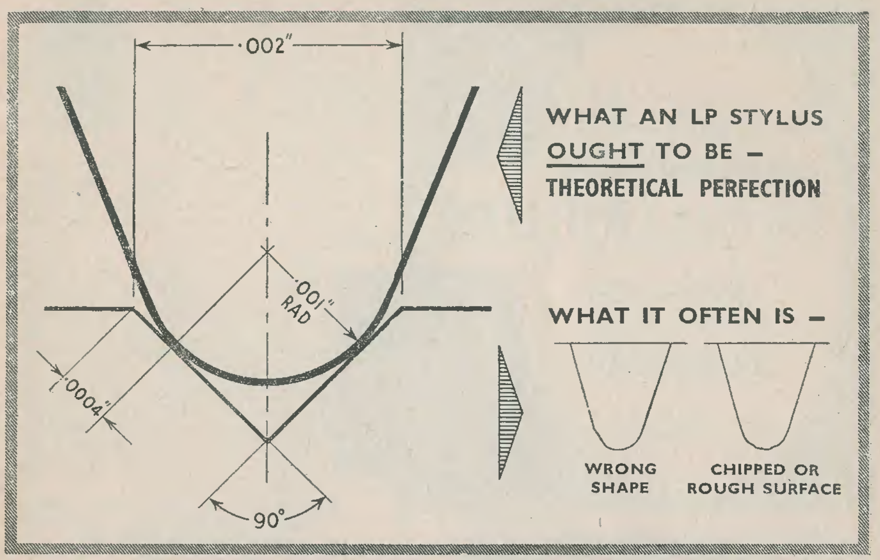

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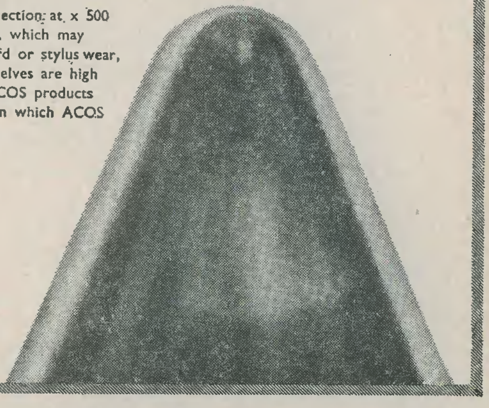

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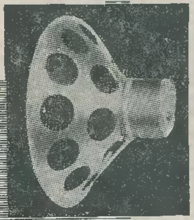

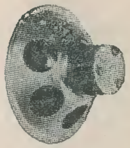

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CONTENTS FOR JANUARY

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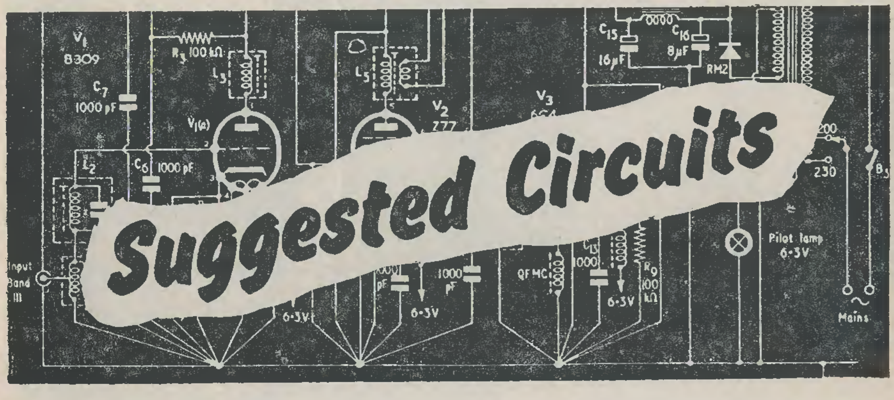


The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data*

No. 74. A "FERRITE FRAME" SHORTED TURNS TESTER

IN *Suggested Circuits No.* 63 (PUBLISHED IN *The Radio Constructor* for February 1956) the writer described a device intended for checking line output transformer windings for shorted turns. The arrangement consisted essentially of an oscillator operating at an audio frequency, and having a pair of test prods effectively connected across the oscillator tuned circuit. A microammeter with an f.s.d. of 500µA was connected in series with the oscillator grid leak. Under normal conditions of oscillation this microammeter gave a reading of some 300 to 400µA. When the test prods were connected across the anode coil of a serviceable line output transformer, this reading would drop slightly. If, however, the prods were connected across an anode coil, which had one or more shorted turns, the microammeter reading would drop by a considerably larger amount, this being caused by the excessive damping placed on the oscillator tuned circuit by the shorted turns in the coil.

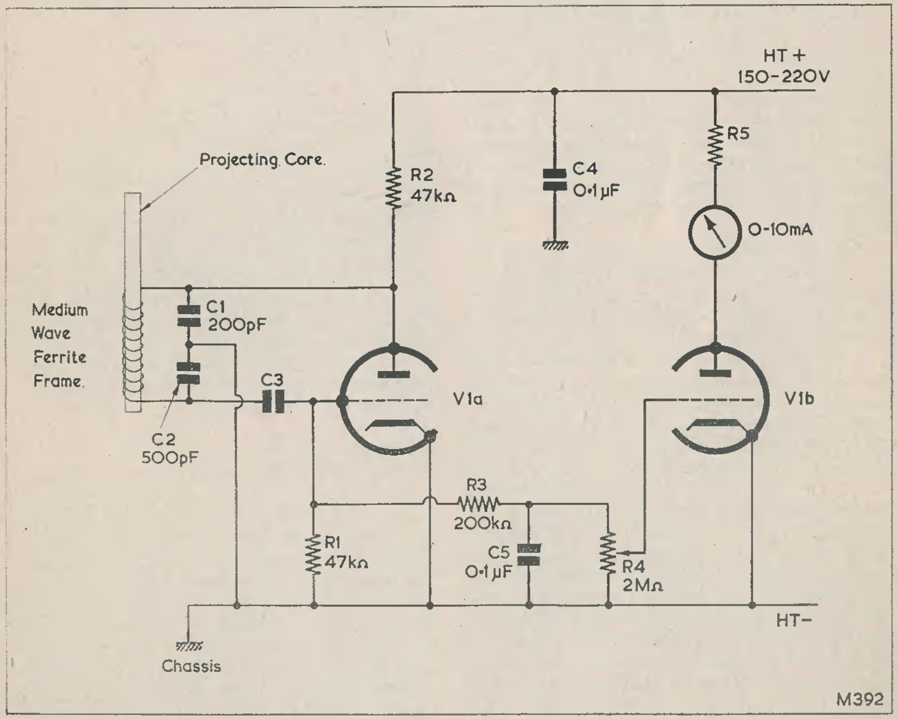
A number of readers have shown interest in this particular circuit, and some have asked for a shorted turns tester capable of checking all types of coil normally encountered in radio and television work. Such an instrument is not too difficult to design nor to construct, but owing to the wide range of coils it is intended to check, test leads for connection to the coil under examination cannot be employed.

In this month's circuit a different test technique is used. The equipment described employs a projecting ferrite core which is tightly coupled to an r.f. oscillatory tuned circuit. The result of this arrangement is that when a coil with a shorted turn is placed over the core a drop in oscillator grid current (flowing through the grid leak) results. Except for certain isolated conditions, which are discussed later, a serviceable coil causes no change in reading. An attractive method of using the device consists of mounting the core and its attendant oscillator circuits in a probe housing. The core can then be inserted into suspect coils without removing these from the chassis to which they are fitted. The ferrite core recommended for use in this circuit is that employed in a conventional medium wave ferrite frame aerial; and a rather interesting feature is that the aerial winding itself becomes part of the oscillator tuned circuit.

In order to reduce construction costs, the 0–500 microammeter specified in the earlier *Suggested Circuit* is replaced by a less sensitive and more inexpensive unit, this being operated by means of a simple valve voltmeter stage.

The Circuit

The circuit of the shorted turn indicating device accompanies this article. It will be seen in the diagram that the coil of the ferrite frame aerial is coupled into the oscillator, V_{1a}, by means of a Colpitts arrangement. An earthy tap into the tuned circuit is made at the junction of C_1 and C_2; these two condensers in series serving to tune the ferrite frame coil. This arrangement enables ferrite frame aerials with single coils to be employed.



Normal leaky-grid bias is employed for the oscillator triode, V_{1a}, and causes a negative voltage (relative to chassis) proportional to the amplitude of oscillation to appear at the grid. A 47 kΩ resistor is specified for the grid leak R_1, but the value of the grid condenser C_3 is experimental. The process of finding the requisite value for this component is discussed later.

As was mentioned above, the cost of a sensitive microammeter for measuring grid current is obviated by the use of a simple valve voltmeter arrangement. The valve voltmeter function is given by the triode V_{1b}. The cathode of V_{1b} is taken directly to chassis, whilst its anode is connected to the h.t. positive line via a resistor, R_5, and a 0–10 milliammeter. The value of R_5 is also determined experimentally.

The grid of V_{1b} is connected to the grid of V_{1a} via the slider of the pre-set potentiometer R_4 and the r.f. decoupling filter R_3, C_5. The purpose of these components is to enable a proportion of the negative voltage appearing at the grid of V_{1a} to be applied to that of V_{1b}. V_{1b} then functions as a simple valve voltmeter, indications being given by the milliammeter in the anode circuit. It will be noted that, with this arrangement, a coil having a shorted turn causes an *increase* in meter reading.

Setting Up

After construction, the circuit is initially set up by choosing an arbitrary value for C_3 which enables V_{1a} to oscillate. A capacity of 50pF should prove quite satisfactory at this stage.

The next step consists of temporarily stopping oscillations by short circuiting the coil on the ferrite frame. Under this condition, and with the slider of R_4 set to the top of its track, a value for R_5 is found which causes the milliammeter to read f.s.d. or slightly greater. This reading will correspond to that given by any later cessation of oscillation in V_{1a}, and the method employed enables the effects of space charges at the valve cathodes to be taken into account. The presence of R_5 ensures that the current passing through V_{1b} is limited to a safe value, and that overheating of the valve or damage to the meter under non-oscillatory conditions does not occur. After R_5 has been selected it may be connected permanently into circuit. It should be remembered that this resistor will require a rating suitable for the wattage it is called upon to dissipate under non-oscillatory conditions.

The short circuit is now removed from the ferrite frame coil, whereupon the circuit resumes oscillation once more. R_4 is then adjusted to give a milliammeter reading between 1 and 2mA.

The circuit next needs to be checked for sensitivity. This may be done in a functional manner by passing single "shorted turns" of wire over the projecting core and observing the resulting increases in reading in the milliammeter. A single shorted turn may be made up by soldering the ends of a piece of wire together such that it forms a circle. A final check of sensitivity could be provided by using a single shorted turn with a relatively large diameter, and made of thin wire. Something approaching the worst case to be met with in practice would be provided by a single turn of 38 to 42 s.w.g. wire, the turn having a diameter of an inch. A shorted turn of this type should result in an adequate increase in meter reading.

The sensitivity of the tester is controlled by varying the capacity of C_3. Reducing the value of this condenser will make V_{1a} oscillate less strongly, and will make the circuit more sensitive to the damping of the tuned circuit provided by shorted turns. It is possible that the circuit may oscillate quite readily when the value of C_3 is reduced to a figure as low as 5pF or so. The value of C_3 should not, of course, be made so low that unreliable working of the oscillator results. R_4 may need to be readjusted for each change in C_3. After the final value for C_3 has been selected, R_4 should only need to be occasionally readjusted.

Practical Points

As will have been gathered, the circuit arrangement is quite simple, and raises few problems from the constructional point of view. The device may be built into a self-contained unit intended to be stood on the bench with the ferrite core protruding upwards and out of its case. Alternatively, the circuit around V_{1a} and V_{1b} could be built into a small probe unit, the meter and R_5 being fitted on the bench with the power supply.

The choice of double-triode required for V_{1a} and V_{1b} is fairly critical. The best type would be a 12AU7, a 6SN7, or any equivalent of these valves.

The ferrite frame employed in the tester should have a thin diameter core, in order to enable it to be inserted into the largest range of coils likely to be encountered. Normally, ferrite frames have their coils mounted at one end of the core, this representing what is required in this particular application. It must be strongly emphasised that the material employed in ferrite frame cores is very brittle, and that any attempts at cutting or filing may result in complete fracture. To protect the ferrite core whilst the instrument is being used, it is advisable to provide some means of strengthening. A good solution would be provided by fitting a protective thin-walled tube of insulating material around that part of the core which protrudes from the body of the instrument.

Resonance Effects

Some slight discrepancies in performance may be given if the coils in which the ferrite core is inserted have a resonant frequency close to that of the oscillator. It is possible that such coils may either cause an increase, or a decrease, in meter reading as they are placed over the projecting core. It is most probable that such effects will be given when the coil being tested has a condenser connected across it; in which case such a condenser should be disconnected during tests. A coil without a parallel condenser should not cause any serious trouble in this respect, but if any is suspected the coil may be detuned by temporarily connecting a 500pF condenser across it. Resonance effects should be evident only with coils having a limited range of resonant frequencies around that of the oscillator in the tester.

IN YOUR WORKSHOP

This month Smithy the Serviceman, who continues to run the Workshop, is "serviced" in his turn by his able assistant, Dick

NORMALLY, SMITHY'S MORNING ARRIVAL AT work was a punctual and brisk affair. However, when Dick took up his station outside the Workshop on New Year's Day he was surprised to find that the Serviceman was late. Twenty minutes after the time when the workshop usually opened, Dick heard an unaccustomed clash of gears in the street, this being followed by the spectacle of Smithy's car jerking spasmodically into its parking space. It was obvious that Smithy was not at his best.

The serviceman left his car and opened up the Workshop. He looked pale and shaken.

Servicing Smithy

"What's up?" asked Dick, as he followed him inside.

Smithy groaned.

"Why—oh—why," he asked, "do I always have to get myself tied up with these New Year's Eve parties? As you know, I haven't been down to my Club for ages, but last night they talked me into turning up at the last minute to fix their radiogram and their amplifier. I'm certain they get me into the place on purpose because, no sooner do I get the job done than I'm at the receiving end of more drinks than I know what to do with!"

He turned a bloodshot and belligerent eye on Dick's grinning face.

"At any rate," he remarked aggressively, "I enjoyed myself."

"Hang on a minute," laughed Dick, "I'm just going to pop out to buy something."

Dick returned after a few moments with a tube of Alka-Seltzers. He dissolved two of the tablets in a glass of water and handed the fizzing mixture to Smithy. Smithy drank the contents and, after some minutes, began to brighten up.

"Ah, that's better," he remarked.

His expression cleared and he began to look thoughtful.

"Perhaps I will break that New Year's resolution after all," he muttered to himself contemplatively.

Putting Things Right

Smithy soon became his normal self, whereupon he lost no time in settling down to his work. Dick watched him, ready to offer any needed assistance.

"What did you have to do down at the Club, Smithy?" he asked.

"Oh, just a couple of routine jobs," grunted Smithy. "In fact, both of them were silly mistakes which should not have needed me at all. The trouble is that one of the members prides himself upon being something of an expert on radio and, usually, when I go down there all I have to do is put right what he's put wrong.

"In the first place, they have a radiogram in one of the Club rooms, and this chap decided to run an extension speaker from it. When he'd done the job, however, the speaker only gave low volume as well as quite a lot of distortion. Almost as soon as I looked at the installation I realised what had gone wrong. The trouble was that this chap had decided to save the Club money by connecting up the extension speaker with the aid of some Government surplus wire, which he'd picked up cheap. The wire he'd used was that ex-field-telephone stuff which has seven strands of stainless steel wire and one of copper. That sort of wire is perfectly OK for telephones which run at 600Ω impedance, but it has far too much resistance to allow it to be used at voice coil impedances."

"How did you clear it?" asked Dick.

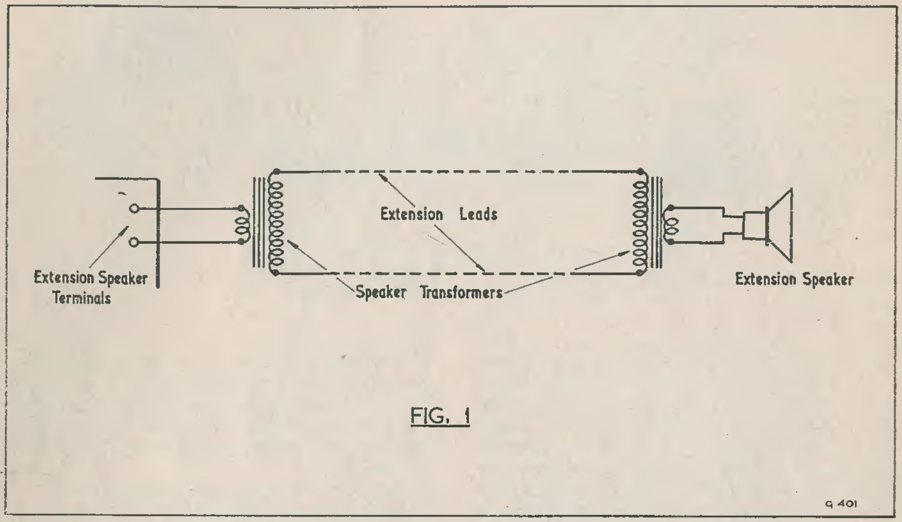


FIG. 1

Fig. 1. How Smithy was able, on a temporary basis, to drive an extension speaker over high resistance leads

"Well, I didn't cure the trouble in the way I wanted to," replied Smithy, "because the proper solution would have consisted of replacing the wire with low-resistance cable. However, as there was quite a long run between the radiogram and the speaker this change would have been rather expensive. In any case they wanted the job done there and then, if possible. Fortunately, I had a couple of speaker transformers in my spares kit in the car, and I rigged up a quick arrangement like this." Smithy scribbled on a piece of paper (Fig. 1). "This worked quite well. What the transformer at the radiogram end does is to convert the low impedance output to a high impedance before feeding it to the extension leads. This high impedance is then converted back to voice coil impedance at the speaker end by the second transformer. The resistance introduced by the wiring does not have so great an effect at high impedance and so there are fewer losses. Theoretically, the arrangement is not very commendable because it introduces too many transformers between the output stage and the speaker, with a consequent reduction in quality. Also the capacity between the wires has more effect at high impedance than at low impedance, and the higher audio frequencies may tend to become attenuated. In this particular case the results weren't too bad, and as it was a rush job it met the immediate purpose. But I would be the first to admit that the dodge didn't represent hi-fi practice, though."

"What was the other job?"

"Well, that was another case where this chap in the Club had caused more trouble than he had cured. You see, they have a microphone and amplifier that they use now and again for dances and things like that. However, people kept complaining that they were getting shocks from the amplifier case, as well as from the microphone and its wiring. The 'expert' did something to the amplifier, whereupon the shocks stopped. Unfortunately, what was then found was that everything reproduced over the amplifier sounded 'gurgly,' as though the person speaking into the microphone needed to clear his throat.

"When I heard the amplifier working I was able to make an accurate guess at what had happened. The 'gurgly' effect was caused by mains modulation, which is occasionally almost as troublesome in a.f. amplifiers as it is in ordinary receivers. A number of manufacturers prevent this trouble by connecting a condenser between one side of the mains input and the amplifier chassis, or by fitting two condensers in a conventional input filter arrangement. Like this" (Fig. 2). "The condensers used for this job normally have a value of 0.01 to 0.05μF. Despite their fairly high reactance to 50 cycle mains voltages, such condensers can still pass enough current to enable you to receive quite an unpleasant 'tingle' from the chassis if it isn't earthed; this being especially noticeable if you're standing on a stone or concrete floor, or are in contact with earth in any other way.

"When I looked inside the amplifier I found that it had the normal input filter arrangement, and that the gentleman who had previously 'repaired' it had, either accidentally or purposely, broken both condensers away from their connections. The condensers were quite serviceable and so I re-connected them. Then I did what should have been done in the first place, which was to earth the amplifier chassis. There was a 3-pin mains socket close to the amplifier which provided a perfectly good electrical earth, and all I had to do was to connect the amplifier chassis to the earth pin."

"Did that cure the trouble?"

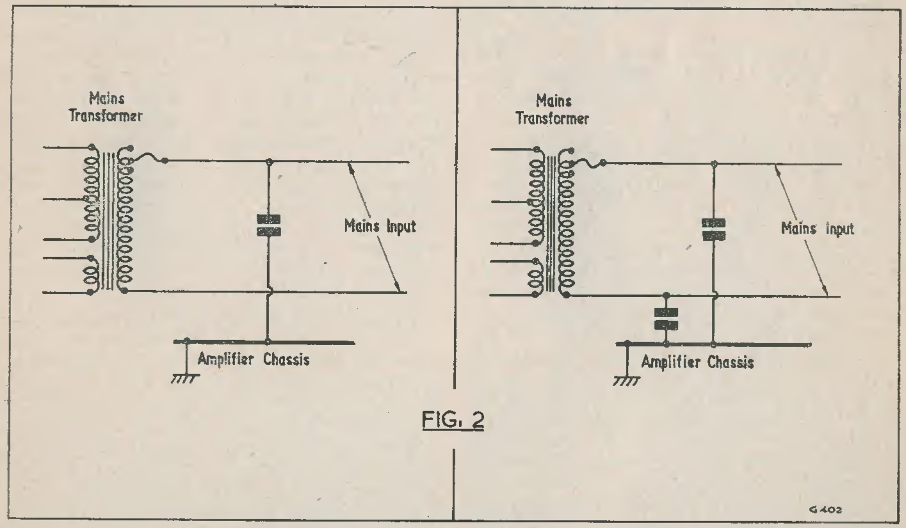


FIG. 2

Fig. 2. Two methods of providing a mains input filter for a.f. amplifiers

"The amplifier worked perfectly after that. Indeed, you couldn't have had better quality when, later on, I was singing—" Smithy stopped in mid-sentence and corrected himself—"I mean when, later on, I carried out further routine checks."

"Something tells me you had a good time last night," chuckled Dick. "It's a good thing New Year's Eve only comes round once a year."

Smithy grunted, but whether it was a grunt of dissent or assent Dick could not decide.

Flywheel Sync

The morning passed on more or less uneventfully after that, with Dick helping Smithy by tackling some of the simpler jobs.

After a while Dick turned round to Smithy. "You know," he said, "I've noticed that there seem to be many more television sets with flywheel sync coming into the workshop these days than there used to be. Do you think flywheel sync is going to be standard in television sets in the future?"

Smithy considered this question thoughtfully.

"So far as Britain is concerned I don't think it will be," he replied finally. "This being the case despite the fact that it is very common in other countries. Let us look at the situation carefully. Line flywheel sync provides a valuable service in receivers which operate in fringe areas, because it ensures a steady picture even when interference overrides the signal level at the aerial. We're in something of a fringe area in this district, especially where Band III is concerned, and so more sets with flywheel sync are sold locally than are those with ordinary sync circuits. And, of course, a proportion of these flywheel sync sets find their way into this workshop. On the other hand, there is the fact that, if a set receives strong Band I and Band III signals, the expense of fitting it with a flywheel sync circuit is not really justified. The normal sync arrangement would cope just as well. So, in districts where a strong signal is available, fewer flywheel sync receivers are sold. It's an interesting situation, really, especially when you compare conditions here with those in the States, for instance. So far as I know, flywheel sync is very common in American sets, this being probably due to the fact that most American set owners want to pick up weak signals on other channels, even when they get strong signals from local transmitters. For reception of weak signals the flywheel sync circuit becomes almost essential. In this country we have two programmes only to choose from, so that each individual viewer requires either a set intended for fringe area reception, and which would preferably have flywheel sync, or a set which is fed with strong local signals, whereupon flywheel sync is not really worth the expense. In this second case the temptation to pick up alternative signals does not exist, because there just aren't any! So far as I can see it seems that Britain, because of its particular programme limitations, may be making more televisors for the home market *without* flywheel sync than many other countries."

"I've always been a little hazy about setting up flywheel sync circuits," remarked Dick. "Have you any hints you could pass on concerning that subject?"

"Well," said Smithy, "before you start playing around with flywheel sync circuits it is advisable to get a general idea of how they work. Basically, the flywheel sync circuit consists of a line timebase oscillator whose frequency can be altered by variations in a d.c. control potential which is applied to it; this control potential being obtained by comparing the frequency of the oscillator with the repetition frequency of the sync pulses on the incoming signal. The control potential is applied to the line oscillator such that it always tends to make the latter run at the same frequency as that of the sync pulses. A simple C-R circuit prevents the control potential from varying too rapidly, and this gives the flywheel effect."

Smithy made a further sketch on the paper in front of him (Fig. 3).

"Now here," he continued, "is the general layout of a flywheel sync circuit. The line sync pulses from the incoming signal feed into what I have described here as a 'discriminator.' Similarly feeding into the discriminator are oscillations from the line oscillator. The discriminator compares the repetition frequency of the sync pulses with the oscillator frequency, and it provides a control potential there from which is a function of the difference frequency. If the line oscillator runs at too high a frequency the control potential moves in one direction; if the oscillator runs at too low a frequency the potential moves in the other direction. The discriminator section may consist of a phase discriminator, which compares the difference in phase between the two frequencies; or a coincidence detector which generates a control voltage proportional to the amount of coincidence, or 'overlap,' of the sync pulses and the line oscillations.

"The control potential from the discriminator feeds through a C-R filter, such as that shown, before being applied to the line oscillator. The purpose of the C-R filter is to prevent rapid changes in control potential from reaching the line oscillator. Such rapid changes would be given if the sync pulses were lost during a period of violent fading or, more frequently, if heavy impulsive interference found its way past the sync separator. Whilst the control potential from the discriminator might vary violently during such times, the line oscillator would press on at practically unaltered frequency, the variations in control potential being integrated, or 'smoothed,' by the C-R filter. The time constant of the C-R filter will vary in receivers of different manufacture, and may be equivalent to the duration of several dozen lines or to that of a complete frame. As you can see, it is the presence of this C-R filter which gives the basic flywheel effect. I should mention that the C-R filter serves a secondary function in many circuits, insofar that it also removes any line frequency ripple present in the discriminator output, and that it need not necessarily take up the simple form shown in the diagram. You will note that no sync pulses, as such, reach the line oscillator. Its frequency is controlled entirely by the d.c. potential from the discriminator.

"The line oscillator itself may consist of a blocking oscillator, a multivibrator, or a sine wave oscillator. If it is a blocking oscillator its frequency may be varied by applying the control voltage to its grid, this being usually done via the grid leak. When this is done the control voltage is always positive with respect to oscillator cathode. This method of connection can give a very wide range of frequency control and, assuming the requisite component values in the oscillator circuit, control potentials up to several hundred volts positive, applied via the grid leak, are quite feasible; although smaller potentials are normally employed in flywheel sync circuits. Exactly the same sort of control can be applied to a multivibrator, the control potential being applied to the grid of the valve which is 'on' during the scan period. Incidentally, with both the blocking oscillator and the multivibrator, the frequency of oscillation increases as the control potential goes more positive.

"A sine wave oscillator is frequently employed in flywheel sync circuits, its sine wave output being converted to the waveform required by the line output valve by special shaping circuits. The frequency of a sine wave oscillator may be controlled with the aid of a reactance valve in quite conventional fashion.

"As you can see, the whole flywheel sync arrangement is really an automatic frequency control device. When the oscillator drifts in frequency, a correcting potential is applied to it which brings it back to its correct frequency again. The oscillator responds relatively slowly to this control potential, with the result that momentary interference and loss of sync pulses are practically ignored."

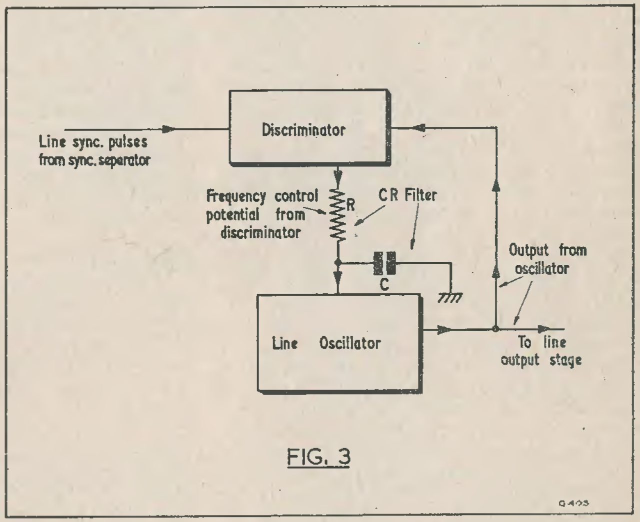


Fig. 3. The basic flywheel sync arrangement

Phasing

"Well, that seems clear enough," remarked Dick, who had been following Smithy's explanation closely. "What I don't quite understand, though, are the queer effects you often get in receivers which have flywheel sync. Like the picture moving from side to side as you turn the line hold control, and so on."

"Ah yes, that can be a little puzzling at first," admitted Smithy, "but there's a perfectly good reason for these happenings.

"You see, there are two requirements which have to be satisfied when a line timebase is synchronised to an incoming signal. The first requirement is the obvious one: the timebase must operate at the same frequency as the repetition frequency of the line sync pulse in the signal. If it didn't, the received picture wouldn't correspond to that which is transmitted.

"The second requirement is that the receiver line oscillator must be *in phase* with the received signal. That is to say, when the camera at the transmitter commences to scan the scene presented to it, so also must the receiver line timebase. When the transmitting camera is retracing its spot, preparatory to scanning another line, the receiver line timebase must similarly be retracing its own spot as well. If these two sets of events did not coincide we would be receiving an incorrect picture once again.

"In practice slight discrepancies are allowed in the receiver so far as the retrace period is concerned. For instance, a certain leeway is provided in the transmitted signal by including a back porch, this being a short period of 'black' signal sandwiched between the end of the sync pulse and the start of the picture information in the following line. Amongst other things, this back porch gives receivers with overlong retrace periods sufficient time to be prepared for the next line before the picture information actually commences.

"In receivers using normal line sync circuits, and assuming that interference or fading do not cause loss of sync, the receiver line timebase is always in phase with the transmitted signal. This is because it is the leading edge of the line sync pulse itself which triggers off the retrace period in the receiver. In consequence, retrace at the receiver must always correspond to retrace at the transmitter.

"With a flywheel sync circuit you don't get this effect. The discriminator arrangement ensures that the line oscillator runs at the same frequency as that of the sync pulses, but it doesn't necessarily ensure that it is in correct phase.

"This sketch" (Fig. 4) "may help to make this clear. At the top I have drawn a number of lines of video signal, as are sent out by the transmitter. As you can see, we have the relatively long scan period during which the picture information appears. We then go down to black level for the front porch, and then we get the sync pulse. This is followed by the back porch and the start of the next scan period.

"Underneath this video signal I've drawn a number of sawtooth cycles, these depicting the current flowing through the line deflector coils and representing, therefore, the deflection of the spot on the face of the picture tube. Waveform A is that which is given when the line oscillator is running at too high a frequency, Obviously, the resultant picture will be out of synchronism with that which is transmitted. Waveform B depicts a line oscillator which is running at too low a frequency, Once again we will be out of synchronism, and we will have an incorrect picture.

"Waveform C is that given by a line oscillator which is running at correct frequency. As you will note, the frequency of this waveform is exactly the same as the repetition frequency of the sync pulses. Despite this, however, we still do not get a perfect picture because Waveform C is *out of phase* with the transmitted signal. For instance, when the transmitted signal reaches its sync pulse, Waveform C is still in the scan period. What happens, therefore, is that the picture given by this waveform ends abruptly before the spot reaches the right-hand edge of the raster. The right-hand part of the raster then shows up as black. Furthermore, if the phase difference is severe, as it is in Waveform C, we will actually see, after the black period, the start of the next line before the receiver goes into its retrace period. During the retrace period, picture information will still be passed to the tube modulating electrodes and will appear faintly in the background of the reproduced picture. When the phase difference is not so severe as it is in Waveform C, we will still get the black period at the right-hand edge of the raster that I have just mentioned. What is perhaps more important is the fact that, since the receiver retrace period occurs after that at the transmitter, picture information may commence during retrace. This information will show up on the picture as foldover on the left-hand side.

"Waveform D illustrates a line oscillator which is running, once more, at exactly the right frequency but is out of phase in the opposite direction. This time the retrace cycle occurs before that at the transmitter. In this case the right-hand edge of the picture is lost and, in cases of severe phase difference, may appear at the left-hand edge of the raster after the receiver retrace period has finished. As before, picture information occurring during the retrace period will appear faintly across the picture. When the phase difference is not so severe the left-hand edge of the picture has a black border, and the right-hand edge exhibits foldover.

"In Waveform E we have a line oscillator which is running at the same frequency as the sync pulse repetition frequency, and which is exactly in phase with it. The result is a perfect picture.

"With regard to your original query about the picture moving from side to side as the line hold control is adjusted, you can now see that this control is actually changing the phase relationship between the line oscillator and the transmitted signal."

"Phew!" said Dick, with a heavy frown. "It makes you wonder whether flywheel sync is worth while when you have all these complications."

Adjusting Flywheel Sync Circuits

"It's not as bad as all that," grinned Smithy, "because so far as phasing is concerned, you have quite a lot of leeway to play with in practice. You see, each line is separated from the next by quite a long period of black signal. First of all there is the front porch, then the sync pulse itself, and finally the back porch. So long as your set has a reasonably quick retrace time you can put up quite comfortably with minor phase discrepancies. For instance, if the length, in time, of the total transmitted black period—that is, front porch plus sync pulse plus back porch—is, say, twenty microseconds and your receiver has a retrace time of ten microseconds, then you have five microseconds of black signal to play with on either side of the picture itself. The picture can drift to right or left—due to phase discrepancies—by up to five microseconds without causing foldover and consequent annoyance to the viewer at all. Indeed, if the drift is slow, and the picture edges remain covered by the tube mask, he probably wouldn't even notice it. There is also the fact that a good flywheel sync circuit is designed such that it tends to stay more or less in phase by reason of the circuit constants it employs."

"How do you set up a flywheel sync circuit?" asked Dick.

"Well, normally, I try to make it a rule not to make any internal adjustments to a flywheel sync timebase until I have read the service manual for the set. By 'adjustments' I don't mean obvious component or valve changes, of course. In practice, I'm afraid I have broken that rule on one or two occasions, but I've kept out of trouble by making small adjustments only.

"One usually finds, in the chassis of receivers with flywheel sync, that there is an adjustment for line phase as well as line frequency. The front panel line hold control is intended, normally, for frequency, and may function by applying a bias to the d.c. potential controlling the line oscillator. As I mentioned earlier, the panel control frequently affects phase as well. With the panel control it should be possible to obtain both correct frequency and correct phase at a single setting. If the control is set for correct frequency—and I shall tell you how to do this in a minute—but then gives incorrect phase, there should be a phase control on the chassis which probably needs adjustment. To adjust for correct phase *really* accurately, you should turn the brilliance up so that you can see the raster at either side of the picture. Turning up the brilliance in this manner makes the normally black front and back porches *and* the sync pulse visible. If necessary, contrast will have to be turned back a little to reduce the beam current which flows with the high brillance setting. When the widths of the 'black' sections at either side of the picture are equal, then the phasing is 'spot-on.' If the edges of the raster are outside the edges of the picture tube face, a temporary adjustment of the width control will narrow the raster sufficiently to enable this check to be carried out. And don't forget that it is necessary to have fairly high brilliance, or the 'blacker than black' sync pulses may not show up on the raster. In receivers with a fast retrace, a little of the sync pulse may occur on the right-hand side when you've got the picture centralised. Incidentally, I should add that phasing adjustments shouldn't be carried out until the set has been allowed to warm up for some fifteen minutes or so. There may be slight drift in the flywheel sync circuits during that time.

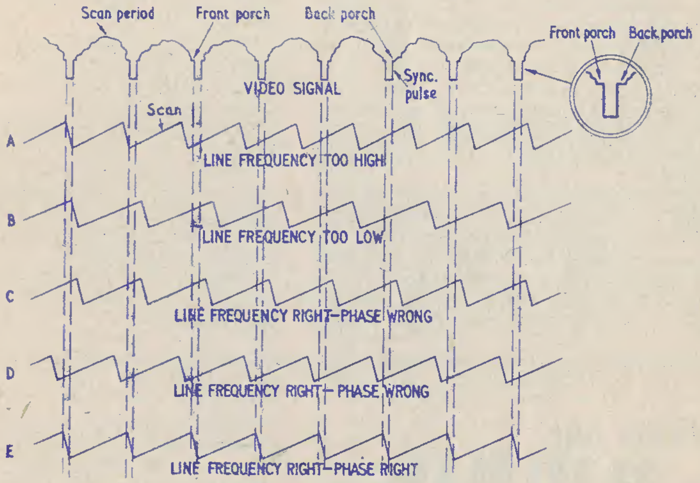


FIG. 4

Fig. 4. This diagram illustrates the possible synchronisation errors which may appear in an incorrectly set flywheel sync circuit. The waveforms are discussed in the text

"As we have already discussed, the panel line hold control often alters phase as well as frequency; and, in consequence, it is difficult to know if it is set up correctly. Before checking for phase error the panel control should be set up for correct frequency by temporarily stopping the sync pulses reaching the discriminator, and then seeing if the line oscillator locks in *immediately* they are re-applied. You can stop the sync pulses temporarily by switching to a 'dead' channel, or by pulling out the aerial plug. Some sets have switches which stop the sync pulses whilst still keeping the picture on the screen. It is possible to set the line hold control for *exact* frequency on these sets.

"But surely," objected Dick, "even if the panel control is a long way off adjustment, won't the circuit automatically bring itself back into lock as soon as the sync pulses reappear?"

"With flywheel sync that doesn't always happen," replied Smithy. "A phenomenom exhibited by most flywheel circuits is that they take an appreciable time to 'pull in' and, if the line oscillator is some way off frequency, they do not pull in at all. Once they are locked, however, they stay locked quite rigidly. That's why, with some sets, after you have adjusted the line hold control to get a locked picture, you can introduce quite heavy phase difference with that control without losing lock.

"And heaven protect you from the chap who has a badly phased picture and tries to put it right again by adjusting the picture centreing magnet!"

Smithy stopped, and Dick realised that this present session had come to an end. As time was getting on, he commenced to clear up some of the things which were lying on the bench.

"By the way," asked Smithy, "what are you going to do with that glass?"

"I'm going to clean it out in the sync," replied Dick promptly.

Smithy groaned. Then a light gleamed in his eye.

"Just a moment, young man," he said; "let me ask you a question for a change! How is it that a young person like you knew how to set about clearing my head when I came in this morning?"

"The idea was recommended to me by my uncle," replied Dick. "He's the steward at your Club!"

From our MAILBAG

Dear Sir,

Some readers who constructed the Negative Feedback Tone Control described in the October issue of this magazine may have done so solely to provide a means of compensating for high note loss due to sideband cutting, and not to improve speech clarity under bad conditions. When this is the case, they may not require the general boosting of all the upper frequencies provided by the circuit as it stands.

The action of the control in the "Treble" position can easily be restricted to the extreme high frequencies by reducing the value of the capacitor joining the sliders of the two potentiometers. Instead of the 0.01μF capacitor shown, values between 0.005 and 0.001μF should be tried. The response in the "Bass" position will also be modified of course, but this should still be quite satisfactory.

I hope the foregoing will be of assistance to those constructors who may have found the original control too drastic for their particular requirements.

(R. Wallace, Teignmouth)

TRADE REVIEW

A. F. Bulgin & Co. Ltd., Bye Pass Road, Barking, Essex

We have received from the above manufacturer a sample of their latest Continental style control knob. This new, smart ribbed and tapered control knob follows the latest trend in the design of radio and instrument knobs. The corrosion-resisting highly polished central golden metal disc is firmly secured to the outer bakelite moulding. This moulding is well made and designed in that it affords a good control grip and is fitted internally with an anti-fracture heavy brass insert within which a 4 BA hardened and well sunken grub screw is incorporated.

This 1in diameter knob is, at present, available in black as standard, or colours to quantity orders. The list number is K.425.

TELEVISION for the HOME CONSTRUCTOR

PART 7.

by **S. WELBURN**

This month S. Welburn, our popular contributor on television topics, discusses ways and means of clearing that irritating fault—picture shrinkage

An irritating fault which occurs in many television receivers is that where picture dimensions change after the receiver has been switched on for some time. The usual trouble is picture *shrinkage*, this being caused by alterations in circuit values in the receiver due to increasing temperatures inside the cabinet. Changes in picture size may also be the result of varying mains voltages. So far as drifting circuit values are concerned, it is sometimes possible to neutralise the effect of these fairly simply, but the question of varying mains voltages is more difficult of solution. This month's contribution in the present series of articles will discuss both types of trouble, as well as giving some hints on reducing their effects.

Varying Circuit Values

Assuming a constant mains voltage, it may safely be said that when the reproduced picture of a television receiver commences to change in size after the set has been switched on for some time, this is the result of a shift in values somewhere in that set caused by the increase in working temperature. Frequently more than one shift occurs, and care has to be taken to ensure that a fault in one section of the receiver does not mask the effects given by variations in another.

The most prevalent and well-known alteration in picture dimensions is that which is described as "frame shrinkage," this covering the case where the height of the picture becomes progressively less as the temperature inside the cabinet increases. Frame shrinkage is almost always caused by changes in the frame timebase and scanning components. There are other, more general, causes of change in picture size, however, which affect either vertical or horizontal dimensions, or both, and these will be considered in some detail before particularising on frame shrinkage on its own. Since, in any case, it would be unwise to attempt to cure frame shrinkage without quickly checking these more general faults, this course seems to be advisable.

The section of the receiver which is common to all other parts is, of course, the power supply circuit. It is the job of this circuit to furnish h.t. and heater power. If either the h.t. or heater voltages varies by an excessive amount after the set has warmed up, changes in picture dimensions may occur.

The h.t. supply in almost all modern television receivers employs half-wave rectification of the type shown in Fig. 1. In this diagram we have a simple half-wave rectifier (which may be a valve or a metal component); followed by a limiting resistor (which could be fitted just as effectively on the mains side of the rectifier); a reservoir condenser; a smoothing choke or resistor (usually the former); and a smoothing condenser. The last-named component also serves to decouple the h.t. line to chassis. In many receivers a second h.t. line, decoupled by a further condenser, feeds part of the receiver circuits. A second h.t. line of this type is illustrated in the diagram.

The total h.t. current consumed by the receiver will normally lie between 200 and 300mA. Such a current incurs a heavy strain on the rectifier and reservoir condenser when these are employed in a half-wave arrangement, and quite large charging currents flow through these two components during the peaks of rectified half cycles. These currents are kept to a safe value by the limiting resistor. (The impedance of the mains supply is normally assumed to be zero ohms.)

When a set suffers a change in picture dimensions after it has been switched on, it is advisable to check the stability of the h.t. supply during the period in which the trouble shows up. Such a check is very simple to carry out, all that is necessary being to check the h.t. voltages across the reservoir and smoothing condensers some five minutes or so after switching on, and to re-check these at intervals as time goes by. When a "branch" of the h.t. line feeds any part of the frame or line timebases, the voltage across the condenser decoupling this branch should also be checked. At the same time as the h.t. voltage readings are made, the mains voltage should be checked to ensure that this remains reasonably steady. Notes should be kept of all the voltage readings obtained.

Although the above process may sound somewhat long-winded, it takes little time in practice. Normally, three sets of readings are quite sufficient; one just after the set has warmed up; one, say, half an hour later; and a third an hour after switching on. It may be presumed that, after this time, the greatest change in picture size will have occurred.

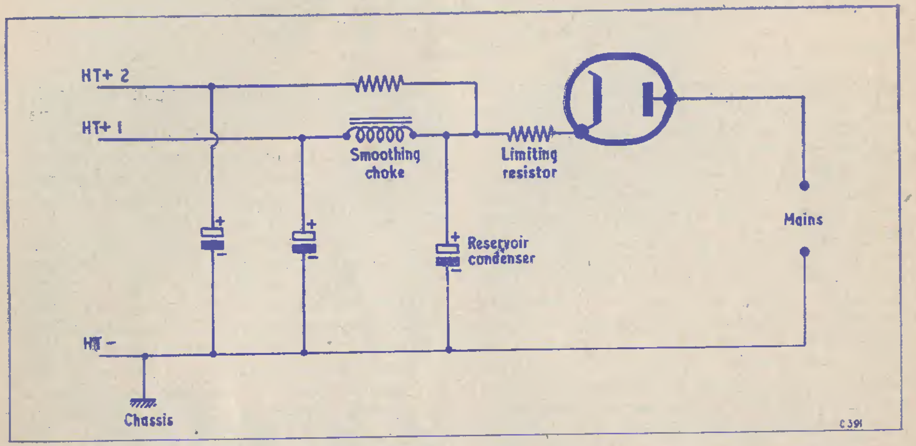


Fig. 1. A typical h.t. supply circuit, as used in modern televisors. A separate h.t. rail, feeding a particular section of the receiver, is fairly common, and is shown here as the "h.t. + 2" line

Assuming that there is a change in voltage on the h.t. line after the set has been switched on, the voltage checking procedure just described will help to isolate the cause. If it is found that the voltages across the reservoir and the smoothing condenser(s) all fall by a similar amount, the cause may be either the rectifier, the limiting resistor or the reservoir condenser. Alternatively, if the h.t. voltage across the reservoir condenser remains steady, but that across a single smoothing condenser drops, then the fault will most probably be caused by excessive resistance in series with that condenser; or by the existence of excessive current in the circuit it serves.

The above remarks are intended to be of a general nature only, and the reader is not advised to make wholesale replacements, which may be expensive and fruitless, if the results obtained from the voltage checks indicate only a slight lack of voltage stability in the h.t. line. In many receivers quite a noticeable drop in h.t. voltage occurs after the set has reached full operating temperature, and this represents a more or less normal state of affairs. Changes of some 10 volts or so may normally be ignored. Where a larger drop in h.t. voltage occurs, and before expending cash on replacements, it is advisable to check that this drop does indeed cause a change in picture dimensions. This check can be carried out by running the receiver at the higher and lower h.t. voltages consecutively just after it has been switched on. (An h.t. voltage lower than normal can frequently be obtained by temporarily using a higher tapping on the receiver mains voltage selector. This results in the set being under-run.)

The component most liable to cause a gradual drop in h.t. voltage is the rectifier. Further possible causes may be the limiting resistor going high in value or, occasionally, a fault in the reservoir condenser. Before condemning any of these components, a check of the h.t. current drawn by the receiver should be made. Excessive current drain, caused by a faulty stage elsewhere in the receiver, will make an otherwise serviceable rectifier and its associated components give poor regulation.

When a reasonably steady voltage appears across the reservoir condenser but the *smoothed* voltage drops considerably, the fault would appear to be caused by the series smoothing components going high in resistance as they warm up, Again a little circumspection is advisable here, especially insofar as smoothing chokes are concerned, because the trouble may once more be caused by excessive h.t. current. It should be remembered that the d.c. resistance of a smoothing choke is *bound* to rise as it gets warmer, simply due to the fact that the resistance of the copper wire with which it is wound increases with a rise in temperature.

All the above points concerning h.t. voltage regulation assume that the mains voltage remains constant during the tests.

Summing up, it may be said that in practically all receivers a small change in h.t. voltage occurs as the receiver components become warmer. This change is usually a drop in voltage. Components should not be changed unless it is certain that they are faulty; as a small drop in h.t. voltage may be quite a normal state of affairs in the particular receiver being tested.

A special case occurs when either the frame or line timebase oscillators is run from the boosted h.t. line. If this voltage changes as the set reaches full operating temperature, picture dimensions may shift in consequence. In receivers employing the boosted h.t. line for timebase oscillators, the voltage of this line will need to be checked in addition to that at the points already mentioned.

Another possible cause of alterations in picture size is variations in heater current. Such variations are feasible in receivers with series-connected heaters, and may be caused by such things as faulty dropper resistors or series thermistors. Although trouble from this cause is rare, the ease of taking heater voltage readings (say between chassis and the lower end of the dropper resistor), at the same time as the h.t. voltages just discussed are measured, renders it worth while keeping an eye on this possible source of trouble also.

Frame Shrinkage

Assuming that the h.t. and heater voltages in the receiver are sufficiently stable with time, the question of altering picture dimensions can be moved to the timebases themselves.

Whilst changes in picture dimension may be caused by shifting characteristics in both line and frame timebases, it is usually the latter which causes the greater amount of trouble. The reason for this is rather difficult to determine, since the conditions causing changes in frame scanning amplitude are just as applicable to the line scanning circuits. Nevertheless, the frame timebase is usually most troublesome, and this will now be discussed.

Unless their effects are neutralised in some manner, the changing characteristics in the frame timebase, including its scanning components, almost always lead to a diminution in height after the receiver has been switched on for some time, As was noted earlier, the condition is well known in the trade, and is normally called "frame shrinkage." The usual cause of the shrinkage is increase in temperature of the windings of the frame deflector coils and the frame output transformer. This increase in temperature results in a corresponding increase in resistance.

Fig. 2a illustrates the anode circuit of a conventional frame output stage. As will be seen, the anode is coupled to the deflector coils via the frame output transformer. Fig. 2b is a circuit equivalent to that of Fig. 2a, with the exception that the transformer and deflector coil windings now shown are assumed to have zero resistance. The individual resistances of these windings are then illustrated as physical series resistors. Thus, R_{TP} represents the resistance of the transformer primary, R_{TS} the resistance of the transformer secondary, and R_D the resistance of the deflector coils. In practice the ohmic values represented by these resistors are relatively high; including, especially, that of the transformer primary, which is normally wound with many turns of fine wire. When the receiver in which the circuit of Fig. 2b is employed has been switched on for some time, the values of all three resistors increase; this being due to the ambient temperature rise in the cabinet plus that caused by the current passing through the windings. The increase in resistance reduces the scanning current flowing through the deflector coils, and the height of the picture decreases.

The visible effects of frame shrinkage are liable to vary considerably in severity for different models of receiver. According to the particular model examined, the picture may become stabilised at any time between a quarter of an hour to an hour or so after switching on, this representing the period needed for the chassis components to achieve working temperature. The *amount* of shrinkage will also vary from model to model. In some sets the shrinkage may be negligible, in others it may be as much as 7% of total picture height. On a 17-inch tube (approximate vertical dimension 10½ inches) 7% represents a reduction of picture height of nearly ¾-inch. With a 21-inch tube (approximate vertical dimension 14 inches), the reduction would be nearly an inch. Such a reduction can obviously not be ignored.

For most receivers frame shrinkage works out at around 3 to 4% and can, if the viewer is prepared to put up with it, be largely ignored. In such instances the usual method of attack consists of so setting the picture height control that the picture is just outside the tube mask area after the set has reached full working temperature (or of initially setting this control to too high a setting after switching on to allow for the later contraction). The shrinkage during warm up then becomes less irritating to the viewer than it would be if he actually saw the top or bottom edges of the picture appear inside the mask area.

Some commercial manufacturers fit circuits which compensate for frame shrinkage. The arrangements employed are usually extremely

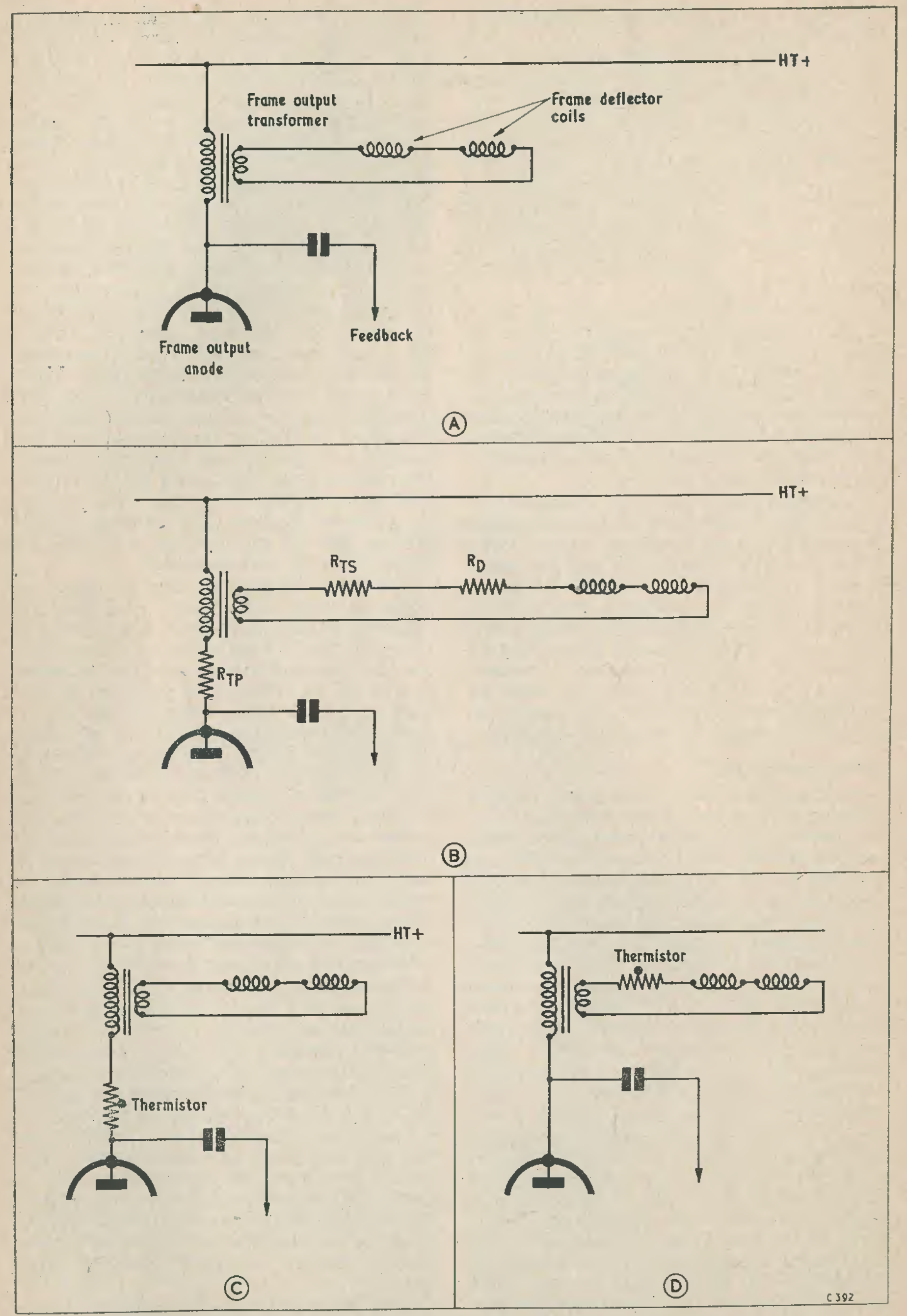


Fig. 2. These four diagrams illustrate aspects of the frame output stage which are applicable to frame shrinkage. The circuits are discussed in the text

simple, and consist of using negative temperature coefficient resistors—thermistors—in some part of the frame timebase circuit. The resistance of thermistors *decreases* as their temperature rises. Thermistors are already frequently employed in television receivers, of course, being normally connected in series with the heater chains of "transformerless" sets. Their high initial resistance reduces the surge of current which would otherwise occur when the set is switched on; this surge being caused by the low resistance of the heaters themselves in the cold condition. Thermistors have also been used to compensate for the increase in resistance of focus coils as their windings warm up. The Brimar CZ2 and CZ3 are typical units for this application. For the home-constructor who is prepared to do a little experimenting, thermistors provide an excellent means of curing frame shrinkage.

It would appear, at first sight, that the obvious place to fit a thermistor which is intended to correct frame shrinkage would be either in series with the frame output transformer primary, as in Fig. 2c, or in series with the frame deflector coils, as in Fig. 2d. When used in either of these positions, the thermistor would then directly compensate for the root cause of the frame shrinkage, i.e. the increasing resistance of the windings to which it is connected. So far as the writer is aware, such a method of connection has not been employed commercially, this being possibly partly due to the fact that the behaviour of thermistors may be problematic whilst passing pulse currents. Commercial arrangements employ the thermistor as a regulating device in a purely d.c. application (in which it varies one of the d.c. potentials applied to a valve in the frame timebase), and it would be advisable for the home constructor to follow this example.

On examining the characteristics of typical thermistors at present available, it will be found that these possess resistance values which are of the order of some 500 to 8,000Ω. Typical examples near the middle of the resistance range are given by the Brimar CZ1 and CZ6, these both having resistances of 4,800Ω at 0°C, 3,000Ω at 20°C, and 1,300Ω at 50°C. A "higher resistance" thermistor is represented by the CZ2, this having values of 8,550, 5,500 and 2,440Ω at 0°C, 20°C, and 50°C respectively. Since these resistance values are relatively low, it follows that thermistors need to be employed in circuits which pass relatively high currents if they are to exert sufficient control. It would, for instance, be impractical to attempt to counteract frame shrinkage by connecting a thermistor in series with the anode feed to the average frame oscillator, such an anode being normally fed via a resistance of the order of 500kΩ.

The most practicable place to insert a thermistor is in the frame output stage, attractive possibilities being provided by connecting it in series with the anode supply, as in Fig. 3a, the screen grid supply (Fig. 3b), or in the cathode circuit (Fig. 3c). All these electrodes pass a relatively high current, and so the thermistor is enabled to have adequate control. It will be noted that the thermistors shown in Fig. 3 do not pass pulse currents, as they are decoupled by the appropriate condensers. In each of these three diagrams the thermistor is paralleled by a resistor. This represents a frequent practice, the parallel resistor serving to reduce the effect of the change in resistance of the thermistor when this proves to be too great. The parallel resistor is not essential, of course.

The thermistor circuit which will give greatest control over picture height is that shown in Fig. 3c, wherein it causes a change in cathode bias voltage of the frame output valve as the ambient temperature of the set increases. It is possible to check the suitability of this part of the receiver circuit for thermistor control by replacing the normal cathode resistor with a suitable wire-wound variable resistor set to the same value. After the set has been allowed to reach full operating temperature, and frame shrinkage is in evidence, this variable resistor should then be reduced in value until the picture returns to its original height. The difference in resistance, as measured by an ohmmeter, between the two settings of the variable resistor then indicates the amount of resistive correction which has to be provided by the thermistor. The only snag given by inserting the thermistor in the cathode circuit is that the altered cathode bias resistance may adversely affect frame linearity to a greater extent than if the thermistor were placed in series with any other electrode. This point should be watched for. The variable resistor technique may be employed when the thermistor is intended to be connected in series with the anode or screen-grid.

When the thermistor is finally connected into circuit it should be fitted at the point in the receiver where it is assumed that the greatest increase in temperature of the frame timebase components is taking place. This will probably be above the frame output transformer, in which case the thermistor will be warmed up by the temperature around this component. The current flowing *through* the thermistor will be much lower than that which it would carry in its normal application (that of reducing heater current surges), whereupon it may be assumed that most of its temperature increase is caused by ambient conditions.

The ideal and most direct method of selecting a particular thermistor type for

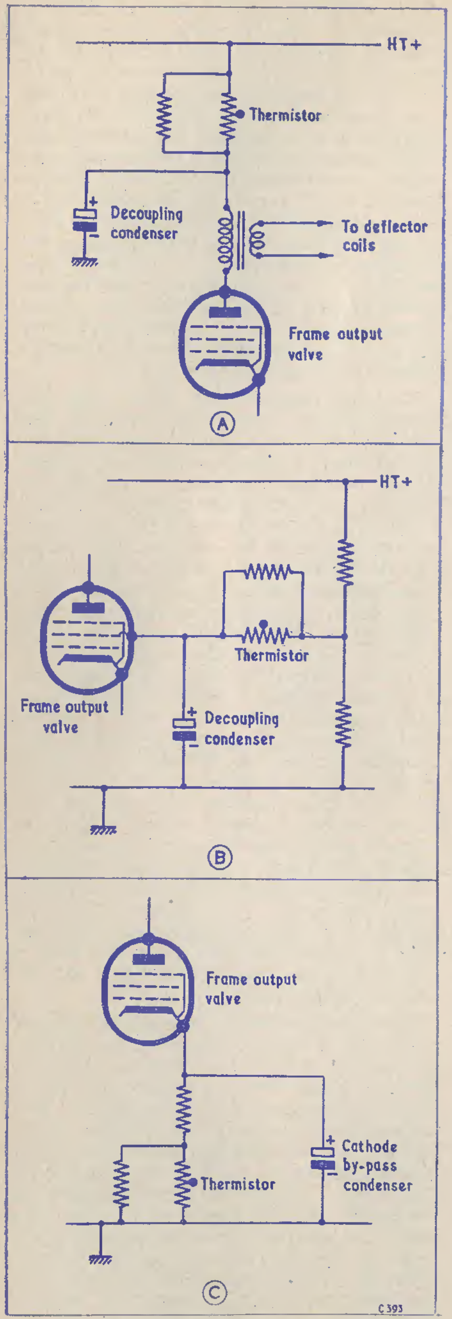


Fig. 3. Illustrating three different methods by means of which the effects of frame shrinkage may be obviated

correcting frame shrinkage consists of applying a thermometer to the point at which the thermistor will be fitted, and noting the temperatures obtained after different periods of use. This idea is not so "high-brow" as it may appear at first sight, since quite reasonably accurate readings will be obtained with the cheap thermometers which are sold in some of the popular stores. The requisite thermistor may then be selected by checking the temperature readings obtained against the data published by thermistor manufacturers. The use of a thermistor providing greater resistance change than that required will enable final experimental "trimming" to be carried out with the aid of a parallel resistor.

Line Shrinkage

As has already been noted, line shrinkage does not appear to cause as much difficulty in television receivers as does frame shrinkage; although the possibility of increased resistance in the copper wire of the line output transformer and the line deflector coils as temperature rises may be just as acute. (It is possible, of course, that, due to the higher frequencies involved, the inductive reactances of most line output transformers and scanning coils may be considerably greater than their counterparts in the frame circuit. Resistive changes would then have less effect on picture width.)

Due to the difficulty of finding suitable points in the line output circuit for the insertion of thermistors, the possibility of controlling line shrinkage with the aid of such components does not represent an attractive solution. It must also be pointed out that attempts at controlling picture width by applying thermistors to the line output valve supply circuits may result in undesirable changes in e.h.t. voltage, and the project is made more undesirable on this score also.

In cases where line shrinkage occurs, the trouble is sometimes caused by excessive temperature rise in the line output transformer. This not only affects the resistance of the transformer windings, but also the permeability of its core, this latter probably having the greater effect on picture width. Assuming that everything else in the circuit is correct and that the overheating of the transformer is not caused by a fault condition, it might be worth while attempting to improve the ventilation of this component. Where a commercial receiver is concerned, changes should not be required, as the set should have been designed to give the necessary ventilation. Nevertheless, it is always advisable to check commercial receivers to see that the ventilation of the set as a whole is not being restricted. For instance, adequate air circulation should always be allowed at the back of the receiver cabinet. (Servicemen occasionally meet the case when a curtain rests against the cabinet back, preventing the passage of air.) Where feet are provided on the cabinet to enable an unimpeded current of air to flow up through the bottom, this current of air should not be stopped by standing the cabinet on a small table with the legs overhanging the edges (another instance occasionally met by servicemen).

The *radiation* of heat away from a line output transformer can often be increased to a surprising extent simply by painting both the inside and outside surfaces of the screening around it with matt black enamel. A shiny metal surface does not absorb or radiate heat efficiently.

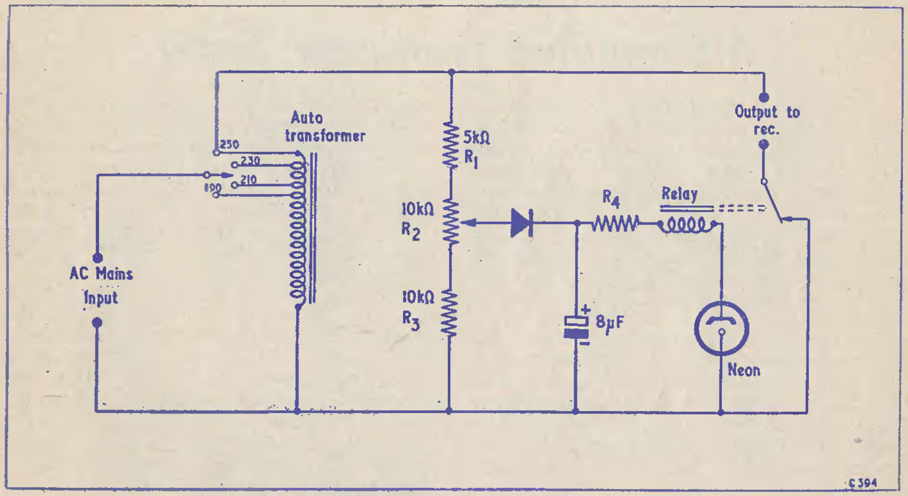


Fig. 4. A circuit, originally appearing some years ago in this magazine, which may assist in overcoming the effects of low mains voltages

Variation of Mains Voltage

Up to now we have considered the case where picture dimensions alter due to variations in receiver constants. There is also the fact that alterations may be caused by variations in mains voltage.

Although the domestic consumer is entitled to be provided with a mains supply having a reasonably steady voltage, this does not occur in some districts. In such localities the mains voltage falls at certain times of the day, these corresponding to peak loads in the district.

So far as the television viewer is concerned, drops in mains voltage are rather infuriating, because he is helpless to do anything that will rectify the trouble. If he adjusts his receiver to a lower mains tapping he has no guarantee that the mains voltage may not suddenly rise to its correct value, whereupon his set will be over-run and may become damaged in consequence. An interesting and possible solution to this trouble was made the subject of an article in *The Radio Constructor* some years ago ("Overcoming That Mains Drop" by J. R. Davies, p. 119, Nov. 1950 issue). This article described an appliance which, with the aid of a neon stabiliser, switches off the mains supply to a receiver when the voltage of this supply exceeds a certain figure. The higher voltage causes the neon stabiliser to ignite, whereupon the resultant current causes a relay to operate. So long as its functioning is checked with a voltmeter at intervals, the reliability of the device in operating at a particular voltage should be quite good. Low mains voltages were stepped up to that required for the receiver by means of an auto-transformer. If, due to a rise in mains voltage, the stepped-up potential became excessive, the device automatically switched the set off. The device also prevented the set being switched on again until the voltage from the auto-transformer had been brought down to a safe value.

This device, whose circuit is illustrated in Fig. 4, may be of interest to readers, although a little caution is needed if the associated televisor has a valve rectifier. When a receiver with a valve rectifier is switched on shortly after being switched off, the rectifier cathode may still be warm, whereupon excessive current can flow into the discharged reservoir condenser. Frequent repetitions of this switching off-and-on cycle may shorten the life of the rectifier. This difficulty does not arise with metal rectifiers. The relay employed in the device has to be sensitive enough to operate with the current passed by the neon in series with R_4 (which should have the value recommended for the series resistor of the neon chosen), and should have sufficiently heavy contacts to switch the receiver current.

An alternative to the use of automatic units of this type is to ensure that the rectifier and reservoir condensers in the televisor are maintained in good condition. The drop in h.t. voltage resulting from falls in mains voltage may then be kept as low as possible without the risk of over-running the receiver.

Practically the only other solutions consist of running the receiver, as a whole, from a voltage stabilising transformer, or of employing a voltage stabilised h.t. supply. Both these solutions are very expensive. A slight reduction in cost might be had by running the line and frame timebases (plus the frequency-changer oscillator in order to reduce frequency drift) from the stabilised h.t. supply; it being assumed that the remainder of the receiver will function adequately at the reduced mains voltage. A suitable stabilised supply for this purpose was described in "Suggested Circuit" No. 66, in the May, 1956, issue of this magazine.

A Simplified Transistor Tester

There are many instances—for example in the production of transistorised equipment, or in the service workshop—where complete and detailed information about the parameters of junction transistors is not needed, but only an indication of their general characteristics and condition.

It is to cater specifically for these requirements that Mullard Limited have introduced their new and simplified Transistor Tester Type L.264. Compact, and as easy to use as a conventional valve tester, the L.264 affords a ready means of checking three of the more important junction transistor parameters; base-collector short circuit current gain; d.c. collector current for zero base current; and collector turnover voltage. All measurements are presented as direct meter readings.

Methods of Measurement

Base-collector s/c current gain (a′). To maintain the simplicity of the instrument this is measured at d.c., advantage being taken of the approximately linear relationship between collector current and base current, which permits finite changes of current to be used to measure this parameter with an accuracy high enough for all practical purposes. Measurement is thus reduced to observing the collector current produced by a convenient known base current, and transcribing it into a direct meter reading of base-collector current gain. The standing current is backed-off in the collector current meter.

D.C. collector current for zero base current ($I'_{c(o)}$). Since the d.c. collector current is sensibly independent of collector voltage, direct metering of this parameter can be made. A controllable collector supply voltage (0-20V) is provided.

Collector Turnover Voltage. In this function the Transistor Tester measures the collector-emitter turnover voltage for zero base current. A relatively high voltage is applied to the collector via a resistance, and the turnover voltage is read directly from the meter. Facilities are incorporated to vary the feed resistance and collector supply voltage to give three ranges of collector dissipation: 2.5, 25 and 250mW.

Technical Summary

Collector Voltage Range: 0-20V, metered
Collector Current Range: 0-2.5A, metered
a′ Range: 0-100. Accuracy ±5%
$I'_{c(o)}$ Range: 0-2.5A, in six ranges. Accuracy ±5%
Turnover Voltage Range: dependent on permissible collector dissipation of transistor: 0-18V on 2.5mW range; 0-85V on 25 and 250mW ranges.
Mains Input: 200-250V, 40-60 c/s single phase. Consumption 10VA.

Next Month . . .

A HIGH QUALITY BROADCAST RECEIVER

by R. HINDLE

MAGNETIC TAPE RECORDERS

Some design considerations for the Home Constructor

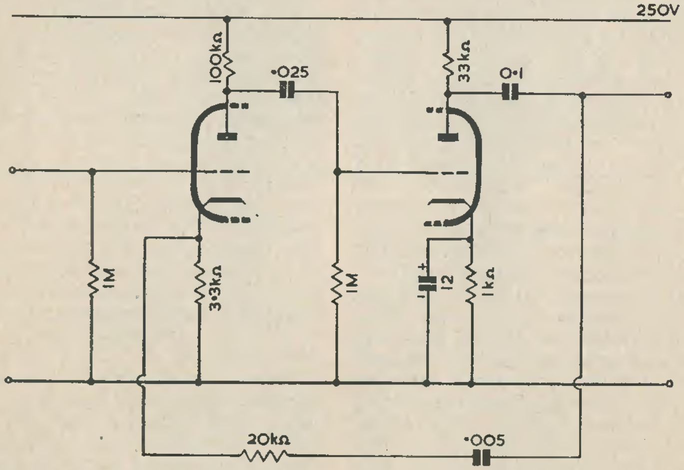
PART 3

by A. BARTLETT STILL

In dealing this month with the design of the Replay Amplifier, we are faced, to a certain extent, with a far simpler problem. Since we no doubt wish to utilise the same amplifier for both recording and playback purposes, the valve line-up and most of the circuitry is already determined. We must, therefore, make sure that we will be able, after appropriate modification to "Replay" characteristics, to obtain our self-imposed "Spec".

After our discussion in the first article, it will be seen that, provided the recording amplifier has done its job correctly, we must now reproduce the C.C.I.R. playback curve. Here the process is certainly more straightforward. We are told that the curve follows the same law as a resistor-capacitor combination having a time constant of 100 microseconds. Obviously, then, all we must do is incorporate such a network in our feedback chain around the double triode instead of the chain used for recording, and the circuit of this stage will now, basically, be as shown in Fig. 9. It will, however, be necessary to ensure that sufficient feedback is used to prevent any "flattening" of the slope of the curve due to our reaching the limit of the gain of the valve. This being the case, the gain available at the frequency of maximum tape response (2–3 kc/s) will be about 25 times. We can reasonably expect a fully modulated signal to produce about 3 millivolts across the head on replay; so, assuming the sort of gain from the first valve that the makers always

FIG. 9. BASIC POST-EMPHASIS CIRCUIT



tell us we should get, the 10V laid down in the specification should be available at the second anode of the double triode.

As in the recording amplifier, the distortion introduced by the replay amplifier should be of a low order with a valve arrangement such as we are considering, and may safely be ignored, when compared to that introduced by the tape itself.

The remaining item on our specification, then, is (3), which states that on replay the noise level shall be 50 db or more down on a fully modulated signal. Taking the signal level as 10V, therefore, the hum level must not exceed 30mV, which represents a signal at the first grid of less than a microvolt! It is not pretended here that this is an easy task, but it can be done, provided sufficient care, patience and forethought are used. In a series such as this, which the writer hopes will prove of assistance to those who may be contemplating the building of a tape recorder, and in which no specific tape deck is being considered, it is obviously impossible to say "if you put the mains transformer just *there*, you'll be alright." What we will do, however, is to point out the likely causes of a high hum level, with possible ways of avoiding the trouble.

Beginning at the beginning, we have the leads. There is little that the amateur can do in the way of head shielding, so we must repeat the advice contained in the first article that attention should be paid to this point when making your choice. Next in line is the connection of the head to the amplifier, perhaps some 8 or 9 inches long. By using twin screened cable, instead of the conventional "co-axial", utilising the two inner conductors, one "live" and one for "earth", to connect the head, and earthing the screen at the amplifier end only, some 3 or 4 db reduction in hum level can be achieved. In a practical design this head connection would go to the Record/Replay switch, and this should itself be carefully screened. The switch will probably consist of several wafers, and ideally the wafer(s) containing the switching contacts associated with the head and the amplifier input would be in its own screening can.

The various rules and "dodges" for keeping the noise introduced by the first stage of the amplifier to minimum are by now fairly well established and generally known. All earth connections in the whole amplifier, including the head leads previously mentioned, should be taken to an earth bus-bar. This bus-bar should be grounded to the chassis at a point as close to the valve holder of the first stage as possible, one of the fixing screws being ideal in this respect. A "low-noise" valve must be chosen for this stage, Z729, EF86, or similar; and all earthing connections for this valve must be taken to the one point. On some of the bias oscillator coils now on the market a winding is provided such that the valve heater may be run from a 50 kc/s supply, this avoiding audible heater/cathode modulation, but results nearly as good may be obtained by the use of the old-fashioned "Humdinger"; and for reasons of simplicity this is favoured by most constructors. A useful dodge to cut the hum introduced by a 50 c/s heater supply still further is to take the humdinger slider to a d.c. potential of about 10 volts positive instead of to earth.

High-stability resistors should be used throughout the first stage, and to reduce noise still further, the anode load resistor should be of generous rating.

Adequate decoupling should be used to avoid the "motor-boating" to which a bass-boosted amplifier would otherwise be prone, and this will also provide the large measure of h.t. smoothing necessary for the first stage.

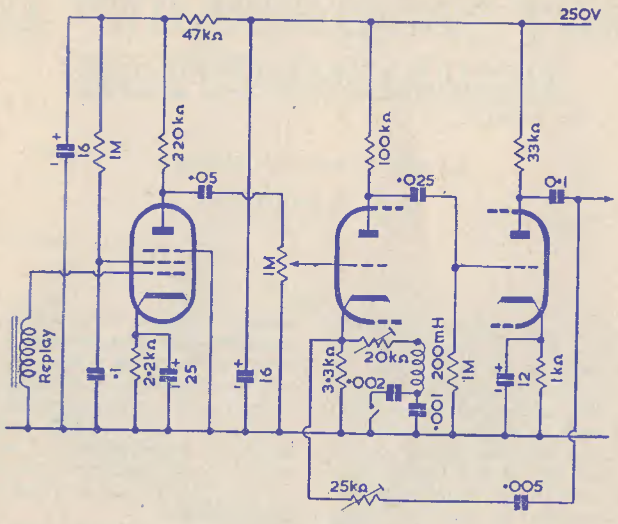
The heater of the double triode should be fed from a separate winding to that used for the first valve, and generally a centre-tapped supply will be suitable, although slight advantage may be obtained by the use of a second humdinger. If a third heating supply can be made available for the remaining valves, so much the better, but this is not imperative. In addition to these particular points, attention must be paid to ensuring twisted heater wiring, short grid leads and so on. The positioning of the major components, and in particular the mains transformer and smoothing choke, will obviously be of utmost importance, and must be the subject of careful experiment.

The Replay Amplifier will, then, be as shown in Fig. 10, consisting of two valves only and bearing a great similarity to the Record Amplifier circuit published last month. The high frequency "lift" circuit in the cathode of the double-triode has been retained, though its effect is drastically reduced by inclusion of a variable resistor. It is intended that this resistor should normally be set "all-in" so that the correct C.C.I.R. characteristic is maintained, but appropriate adjustment at a later stage will usefully counteract the effects of head wear. The variable resistor in series with the feedback chain determines the amount of bass lift and can be set on playback of a recorded frequency "run" to give a level response.

Before considering a complete tape recorder design, let us look at this question of adjustment. Manufacturers, of course, use a wide range of expensive instruments for the production, testing and alignment of their machines, such including valve voltmeters, audio oscillators, distortion factor meters, "wow" and "flutter" meters, oscilloscopes, and "standard" tapes. It cannot be expected that the amateur constructor will have these instruments available to him, and in consequence a minimum of equipment will be specified. For any worthwhile results, however, a valve voltmeter is essential, and it is strongly recommended that anyone considering the construction of a tape recorder, who is not already in possession of one of these versatile pieces of equipment, should turn up one of the excellent designs already published in past copies of *The Radio Constructor* and start now! The other items of "test gear" that will be specified will consist of a record player and a frequency test record, readily obtainable on 78 or L.P. It is not pretended that this form of "signal generator" will give constant output, even with correct equalisation of the pick-up, but if it is first calibrated by feeding the output of the record player directly into the meter, it makes a useful substitute.

The final article will include the circuit diagram of a suggested complete recorder, and will deal with the complete alignment and adjustment.

FIG. 10. REPLAY AMPLIFIER CIRCUIT



New V.H.F. Triode Valve

An indirectly heated, high slope, low noise triode, the A.2521, especially suitable as an r.f. amplifier for use at frequencies in the region 500 to 1,000 Mc/s, has been developed by the General Electric Co. Ltd.

The valve has a slope of 12mA/V and an anode dissipation of 2.5 watts. In normal receiver applications it is free from microphony. At 500 and 900 Mc/s the noise factors are 9 and 12 db respectively.

When operating in a u.h.f. grounded grid amplifier circuit, the power gain and bandwidth may be adjusted by altering the coupling between the anode line and the output loop. At 900 Mc/s, for power gains of 6 and 16 db the available bandwidths are 80 and 4 Mc/s respectively.

The JUNIOR Amplifier

In the circuit on page 253, November issue, the Treble Control is shown inserted between the anode of V_1 and Chassis. In the point-to-point wiring diagram, page 339 December issue, the control is shown connected between the grid of V_2 and Chassis; the latter is to be preferred since it will remove (or reduce) clicks when operating the control.

SILENT "LONG-PLAY" DISC REPRODUCTION

by **N. A. BARGERY**

UNLESS HE HAS A VERY LONG PURSE, THE record lover has to use equipment which is made down to a price. In most cases this equipment is mechanically quite efficient, but often not quite good enough to allow really first-class reproduction of long-play records because of noise transmitted to the pick-up, usually motor hum, but occasionally manifested in other forms. Fortunately, much can be done to reduce considerably the annoyance caused by these defects, providing one is prepared to take a little trouble. Most "hi-fi" enthusiasts are by way of being handy with tools, and so are able to make small modifications to their equipment.

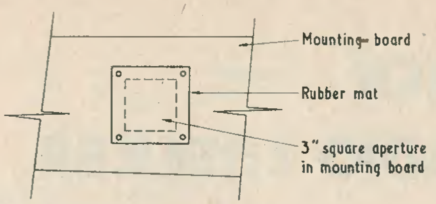
When purchasing turntables choose only those that have no mechanical contrivances on them, such as changing mechanisms, contrivances for placing the arm on the record, or auto-stop. Often these transmit impulses to the turntable, which in turn are picked up by the cartridge head and amplified, manifesting themselves through the loudspeakers as rhythmic thumps and similar unpleasant noises. Also avoid equipment which has the pick-up mounted on the motor plate; the vibration from motors can reach the pick-up through the pedestal. The point, therefore, in all this, is purchase only a motor and turntable; avoid equipment with other attachments. If the set-up in use has a pick-up mounted on the motor plate, the writer advises its removal as a first step.

The next step is to mount the metal motor plate on ¾in plywood (minimum width), cutting out the space necessary to accommodate the motor and associated turntable bearings. Bolt the motor plate really tightly to the plywood. If the turntable is of the usual hollow rim-drive type, cut a circle of rubber (as used for flooring) and, after removing a circular centrepiece to allow for the turntable spindle, stick the rubber to the underside of the "table" with rubber glue (Pliobond or similar). Ensure, however, that the rubber undermat will clear the motor pulley. If it does not do so, use thinner rubber, or fit the mat in two sections concentric with each other, so as to leave a gap between them sufficient to avoid the pulley. This will reduce the acoustical amplification of vibration transmitted to the turntable rim by the motor pulley. (Always use a rubber mat on top of the turntable.)

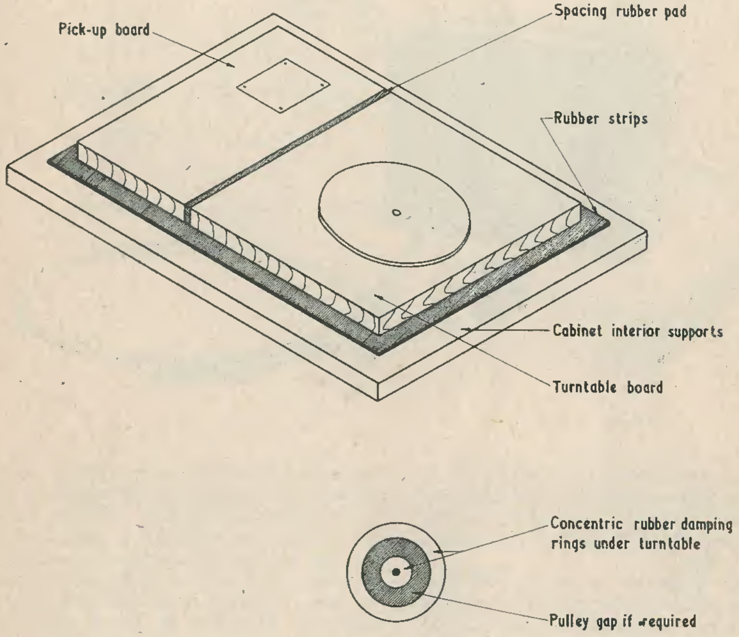
Mount the plywood motor base in the cabinet on strips of ⅛in rubber to reduce loudspeaker vibrations reaching the turntable. It is assumed that, as is usual with high quality equipment, the loudspeaker assembly is separate from the motor assembly and amplifier.

Mount the pick-up on a separate piece of ¾in plywood, in the manner described—cut out a square or circular aperture in this piece of plywood, about 3in across, where the pick-up pedestal is to be mounted. Over this aperture secure a piece of stiff rubber substance such as is used to sole footwear (about ⅛in thick) and mounted the pick-up pedestal on this. This method of mounting cushions the pick-up pedestal from acoustic vibrations.

Care must be taken to see that all metalwork associated with the motor, motor board, or pick-up is connected directly to earth, and that leads to the amplifier from the pick-up are carefully screened all the way with metal braiding connected to earth. Any potentiometers, volume controls or switches with metal casings that may be mounted on the motor or pick-up board should similarly be earthed. If of the plastic variety, try enclosing them in separate earthed screening boxes. These points are often overlooked. Some mains switches can cause hum if badly screened.



RUBBER PAD FOR PICK-UP PEDESTAL.



SET UP FOR MOTOR AND PICK-UP

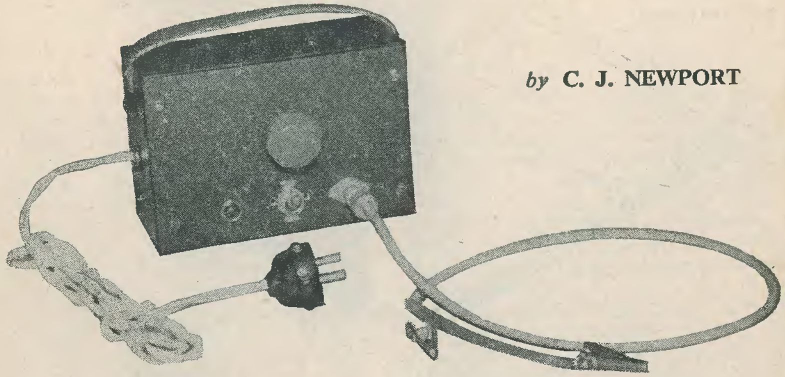
When using bass boost circuits on the pick-up, choose component values that are recommended by the makers of the equipment. If these values do not do the trick, then there is something wrong with the response of the amplifier and/or speaker—over-boosting the bass can only lead to abnormal sensitivity to any mains hum that reaches the pick-up stylus.

It should be borne in mind in this connection that there are quite a few discs that have poor bass, especially among the E.P. 45 r.p.m. fraternity.

Before rushing for resistors and condensers to boost the bass, therefore, try a record which has an acknowledged fine bass response.

One final hint: keep the speakers, especially the bass one, at least 3 feet from the motor set-up to minimise pick-up from this source.

A QUICK RADIO CHECKER



by **C. J. NEWPORT**

THE SMALL AND SIMPLE UNIT ABOUT TO BE described was made by me some time ago, and I have found it so useful for checking radio receivers and amplifiers that I would not be without it now.

The circuit is shown in Fig. 1, and it is essentially a multivibrator circuit employing an ECL80 valve. The oscillatory action takes place between the triode section, and a triode formed by the screen grid and control grid of the pentode section of the valve. The output is taken from the anode of the pentode section, and the output voltage approximates to a square waveform as shown. The fundamental frequency depends on the values of the two grid coupling capacitors and the two grid leaks, and with the values shown this frequency is about 1,000 c/s. It is well known that a square wave contains an infinite number of harmonics—theoretically, at any rate. The harmonics of the fundamental frequency of the output voltage from this circuit extend up to and into the short waveband.

Construction

Construction is very easy, and the positioning of various components above and below the small chassis is shown in Fig. 2 (a) and (b). The layout is really not in any way critical, and you can please yourself whether you use the layout shown or not. Because very few components are used and these are of small size, the unit can be made very compact and portable. The mains transformer is the largest item, and this is a small pre-amp. type supplying 200–250V at 20mA and 6.3V at 0.6A. A very suitable little mains transformer has been advertised by John Anglin, 160 Cleethorpe Road, Grimsby, in *The Radio Constructor*. The metal rectifier was mounted under the chassis in order to limit the height to fit a small metal case. The test lead is a length of coaxial cable fitted with a coaxial plug at one end and crocodile clips at the other.

Application

When construction is completed and the wiring checked over, the unit can be connected to the mains and switched on. If now the output is applied to a pair of high impedance headphones, or the gram. input sockets of a radio receiver, you will hear the 1,000 c/s fundamental note.

The procedure used in checking a radio receiver is similar to that adopted with a signal

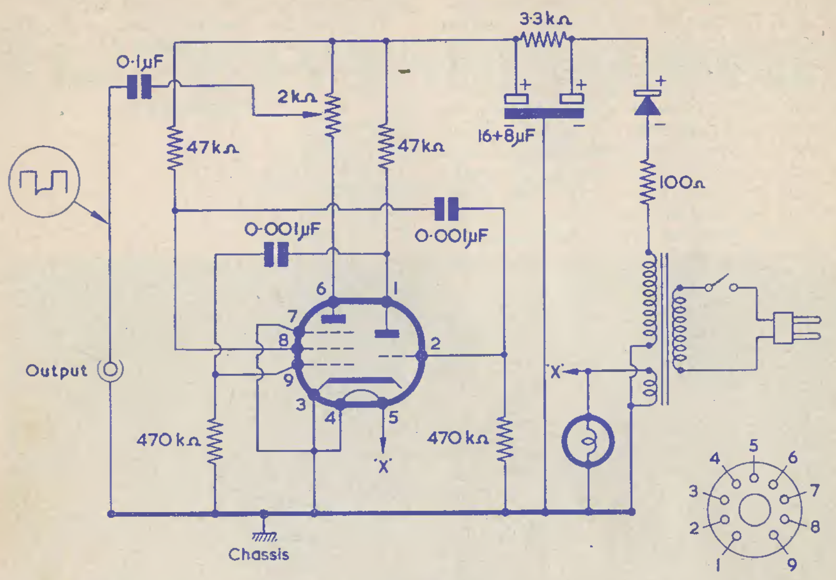


FIG. I.
Circuit Details.

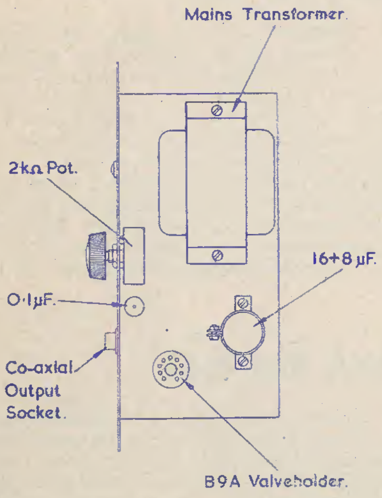


FIG. 2A.
Top Chassis Layout.

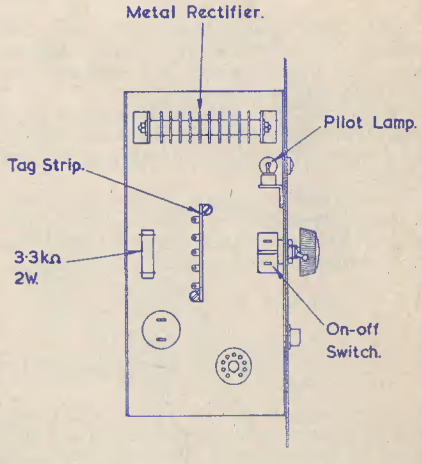


FIG. 2B.
Under Chassis Layout.

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generator, only there is no switching to be done. You connect the output across each valve grid (or anode) and chassis, working back from the loudspeaker to the aerial. In this way each stage can be checked for continuity of signal through to the loudspeaker. The fault will lie between where the signal is getting through and where it ceased. When the output is connected across the speech coil of a loudspeaker, the note heard will not be very loud even with the output set to maximum, but the note will be quite audible and will check whether the loudspeaker is working. The reason for this is that the output is at high impedance.

The unit can be used for a quick check on the alignment of the oscillator and r.f. tuned circuits of a superhet receiver, using an output that is just audible. Set the receiver dial pointer to a frequency at the h.f. end of the waveband, and adjust the oscillator and r.f. trimmers for maximum output. Then swing the receiver dial pointer to a frequency at the l.f. end of the waveband, and adjust the oscillator padder for maximum output. Then go back to the same point at the h.f. end and repeat, and back again to the same point at the l.f. end and repeat, until no further improvement is heard. The i.f.t's of a superhet receiver should only be aligned with a signal generator set to the correct i.f.

One final use to which I have put my unit is for morse practice—it makes a fine oscillator with headphones and key.

Component List

Resistors
100Ω ½W (one)
47kΩ ½W (two)
470kΩ ½W (two)
2kΩ Potentiometer (one)
3.3kΩ 2W (one)

Capacitors
0.001μF mica (two)
0.1μF 500V paper (one)
16 + 8μF 350V electrolytic

Valve
ECL80 (Mullard)

Miscellaneous
B9A valveholder
Coaxial plug and socket
Metal Rectifier 250V 30mA
Mains Transformer (small pre-amp type, 250V 20mA; 6.3V 0.6A
On-off toggle switch
Pilot lamp 6.3V 0.3A and holder

New Facts on Sonotone Pick-ups

Full details of "Sonotone," the new ceramic pick-up head for record players, have now been released in a leaflet issued by Technical Ceramics Limited.

"Sonotone" is a high performance gramophone pick-up head of the turnover type for the playing of all standard and long playing records.

"Sonotone" is unique in that the reproducing element itself is made from a ceramic known as barium titanate which is impervious to distortion through humidity and temperature changes and thus gives high fidelity reproduction in all seasons and climates. Accurately polished sapphire styli which give optimum frequency response with minimum record wear are fitted as standard, but it is anticipated that diamond styli will also be made available as an alternative.

Copies of the leaflet, which contains a response curve and performance and installation figures, are obtainable from Technical Ceramics Ltd., Wood Burcote Way, Towcester, Northants, telephone Towcester 312.

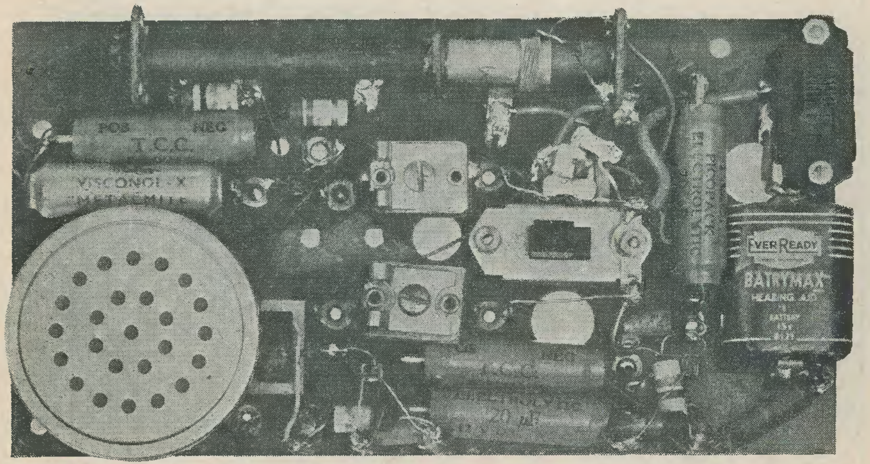
New Instrument Cathode Ray Tube

A new range of 3½in instrument tubes, type 4GP, to replace the existing 3½in E4412 series, is announced by the General Electric Co. Ltd. Four varieties of screen are available with persistences ranging from 1 millisecond to 20 seconds. A further screen, suitable for radar applications, will be introduced later, although the tube can be made to a special order with any of the majority of other standard screens.

The plate sensitivity of the new tube does not vary by more than 2% for deflections up to 75% of the useful scan. Improved spot centring ensures that the undeflected spot will fall within a radius of 5mm concentric with the tube face. The deflection axes are orthogonal to within 1°. Other changes from the E4412 series are single stage post-deflection acceleration, reduced inter-electrode capacitance, a flat-plate glass screen, and a 6.3V heater. Readily available from stock, the new tube is list-priced at £10.

The "EAVESDROPPER"

A miniature transistor receiver for local-station reception



PART 2

by **W. G. MORLEY**

IN LAST MONTH'S ISSUE WE DISCUSSED THE circuit of the "Eavesdropper" and illustrated the layout of the various holes and cut-outs needed in the Paxolin sheet which forms the chassis. We will now proceed to the mounting of the components on this chassis, together with their wiring.

Commencing Wiring

Due to the fact that its own position governs those of components close to it, the ferrite frame aerial is the first thing which has to be mounted; even though it is not wired into circuit until a later stage. The ferrite frame is mounted by soldering the eyelets on its two end tagboards to the solder tags shown in Fig. 7. The two eyelets connecting to the ferrite frame coil itself are kept away from the panel, the eyelets to which the tags on the chassis are soldered carrying no connections from the ferrite frame. If desired the strength of the solder joints holding the ferrite frame to the chassis may be increased by fitting wire to the tags and eyelets before

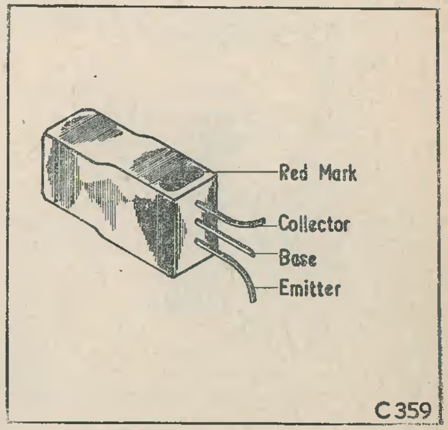


Fig. 8. The lead-out wire connections to the transistors employed in the "Eavesdropper"

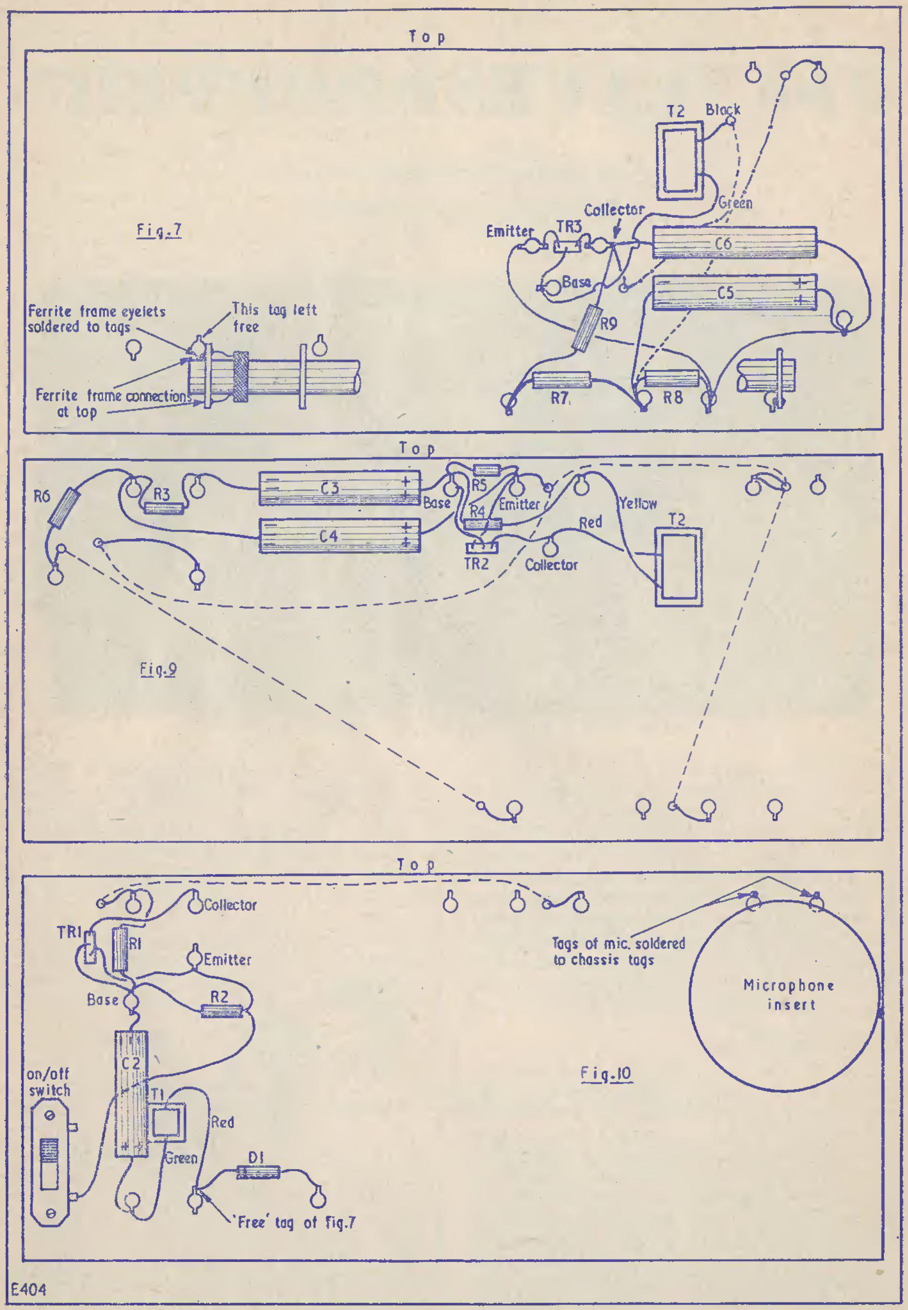


Fig. 7. How the ferrite frame is mounted. The wiring to TR$_3$ is also carried out at this stage. Fig. 9. The wiring to TR$_2$. Fig. 10. The layout and wiring of the components around TR$_1$

soldering, but this did not prove to be necessary in the prototype. The ferrite frame tagboards should lie against the chassis, their outer edge being flush with, or just slightly inside, the edge of the chassis. It may be necessary to bend or orientate the two chassis solder tags slightly to achieve the mounting of the ferrite frame. The left-hand solder tag is a double type, and its upper tag should be left free for later connections. There are three single tags below the ferrite frame. If there is any risk of these fouling the underside of the ferrite frame core, they should be bent outwards accordingly. It must be emphasised that care should be taken when handling the ferrite frame because, although the material employed for its core is quite strong, it is also extremely brittle. A sharp tap can easily cause it to shatter.

Fig. 7 also shows some of the receiver wiring, this applying mainly to the output transistor. The output transistor, itself, is fitted at this stage. This transistor is intended to be a loose fit in the chassis hole cut out for it, and it stays in position by reason of its own lead-out wires. No strain should be put on these wires. In addition, all solder connections to the transistor should be made quickly, in order to avoid overheating. A good precaution consists of employing a heat shunt between the appropriate tag and the transistor whilst the leads are being soldered, this shunt being provided by holding the transistor lead-out wire with a pair of taper-nosed pliers. These remarks, insofar as mounting and soldering precautions are concerned, apply to the other two transistors in the receiver as well. The positions of the lead-out wires of the transistors recommended for this receiver are illustrated in Fig. 8.

Little further needs to be stated concerning Fig. 7 apart from the fact that, if both the condensers C$_5$ and C$_6$ are obtained without insulating sleeves, care should be taken to ensure that their metal bodies do not touch each other, as this may cause crackling. The best solution to this problem consists of wrapping one of the condenser bodies with thin tape. The wires shown in dotted line in Fig. 7 are those which travel below the chassis. For reasons of clarity the components shown in this and subsequent wiring diagrams are not necessarily drawn to scale.

Connecting TR$_2$

The next stage in the wiring consists of connecting up the second transistor and of making several incidental power connections. This process is carried out in Fig. 9. The remarks concerning the insulation of the bodies of C$_5$ and C$_6$ in Fig. 7 apply also to C$_3$ and C$_4$ in Fig. 9.

The wiring to TR$_1$ comes next, and this is illustrated in Fig. 10. It should be noted that C$_2$ is mounted such that it lies directly between the two tags to which it connects. In this position it covers the left-hand edge of T$_1$. The on-off switch and the microphone insert are also mounted at this stage.

The on-off switch is fitted to the two holes marked "C" in Fig. 3. It needs to be spaced away from the chassis, and a simple method of doing this is illustrated in Fig. 11. The distance between the switch and the chassis will depend somewhat upon the subsequent cabinet dimensions, and it is advisable to make final adjustments to the spacing after the receiver has been completed and checked.

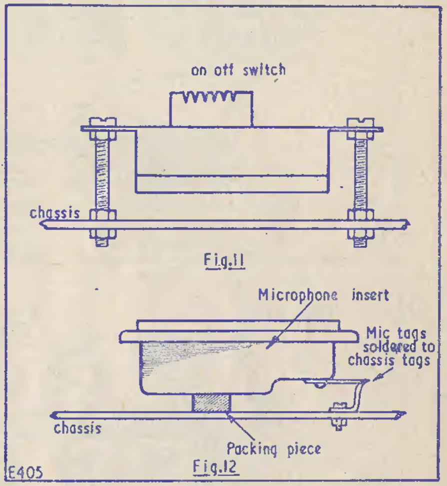


Fig. 11. How the on-off switch is mounted. Fig. 12. The microphone insert is fitted to the chassis in the manner illustrated here

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The microphone insert is fitted to the top right-hand corner of the chassis by soldering its tags to the two chassis tags at this point. A small packing piece behind the microphone keeps it at the desired level. The packing piece should preferably be of some material such as sponge rubber or P.V.C., and it may be fixed to the chassis with adhesive. Fig. 12 gives a side view of the arrangement required, this showing the microphone soldered into position. When the receiver is later inserted into its cabinet it is intended that the latter should cause the microphone to be lightly pressed against the packing piece

Tuning Arrangements

Since, as was described in the first article, it is possible for the "Eavesdropper" to have either continuous or pre-set tuning, it becomes

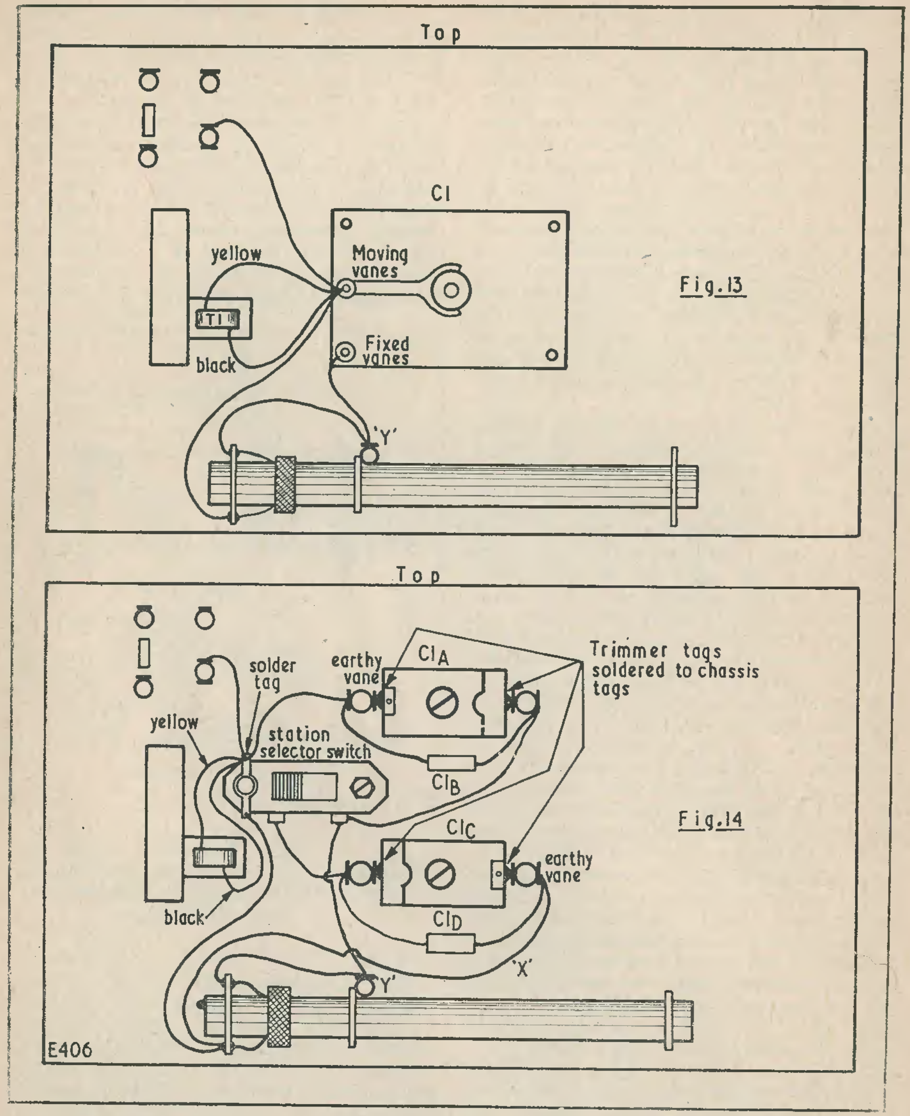


Fig. 13. Connections to the tuning condenser. Fig. 14. The wiring to the station selector switch when the pre-set version is made

necessary to consider the wiring of the tuning circuits from these two points of view.

Fig. 13 illustrates the layout required when a tuning condenser is employed. The wiring shown here is self-explanatory.

Fig. 14 gives the layout needed when the pre-set arrangement is used. It will be noted that an additional two-way solder tag is fitted under one of the bolt heads securing the switch. This solder tag should be bent flat to prevent its projecting too far above the chassis. The lower end of the tag lies above transformer T_1, and care should be taken to prevent damage to this transformer during soldering. A useful amount of protection would be provided by slipping a thin piece of card under the tag whilst wiring up. Alternatively, the tag could be bent down flat after soldering is completed. The pre-set switch is fitted to the two holes marked "H" in Fig. 3, and is spaced away from the chassis in the same way as in the on-off switch, The two trimmers are mounted by soldering their tags to the appropriate tags on the chassis. Note that the tag for the earthy vane of each trimmer (that which is connected to its adjusting screw) is to the left for the upper trimmer, and to the right for the lower trimmer. The lead marked "X" provides a short earth return for the lower trimmer. This connection is already provided through the receiver wiring, but the additional wire ensures that long leads are not employed in the tuned circuit. Lead "X," together with the lead from $C_{1(d)}$, is connected to the same tag as is the emitter lead-out wire from TR_3. Care should be taken, therefore, to ensure that soldering these two wires to the tag does not overheat the transistor.

Fitting the Battery

The receiver is now completely wired up, and is ready to operate as soon as the battery is connected. It is advisable, however, to check that all connections have been made correctly before this is done.

After checking the wiring, the battery should be fitted in the manner illustrated in Fig. 15. It will be noted that the battery is soldered into the receiver, this being the method adopted in the prototype. There is no reason why spring clips for the battery should not be employed if the constructor so desires. However, the battery has quite a long life with normal usage, and the use of the soldered connections helps to prevent accidental incorrect fitting of the battery. The battery must be connected up with correct polarity. If h.t. is applied with reverse polarity, the transistors may be damaged.

After the battery has been fitted, the set may be checked for correct operation. There should be a continual slight hiss from the microphone insert after the set has been switched on; and it should be possible to tune in local stations by adjusting the tuning condenser in the continuously variable tuning version, or by fitting the requisite values for $C_{1(b)}$, and $C_{1(d)}$ in the pre-set version and adjusting $C_{1(a)}$ and $C_{1(c)}$.

In localities of poor signal strength a short aerial of four feet or so should help to increase sensitivity. This aerial needs to be connected to the non-earthy end of the ferrite frame, and may be soldered to the tag marked "Y" in Figs. 13 and 14.

Cabinet Design

It is not intended to give specific details of the cabinet used for the "Eavesdropper," as individual constructors will have their own ideas on this particular point. There is also the fact that the construction of a cabinet is a fairly well-defined job, and does not involve the intricacies required for the construction of the chassis. Whilst the latter needs a full description if the receiver is to be built successfully, the former does not.

Although no particular details of cabinet work are given, the writer feels that one or two general hints might be of interest. It is obvious that the cabinet needs to be a light structure, and that it should not increase the bulk of the receiver to any excessive extent. Due to its layout, the receiver will comfortably "fill" a shallow rectangular case with little waste volume. In consequence, a simple rectangular cabinet made of a light material is all that is required.

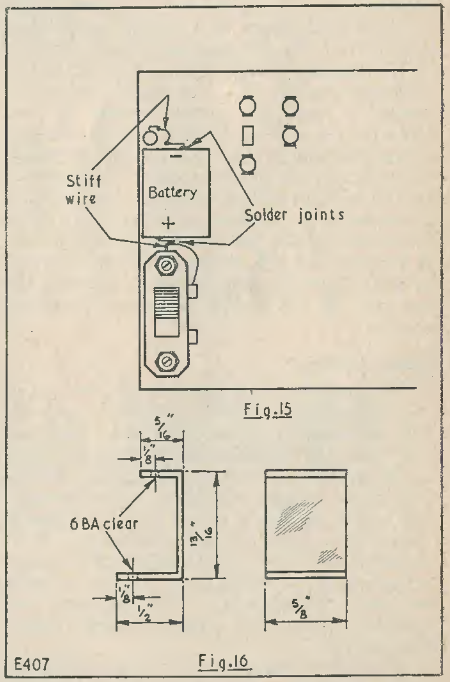


Fig. 15. The battery soldered into position. Fig. 16. A suitable bracket for the Bulgin S.591 switch. The material for the bracket may be aluminium sheet

A further factor is the necessity of making the cabinet from an insulating material. A metal case would, of course, screen the ferrite frame aerial and prevent signal pick-up. Suitable materials for making the cabinet would be thin plywood, Perspex or Paxolin.

continued on page 406

Radio Control of *MODEL AIRCRAFT*

PART 4 GENERAL LAYOUT OF RADIO INSTALLATION

by **"QUENCH COIL"**

IF THE READER BUILDS HIS MODEL FROM recognised plans, the radio layout will be indicated in the instructions. A few words on this subject may not be amiss, however.

A circuit diagram of a typical installation is shown in Fig. 15, and the actual position of the various components in the model is indicated in Fig. 16. The meter sockets A, switch B and the potentiometer C are mounted on a small balsa panel on the side of the fuselage, so that they can be controlled from the outside of the model. The batteries should be kept as low down as possible, and the actuator is mounted on the rear of a balsa bulkhead behind the receiver compartment. A long torsion rod, which should be of wood or similar non-metallic material, connects the actuator to the rudder operating crank as shown.

Initial Testing

The process of field testing on the day of the first flight is rather involved, and the following notes may prove helpful. They are only intended for guidance, as most R/C fans seem to differ in the procedure they adopt. The whole system should be given a thorough test in the workshop where tools and instruments are available for checking. It is essential that everything works 100% before venturing to the flying field. Check batteries *on load*. Check wings and tail-plane and rudder for correcting alignment and freedom from warps.

When all is ready, choose a fairly calm day with a slight breeze. This will be helpful in reducing speed when landing, providing the landing is made into the wind. On arrival at the flying field, ascertain the direction of the wind and choose a spot near the centre of the field and slightly down-wind. Set up the transmitter and aerial, and check for operation and correct frequency. Wind on a few turns on the actuator motor, stand in front of the model, place the bands flat underneath the wings near the fuselage, lift the whole model off the ground and check that the rubber bands are holding the wings and tail-plane secure and will not move. Make sure the rudder is in the neutral position.

Turn and face the wind, and holding the model level and at head-height, take three or four running steps and launch the model smoothly and deliberately into the wind, pointing the nose either level or slightly downwards. The glide will not be prolonged, but it should be straight and the model should land on an even keel. Correct any tendency to turn violently *now*, as it will be more violent during the power flight. Plug in the meter and switch on the receiver and check the relay for operating points by varying the meter current with the potentiometer. After checking the relay points, adjust the potentiometer to give normal standing current on the meter. Now switch on the transmitter and transmit a signal. The standing current should now drop, but the receiver should be tuned to the signal until the meter shows maximum drop with *the model held well clear of the ground.* Release the transmitter key and see that the standing current returns to normal immediately, and that the operation of the rudder is satisfactory.

The tuning of the receiver detailed above has been done close to the transmitter, and it is possible that the receiver has been "swamped." To be quite sure that the receiver has been tuned "spot-on", the model should be taken about one or two hundred yards away from the transmitter and retuned. This is where the Auto Key described in a previous article comes in useful, as it is preferable to the often erratic keying effects of a friend.

The operator should now take up a position near the transmitter, with the model on the ground facing into the wind. Wind on about 100 turns on the actuator motor and fuel up for about two minutes engine run. Switch on the transmitter, plug in meter and check receiver for dip. Start the engine, and with three or four running steps launch the plane as before, dead into the wind. Return quickly to the transmitter and pick up the key. Do not attempt to control the model until it is about twenty feet up.

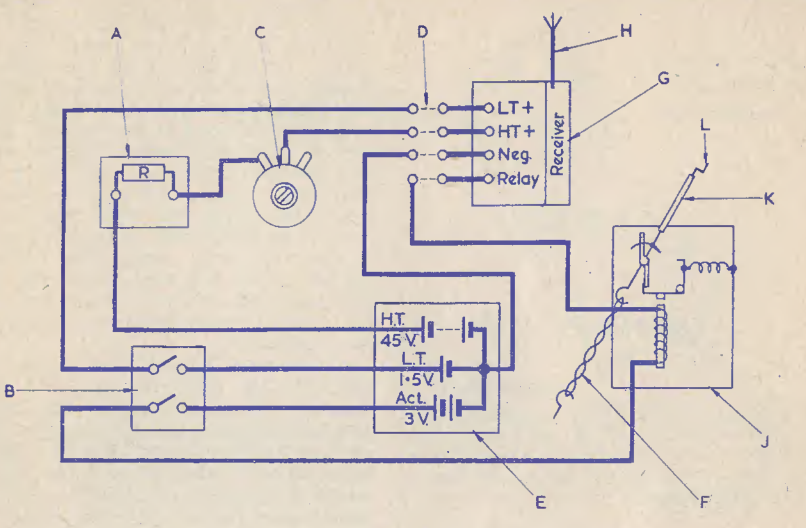


FIG.15.

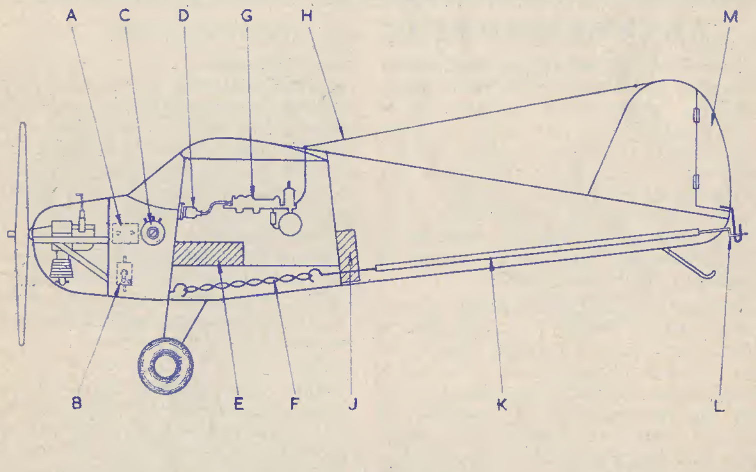


FIG.16.

M393.

KEY TO FIGS. 15 AND 16

A—Meter Socket, with shunt resistor R to give desired meter range
B—Double-pole "On-Off" switch for L.T. and Actuator
C—5kΩ Variable Resistor to adjust "standing current"
D—4-pin Miniature Plug and Socket
E—Battery Pack: H.T. = two B122; L.T. = one Pencell; Actuator = two Pencells
F—Double Strand $\frac{1}{8}$-in flat rubber escapement motor
G—Receiver using XFG1 and Siemens relay in super-regen. circuit
H—Flexible Aerial Wire J—2-pawl Self-Neutralising Escapement
K—Torsion Rod (non-metallic) linking Escapement to Rudder Crank
L—Rudder Crank giving three rudder positions; Left—Neutral—Right

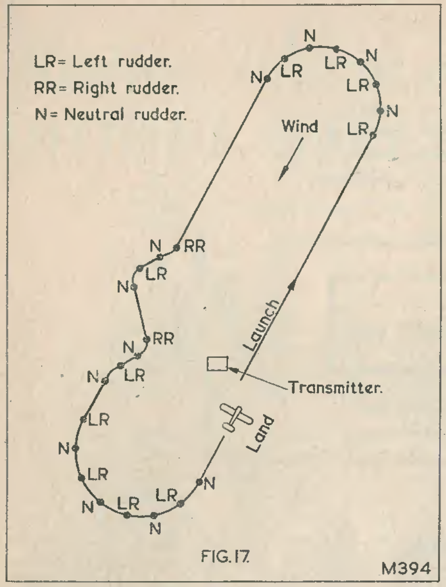


FIG.17

A suggested "flying plan" is shown in Fig. 17. Test for right and left rudder control when the model is flying towards the transmitter. On the glide-in, after the engine has stopped, the rudder will have to be held on a little longer to give the right amount of turn, as the fast slipstream has now ceased. Do not try to control the plane when it is less than four feet above ground. Without a doubt some rough landings will be made, but if the model has been well built and the gear installed properly, little damage will be done to the radio gear. Some little practice is needed before one can control the model sufficiently well to land it where one wishes, but experience and practice will soon give their rewards.

A label should be attached to the model, where it can easily be seen, bearing the owner's name and address. The operator should be insured for third party risks of damage to property and persons. This can be obtained for the sum of 3s. 6d. per year, covering claims up to £25,000. A model weighing about two pounds or upwards, travelling in the region of 30 to 40 m.p.h., can give rise to nasty injuries and equally nasty claims for damages.

The "EAVESDROPPER"—*continued from page 403*

The finish of the cabinet depends somewhat upon the skill with which it has been made. An attractive "professional" presentation is given by painting with hard gloss enamel, although the application of such enamel requires a little practice if the constructor has not had previous experience. Quite a good finish can be obtained by covering the completed case with thin leatherette. This latter method, incidentally, has the advantage of covering up faults in the cabinet work!

As was mentioned in the first article, it may be necessary to use a short four feet aerial in localities where poor reception conditions prevail. To accommodate such an aerial a socket could be fitted to the cabinet. (To increase the versatility of the receiver, no harm would result by fitting an earth socket as well—this being connected to the h.t. positive line in the receiver—even if such a socket were used very infrequently.) An alternative suggestion would consist of fitting the cabinet with a shoulder strap similar to those used for cameras. The aerial could then be made integral with this strap.

Switch Bracket

In the first article it was pointed out that an almost exact equivalent of the Henry's Radio switch employed in the prototype is the Bulgin switch type S.591. This switch has 1 5/16-in mounting centres instead of the 1⅛-in centres employed by the Henry's Radio switch. To take up the extra 3/16-in, a simple off-set bracket is shown in Fig. 16. This bracket also enables clearance of the switch lugs to be obtained. When used, the bracket of Fig. 16 is fitted at one end of the switch, whilst the mounting method shown in Fig. 11 is used at the other.

Notes

The Teletron FRM ferrite frame aerial is normally supplied with only one tag panel, and two rubber grommets. In this model two tag panels are required. An additional panel is obtainable from the Teletron Co. Ltd. at 4d. post free.

For those who rely upon reception of the 1,500m Light programme, a LW version of the ferrite frame (LW only), type FRM/1, is available at 8s. 9d.

RIGHT—*From the Start*

PART 11

STRAYS

by **A. P. BLACKBURN**

IT APPEARS TO BE A UNIVERSAL FACT THAT any technical activity invariably bristles with "ifs" and "buts." The last two articles, for example, which dealt with the characteristics of valves might give the impression that here we have a device which amplifies small signals, so let's go ahead and use it. Immediately, however, we have to make qualifications; for instance, what sort of signal? Will it be at a low frequency or a high one? It would scarcely seem to matter, if the last two articles are anything to judge by, what the frequency is. No mention was made of it with regard to μ and g_m, etc. It is true these are independent of frequency, but the circuit external to the valve has some considerable effect upon the valve's performance.

Stray Capacity

Between any two points in an electrical circuit a capacity exists. Between the wiring on the upper floors of a house and the wiring of the lower floor there is some capacity. Minute, of course, in that extreme case, but in the narrow confines of a receiver or amplifier, not always small enough to be ignored. The capacity of two objects varies directly as their area and indirectly as the distance separating them. Or in simple terms, the greater their area, the greater the capacity and the nearer they are together the greater the capacity; and, of course, *vice versa* in each case. Now, if you can find a modern miniature valve with a transparent envelope, look inside at the electrodes. You will find that they are very close together indeed. Although the area of the electrodes is not great, their close proximity does lead to some significant capacity. Fig. 1 shows how these capacities are distributed inside the valve. The subscripts indicate the electrodes between which they exist, therefore C_{ac} is between anode and cathode, sometimes called the output capacity; C_{gc} is between grid and cathode, and may be referred to as the input capacity; and C_{ag} is between anode and grid and is sometimes known as the "Miller" capacity. The next thing we have to find out is why these capacities are important, and to do that we have to resort to plain a.c. electrical theory.

Capacity and Frequency

It has been mentioned before in this series that a capacitor in a circuit carrying an alternating current has the property of resistance; that is, it impedes the flow of current. Unlike resistance, however, the extent of this impedance depends upon the frequency with which the current alternates. To avoid confusion, this resistance effect is called the "reactance", and if the capacity and frequency are known, then

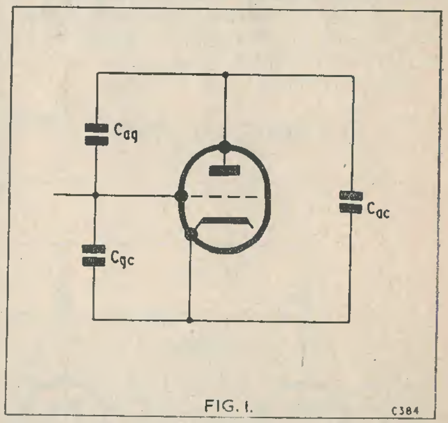


FIG. 1.

$$\text{Reactance } X = \frac{1}{2\pi \times \text{frequency} \times \text{capacity}}$$

where frequency is in cycles/sec. and capacity is in Farads.

The important thing in this formula is that the reactance is *inversely* proportional to frequency; that is, a higher frequency produces a low reactance and a low frequency a high reactance.

This frequency dependence of the reactance alone does not account for any peculiar behaviour of the valve, but it does affect the circuit.

Fig. 2 shows two stages of an audio amplifier. Two of the "stray" capacities of Fig. 1 are shown, C_{ac} of V_1, and C_{gc} of V_2. Now imagine that a signal voltage of 20 kc/s is applied to the grid of V_1. We have just seen that if the frequency is high, the reactance is low, so the coupling capacitor C will have a low reactance of value

$$X_c = \frac{1}{2\pi \times 20{,}000 \times 0.1 \times 10^{-6}} = 80 \text{ ohms}$$

approx.

This capacitor forms a potentiometer with R_g, but R_g is 100kΩ (see Fig. 3) so virtually all the output of V_1 will appear across the input of V_2. The coupling capacitor can be ignored at this frequency, therefore.

So now Fig. 2 can be redrawn without C as shown in Fig. 4. Remember that C is only included in practice to prevent d.c. at the anode of V_1 from reaching the grid. Referring again to Fig. 4, the two "shunt" capacities C_{ac} and C_{ag} are now merely connected in parallel. Remembering that capacitors in parallel can be added, the total capacity is $C_{ac} + C_{ag}$, which is $5 + 15 = 20$pF in this case. This capacity appears directly across the output of V_1 and is, therefore, directly in parallel with R_L. So we can forget V_2 and redraw V_1 as in Fig. 5, where C_T is $C_{ag} + C_{ac}$.

The reactance of C_T at 20 kc/s is

$$X_{CT} = \frac{1}{2\pi \times 20{,}000 \times 20 \times 10^{-12}} = 500\text{k}\Omega$$

approx., and this is in parallel with R_L. If R_L were 500kΩ (a much higher value than normally used in practice) then we want to find what the resultant anode load is, because the gain is directly dependent upon it. Unfortunately, the formula for a resultant "impedance" of a capacitor and resistor in parallel is a little more complicated than most we have met. It is

$$\text{Impedance } Z = \frac{R}{\sqrt{1 + \frac{R^2}{(X_{CT})^2}}}$$

Putting in the values from above

$$Z = \frac{500}{\sqrt{1 + \frac{500^2}{500^2}}} \simeq \frac{500}{\sqrt{2}} = 350\text{k}\Omega \text{ approx.}$$

The gain of V_1 is directly dependent upon the anode load, and as this has dropped from 500kΩ to 350kΩ the gain will have dropped by a similar amount. If we do the same sum at 10 kc/s the reactance will be 830kΩ and the apparent anode load will become 420kΩ approximately. At 5 kc/s the change is negligible. So we can see that the gain will suffer as the frequency gets higher and higher.

The examples quoted might seem to some to be scarcely significant. In an amplifier 20 kc/s is not necessarily important, because it is too high a frequency to be audible, and secondly 500kΩ is rather an unusually high value of anode load. This has been quoted, however, as an extreme example; extreme in the respect that all the capacities are valve inter-electrode capacities, and no wiring strays have been added.

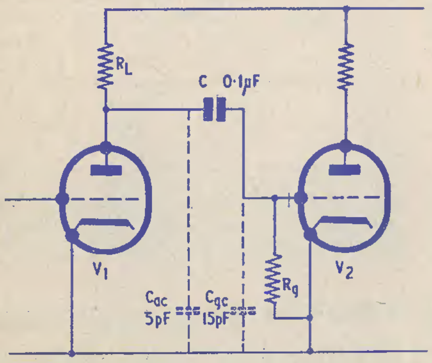


FIG. 2.

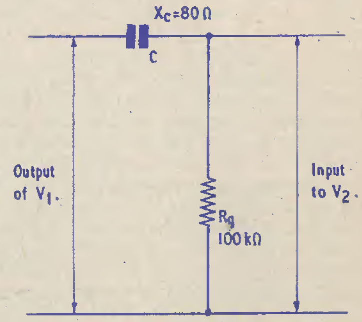


FIG. 3.

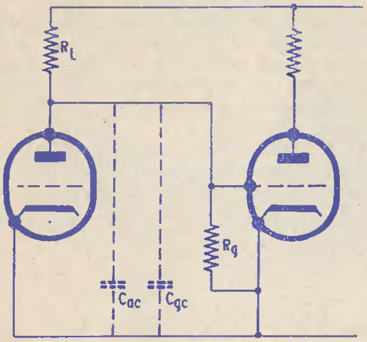


FIG. 4.

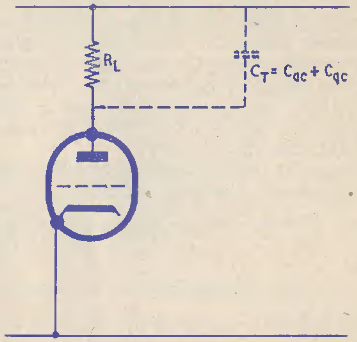


FIG. 5.

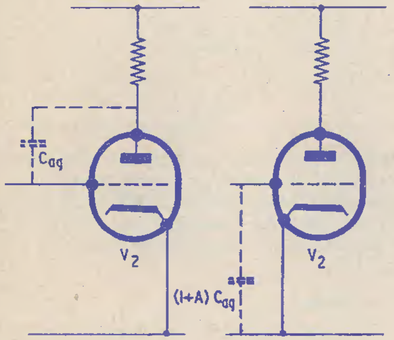


FIG. 6.

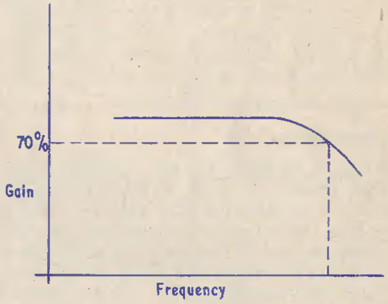


FIG. 7.

Wiring

As mentioned at the commencement of this article, all objects have some capacity between them. The intervalve wiring will, therefore, have some capacity to earth, particularly if long leads are used, and if C, say, were metal cased and clamped to the chassis. In an extreme case another 30 or 40pF could be added to the existing inter-electrode capacities. Assuming 40pF for wiring, the total now becomes 60pF when the original 20pF is added. Before we calculate what additional effect this extra wiring capacity will have, it would be as well to consider the "Miller" capacity C_{ag}. This has a rather peculiar property. It has been found that an "apparent" capacity of $(1 + A) \times C_{ag}$ appears from grid to cathode. A is the gain of the stage; Fig. 6 illustrates this. Now the gain of V_2 may be 30 times and C_{ag} 2pF. Therefore, the reflected grid to cathode capacity will be 62 pF. Once again this will appear in parallel with the inter-electrode and wiring capacities. Adding this to our previous 60pF gives a total of 122pF. This is clearly becoming quite significant. The next step is to calculate the effect of this 122pF at, say, 10 kc/s with a practical anode load of 100kΩ.

The reactance of 122pF at 10 kc/s is 140kΩ. The resultant anode load is therefore

$$Z_L = \frac{100}{\sqrt{1 + \frac{100^2}{140^2}}} = 83\text{k}\Omega$$

The gain will have dropped proportionally, i.e. 17% at 10 kc/s.

These results are usually shown graphically as indicated in Fig. 7. This shows the gain at all frequencies (ignoring the extremely low end for the moment). The dotted line represents the point where the gain has dropped to 70% of its middle frequency value. This point is called the "half power point" and the gain is said to be "3db down." We will come to an explanation of db's later.

So much at the high frequency end. Now what happens at low frequencies?

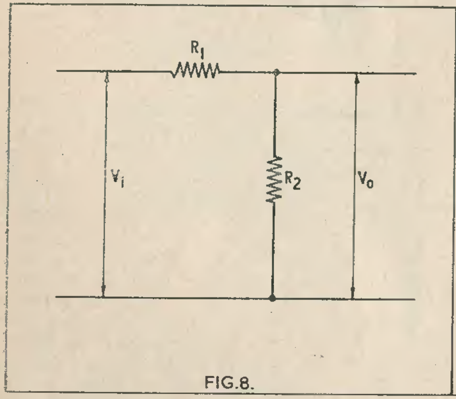


FIG.8.

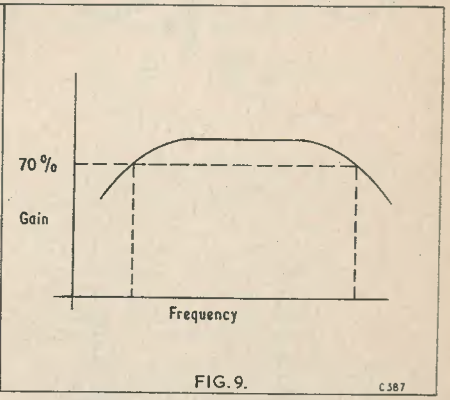


FIG.9.

C587

Low Frequencies

As the frequency of the applied signal becomes lower the effect of the shunt strays C_{gc}, C_{ac}, etc., becomes less and less. So at really low frequencies they may be ignored. But the reactance of the coupling capacitor C is also rising and there will come a time when its effect will be significant. If we apply a voltage V_i to a simple potentiometer as in Fig. 8, the output voltage V_o will be

$$V_o = \frac{R_1}{R_1 + R_2} V_i$$

This network is rather like the coupling between V_1 and V_2 in Fig. 2, except that R_1 is a capacitor and R_2 is the grid leak R_g of V_2. Once again the formula for calculating the grid voltage (V_o in Fig. 8) with a capacitor is rather more complicated than for resistances

$$V_g = \frac{R_g}{\sqrt{R_g^2 + X^2}} V_a$$

where R_g is the grid leak X is the reactance of the coupling capacitor V_a is the anode a.c. voltage

Suppose that C were 0.1μF and R_g 100kΩ, and the frequency 50 c/s. At 50 c/s the reactance of C is 30kΩ and V_g is $0.95 \times V_a$. The loss is, therefore, quite small, because 0.95 of the output of V_1 reaches the grid of V_2; only a 5% loss. At 10c/s, however, the reactance of C is 150kΩ, and V_g is only $0.55 \times V_a$. In other words, nearly 50% of the output of V_1 is lost in the coupling.

These results, as in the high frequency case, are usually plotted on a graph. The complete performance of the amplifier can thus be clearly shown, as in Fig. 9. Once again the 3db down points are shown. Fig. 9 is often called the "frequency response" curve of the stage or amplifier.

If another similar stage were added, a similar curve would result, but at 10 kc/s the output of this further stage would have dropped 17% from the output of the previous stage, and the previous stage was already 17% down, so the final output would be 31% down, on the medium frequency $_{gm}$. Similarly, at 10 c/s the output would be 50% of 50% down, i.e. 75%.

Conclusions

The conclusions to be drawn from these results are:

(*a*) At the high frequency end of the range the wiring capacities and if possible valve capacities should be kept to a minimum if the high notes are to be reproduced with the same volume as the middle notes. Pentodes are useful for this. The C_{ag} of a pentode may be as small as 0.002pF and usually C_{ac} is smaller than for a triode. Careful wiring, avoiding long leads pressed down to the chassis, helps to some extent.

(*b*) At low frequencies the grid leak and coupling capacitor should have as large a value as possible. The grid leak upper limit is, however, fixed by other considerations, and does not usually exceed 1MΩ, so the capacitor usually decides what the low frequency response shall be. Briefly, the greater the numerical value of $C \times R_g$, the better will the amplifier be at low frequencies.

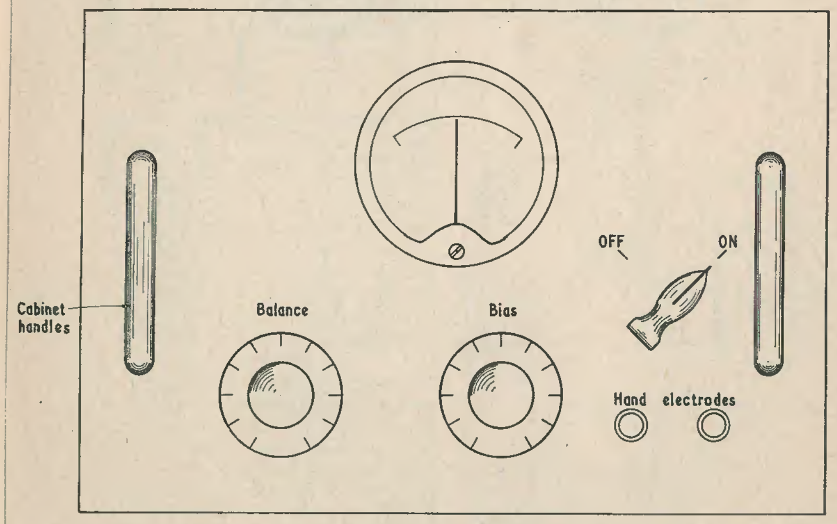
A SIMPLE LIE DETECTOR

by ALAN GUY

The principle underlying the equipment described by our contributor has a definite scientific basis, and whilst we make no claims that it will prove infallible as the "perfect lie-detector," it should provide an amusing piece of apparatus for those who would like to experiment along these lines.

IT IS A WELL-KNOWN FACT THAT THE HUMAN skin varies in resistance over quite wide limits depending on a number of factors. Fear in its many and varied degrees causes an appreciable drop in a person's resistance. The range usually varies between some 2,500 and 140,000 ohms, and can therefore be easily detected by a sensitive ohmmeter. However, an instrument of this type causes erroneous readings, as will be clear from the text. The full capability of the equipment to be described depends on the ability, experience and ingenuity of the operator in dealing with both simple and difficult tests. It can be used seriously or as a very amusing form of entertainment at a party. For serious work the location should be quiet, with as little distraction as possible. For a party, however, it would be found that most people have a strong disbelief in such "contraptions," and some very interesting results will be obtained, creating endless amusement.

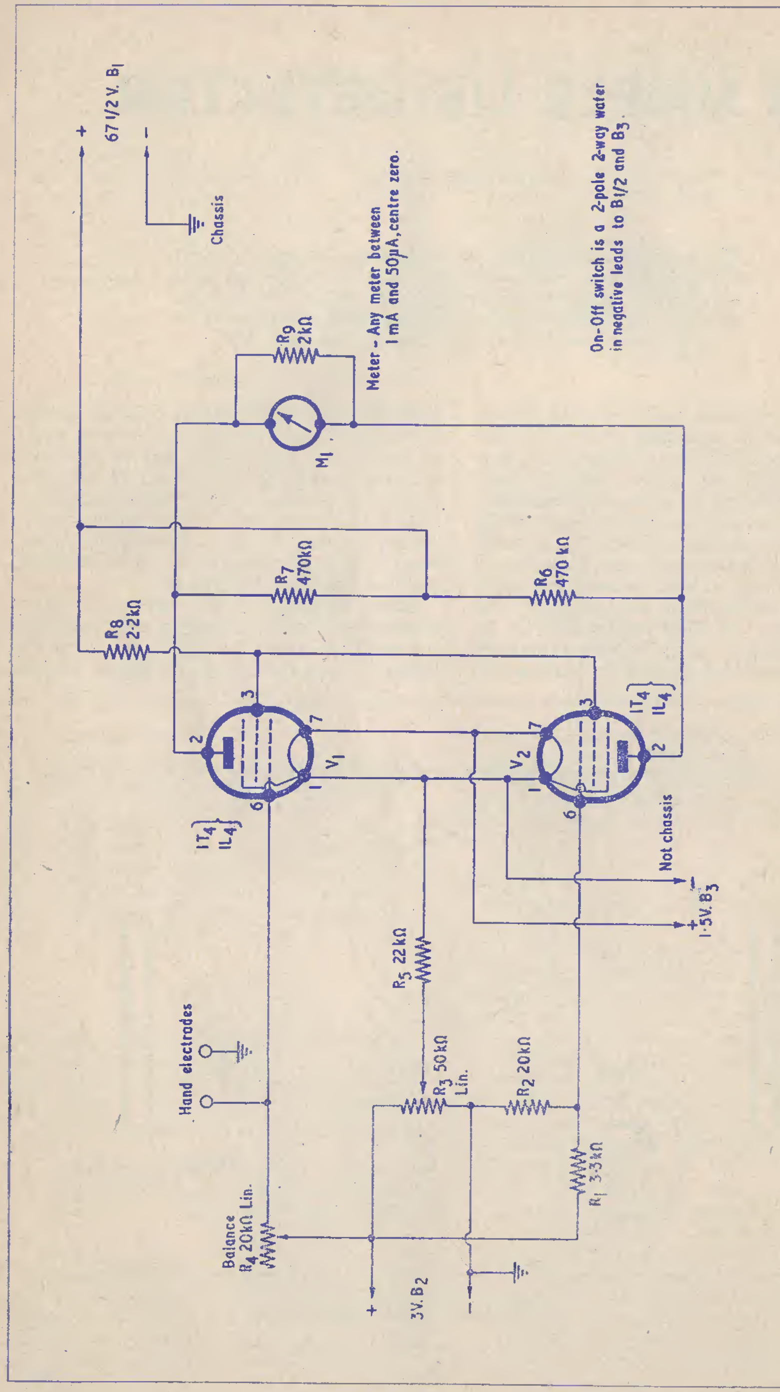
Before testing a person, his or her hands should be washed, as a greasy skin can affect the readings obtained when balancing the bridge. Clean the centre of the palm and the



FRONT PANEL LAYOUT

FIG. 1.

C388



SIMPLE LIE DETECTOR - COMPLETE CIRCUIT

FIG. 3.

back of the hand with surgical spirit. Immerse the sponges in a weak salt solution, and squeeze to avoid dripping. The electrode painted *red* is to be in contact with the palm.

Circuit

The circuit consists of a bridge, followed by a voltage amplifier consisting of two 1L4's or IT4's having symmetrical grid and anode circuits. The bridge balance potentiometer R_4 in the grid circuit of V_1 and a centre-reading meter connecting the anodes of V_1 and V_2 provide a means of maintaining the balance when the subject's skin forms an arm of the bridge. The 3-volt battery supplies voltage for division across three parallel resistive branches. The bridge balance potentiometer R_4 in series with the subject makes up the first arm of the bridge. The grid of V_1 is connected to the junction of the elements in the first branch. The second arm consists of R_1 and R_2 with the grid of V_2 at the junction. When R_4 is adjusted the ratio of resistances in the two arms is made equal. The third arm consists of R_3.

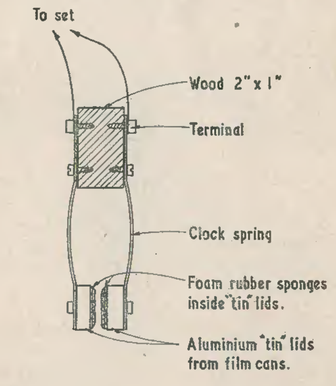
The negative filament of V_1 and V_2 is returned through R_5 to the slider of R_3. The combined anode and screen currents flow through R_5 and that portion of R_3 between the slider and chassis. The polarity of the voltage drop is such that the negative filament is positive with respect to chassis. This voltage drop is in series opposition to the voltage drops across R_2 in V_2 grid circuit, and the subject's resistance across terminals in V_1 grid circuit. The resultant voltages in each grid circuit are equal and negative, thus furnishing grid bias to balance the two anode currents of V_1 and V_2.

The screens are strapped together and supplied through R_8. The anodes are fed from a voltage divider consisting of R_6 and R_7, both being supplied from a 67½-volt battery. (This is an H.T./L.T. B114 battery.) The battery for the bridge is a type 800 twin cell. The meter is connected across the anodes of the valves, and it can have a movement of anything from 1mA down. The greater the sensitivity of the meter, the more pronounced will be the readings. In the writer's case a 50–0–50μA movement was used.

When the bridge is balanced, no potential difference exists across the meter, as the valves are drawing equal anode current. The meter will then be at its centre zero position. The meter is shunted by a 2,000 ohm resistor, and forms a very sensitive voltmeter. The subject's skin reflex to questions causes the palms of the hands to sweat. The accumulation of moisture lowers the skin resistance. The voltage drop across this portion of the V_1 grid divider becomes lower, and the grid of V_1 is driven more negative, resulting in lower anode current and an unbalanced bridge condition which will be registered on the meter.

After the skin resistance has returned to normal, the meter will probably not return to zero but will be slightly off. This will entail balancing the bridge again, but the balance control will only require a touch. Always allow a few seconds to elapse before rebalancing the bridge and asking any further questions.

No layout or constructional details other than the front panel and the hand electrodes are given, as the circuit is in no way critical, and the constructor can use any form of layout and cabinet to hand. The hand electrodes are very simple, consisting of a block of wood 2in × 1in on which are screwed two pieces of clock spring (see Fig. 2). On the other end of the springs are attached two aluminium 'tin' lids (obtained from a film spool container) into which are pressed two pieces of foam rubber or sponge. These form the contact to the bridge and should be treated as previously mentioned. The whole circuit can be rigged up in an hour, and will form the basis of many hours of entertainment and amusement at parties.



Detail of hand electrodes.

FIG. 2.

Questioning

Here are a couple of suggestions for questioning subjects; no doubt many others will present themselves to the constructor.

1. Ask the subject to write a number between 1 and 10 on a piece of paper without

letting anyone see what he has written. Attach the hand electrodes and tell the subject that he is to answer "No" to all questions. Ask him the numbers in a mixed-up order, one at a time. When the number that he has written is asked an indication will show on the meter at the moment his skin resistance drops. Make a note of this. You can then tell the subject at the end of the questioning what he has written on the paper, to the endless delight *and* scepticism of himself and the onlookers. Always allow a few seconds to elapse in between questions to allow the amplifier to settle. Any number of variations on the above system will no doubt be obvious; birthdays, for example. Awkward questions are always good for a laugh, but don't forget that unless you know your subjects very well that feelings may be hurt. So stick to general questions, and stick to your friends.

The balance controls and the bias control are calibrated from 1 to 10 and a note can be kept of a subject's balance positions to make balancing easy on the next occasion. This will not be strictly accurate, as even the temperature of the room varies and consequently so will skin resistance.

List of Components

Resistors

3.3kΩ ½W
20kΩ ½W
22kΩ ½W
2.2kΩ ½W
470kΩ ½W
470kΩ ½W
2kΩ ½W
20kΩ pot linear
50kΩ pot linear
2 1L4 or 1T4
2 B7G bases
Meter 50μA to 1mA centre-zero
2 terminals for hand electrodes
2 calibrated knobs
1 pointer knob
2-pole 2-way wafer switch (on/off)
Pair of cabinet handles
Chassis, cabinet, wire, nuts, bolts, etc.

Batteries

B114 (67½V and 1.4V), 800 (3V)
Length of twin flex for leads to hand electrodes
Two pieces of clock spring or any springy metal strips.
Two small sponge containers and two pieces of sponge

Can Anyone Help?

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

G. E. Bingham, 10 Whinney Grove West, Maghull, near Liverpool, would like to buy or borrow a handbook for the ex-Admiralty receiver type B21A or its civilian version the Marconi receiver type RG42.

* * *

E. M. Olton, 73 Salmen Road, Plaistow, London, E.13, is in difficulty with an ex-WD R.1125D receiver, and wishes to know the voltages and connections for the valves, marked STCC101 and VR108. Can anyone help?

* * *

2759154 L.A.C. Gray, K, Tailor's Shop, c/o Post Office, Royal Air Force, Kinloss, Morayshire, Scotland, is rebuilding a Premier tape recorder and would like to buy or borrow the full circuit details. The recorder is an older model, with Lane single speed three-motor deck, in a walnut table cabinet.

* * *

D. J. Cooke, 14 Mill Close, Hartford, Huntingdon, would like to buy or borrow circuits of the A.M. Speech Amplifier 367 and the Admiralty M361 TRF receiver.

* * *

M. Culling, "Bailey's Beating," Tamworth Road, Freeford, near Lichfield, Staffs, wishes to buy or borrow data on how to build a photographic electronic flash-gun.

E. Ward, 11 Gobb Green, Horseshoe Lane, Garston, Herts, is anxious to obtain service sheets or data of the H.M.V. 360 and H.M.V. 491 receivers.

* * *

M. Bayley, 9 Mill Hill Gardens, Old Shoreham, Sussex, is urgently seeking data on the M.W. Receiver type 645 manufactured by Gambrell Radio Communications for, it is believed, the Dutch Navy. He will willingly buy and/or defray any expenses involved.

* * *

B. Reddington, G3JWY, 42 Woodhouse Avenue, Fartoun, Huddersfield, Yorks, wishes to obtain details of the Aerial Tuning Unit for use with the Army 12 Set transmitter.

* * *

L. J. Channing, Empire House, Wembdon Hill, Bridgwater, Somerset, wishes to buy a copy of Data Book 4 ("Inexpensive Television"), or the circuit details for dividing sound and vision in the R1355 I.F. Strip.

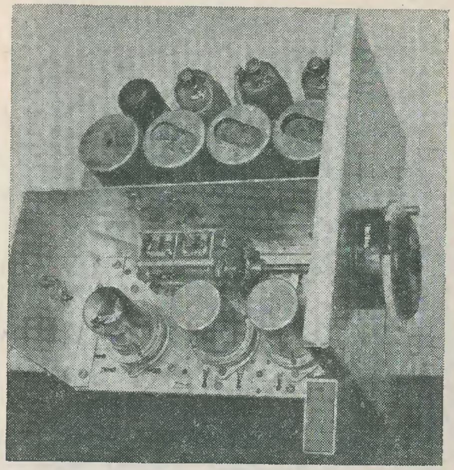
* * *

G. H. Leatherland, 75 Gainsborough Road, Leicester, wishes to buy or borrow a copy of the *Electronic Engineering* De Luxe Home Built Televisor and Radiogram.

continued on page 417

R.F.27 UNIT *for* F.M.

by **R. DAVIS**

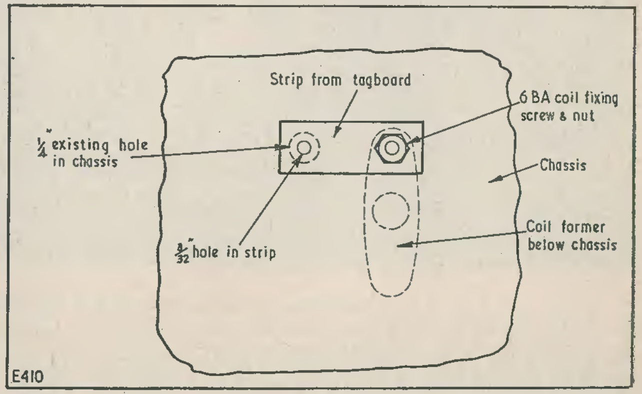


The R.F.27 unit can be quite easily modified to cover the F.M. band, and such a unit, modified with a view to receiving Wenvoe, has, at Bath, 120 miles away, received the three programmes transmitted from Wrotham.

Details of the modifications are as follows:

1. Remove all ceramic trimmers from the unit except the oscillator trimmer below the chassis. This will raise the maximum frequency covered to above 100 Mc/s.

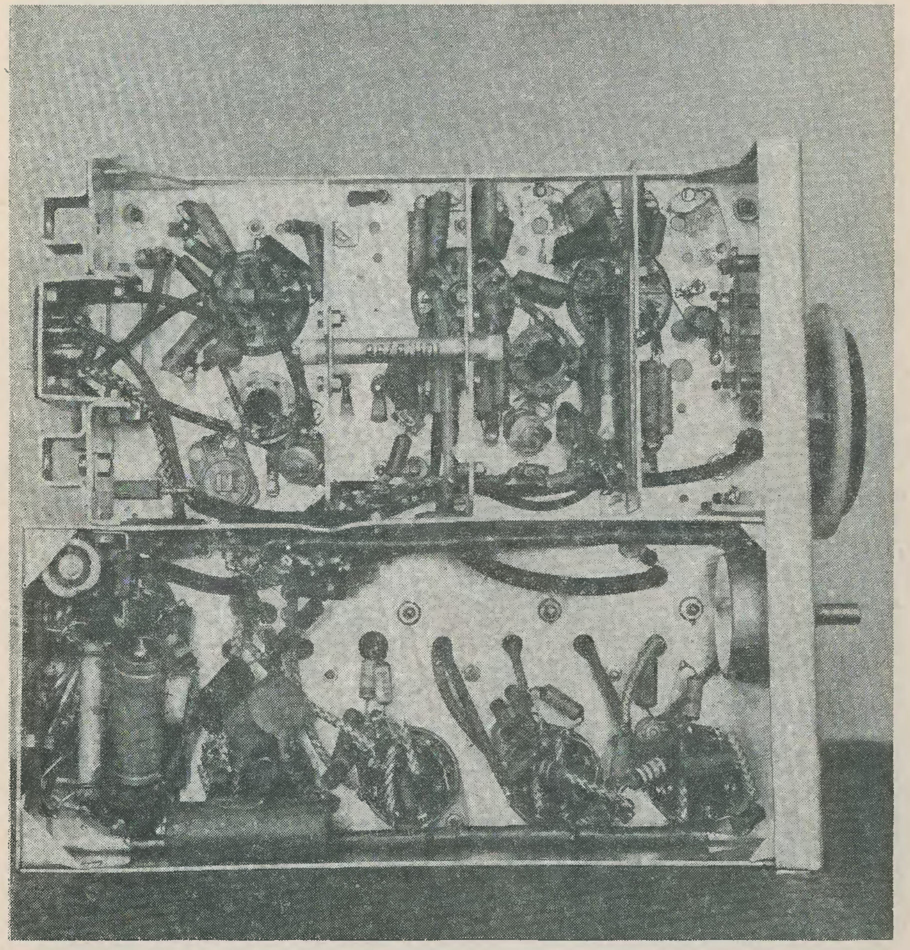
2. The r.f. stage is untuned, so the first section of the main tuning condenser should be disconnected or removed altogether. The tuned circuits of the r.f. stage should be entirely removed, and a coil consisting of 3½ turns of 22 s.w.g. enamelled wire wound directly on a ¼in iron dust core substituted. The core should be reduced in length to five threads, and the coil connected between the control grid of V_1 and earth. Couple to aerial by single turn loop wound directly over the middle of 3½ turn winding.



3. Insert iron dust cores in the mixer and oscillator coils.

4. The frequency coverage with the 75pF tuning condenser is such that the F.M. band will be crowded into the first 20° of dial rotation, therefore replace the two leads joining the fixed vanes of the two-gang condenser to their respective coils by Philips 30pF air-spaced concentric trimmers. This will reduce the main tuning capacitance to 21pF maximum, and will give just sufficient frequency variation to cover the F.M. band.

The two-gang condenser must be removed to do this. To ensure that the Philips trimmers are firmly secured in place, small pieces of tag-board material are secured on top of the chassis by means of the adjacent coil fixing bolts, as shown in the sketch. These strips cover the ¼in holes in the chassis from which the rubber grommets should have been removed. These strips of tag-board should each have a 3/32in hole drilled to be concentrically over the ¼in hole in chassis. The centre connectors of the Philips trimmers are then passed up through these 3/32in holes, and the side connector of the trimmer soldered to the appropriate coil tag. The two-gang condenser can then be replaced, with short lengths of connecting wire soldered to its lower fixed vane connecting points. These wires can then be soldered to the slightly projecting centre connector of the Philips trimmers. Set trimmers to maximum capacity and leave.



Underneath view of converted R.F. 27 Unit

5. Remove the 7 Mc/s i.f. transformer and its resistor in parallel from the anode of the mixer, which latter can then be wired directly to the primary of a new i.f. transformer and thence to h.t.+.

6. The i.f. strip and discriminator circuit can be to suit individual requirements. That shown in the photo uses two SP61's as i.f. amplifiers, SP61 limiter and EB34 ratio detector. The i.f. transformers are 7 Mc/s converted to 10 Mc/s and are from an ex-Government 1124 receiver (22 turns of 26 s.w.g., windings spaced ⅜in). The ratio detector coil is as described for the Jason F.M. Tuner, and the circuit generally is almost identical. The reason for using these components is, of course, because they were already "to hand." However, no trouble has been experienced. Two a.f. stages can also be seen in the photos. These are temporarily wired only, and the a.f. valves are not in place.

7. For the alignment of i.f. and discriminator circuits the reader is referred to previous articles in *The Radio Constructor*.

To align the R.F.27, set the tuning dial to "O," inject a 100 Mc/s signal and trim the mixer and oscillator iron dust cores and oscillator ceramic trimmer, for maximum signal. Set tuning dial to 180°, re-tune signal generator until signal reappears. This should be at about 88 Mc/s. Re-trim slightly if necessary. Set signal generator to middle of band, i.e. 95 Mc/s, and adjust tuning dial for maximum signal. Now, using the 3½in turn winding of the r.f. coil as a "screw thread," adjust the shortened iron core for main signal. Finally fix all cores. In the absence of a 100 Mc/s signal generator, adjust for maximum results on the Wrotham signal.

In the photographs it will be seen that in this case the aerial input has been arranged for twin screened feeder, it being more effective than co-ax. against interference on the i.f. frequency. The Jones plug at the rear of the unit has been changed for an octal valve base to suit an existing power pack. In the oscillator section a stand-off insulator, which carries heater wiring, has been repositioned to allow clearance for the Philips trimmer. The resistor joining the top fixed vane lug of the mixer section of the gang condenser to earth should be left in place to provide an earth return for the mixer control grid; that above the oscillator section can be removed with the ceramic trimmer.

The r.f. stage could, if desired, be tuned in a similar manner to the mixer stage by keeping the first gang of the tuning condenser in circuit, and using a further Philips trimmer. This stage would not then be so convenient for the injection of an a.v.c. voltage, should one be found necessary.

Can Anyone Help?

continued from page 414

R. F. Smith, 7 Council House, Fivehead, near Taunton, Somerset, asks if any reader can kindly help in selling or lending the circuit or give any other information regarding the ex-Govt. receiver B.29 A.P.W. 2698. The receiver is a 5-valve plus rectifier with 4 wavebands covering 15 kc/s to 600 kc/s. All letters will be replied to and any expense will be reimbursed.

* * *

J. M. Allsop, 23 Audrey Crescent, Mansfield Woodhouse, near Mansfield, Notts, wishes to borrow or to purchase copies of *The Radio Constructor* for June and July 1952, giving details of a 28 Mc/s Converter for the R.1155.

* * *

Bryan Hayes, G3JBU, 7 Western Terrace, Northampton, wishes to purchase or borrow servicing data and circuit of the Ekco model T141B televisor.

He has available for loan to any reader the official manual on all models of the R1155, and also the BC312 and BC342, and the manufacturers' manuals for the HRO-60, AR88D, AR88LF, SX28A and Super Pro.

Radio Miscellany

IN WRITING LAST MONTH OF THE DAYS when broadcasting was very young, I mentioned a fellow Clubman, the radio-amateur-meteorologist. To my delight I have since heard from him. He is still going strong with both hobbies, especially radio, and is now in the course of building a super sound recorder—his fourth. Each has been a rebuild of previous models, and he says it is the dearest way of going about it as well as the most speedy means of making the junk-box overflow. Although it has been lots of fun, he is beginning to feel that he might have got a jolly good commercial model for a lesser expense. On the other hand, he can now claim to know more on how not to go about it than anyone else in Great Britain!

In his cheery letter he also reminds me of my mild flirtation with a pet theory of climatic changes. This was drawn from all sorts of sources and was related to periods before records were kept. In turn I reminded him of how we used to pretend that his kid brother made a practice of "topping-up "his catchment jars, especially when the local paper published a seasonal report which he prepared. This, after a reasonably good summer, showed that we had nearly double the average rainfall. The editor inserted the cautious words "According to Mr. ——" before his figures. From that time on, whenever we planned an outdoor club event, such as a field day, factory or broadcast station visit, etc., we always trusted that "According to Mr. —— it was going to be decent weather."

My own little foible of which he reminded me was some wishful thinking in which I had indulged since my latter schooldays, that our weather was on the upgrade. I then had an optimistic belief that our climate was returning to the warm, dry period of centuries ago when the Northmen rowed their crossings over a calm North Sea and Greenland's icy mountains were covered with verdure and pleasant sunshine. Such conditions would assure us of semi-tropical warmth and exotic fauna. Many other readers no doubt share this yearning for sunshine. Incidentally, Mal Geddes (who despite his absence abroad for some years will be well remembered by most readers of the *Radio Amateur*) in a recent letter from Salisbury, Southern Rhodesia, says he believes he would pass out if subjected to a bitter winter again.

Deed Depression

Mine was a nice dream while it lasted, but on getting down to more exact facts I found that at some periods England was so wet that the low-lying areas were vast swamps and only the chalk uplands were habitable. Geological evidence soon proved that the area north of the Thames was covered with ice, and great rocks torn from Norway by glaciers still scatter the eastern counties. The deeper I went into it the more depressing it became. On discovering there wasn't simply one Ice-age, but several, separated by warmer periods, I was so discouraged I gave up going further into the matter.

Yet it has left its mark. Each succeeding summer since then my inner suspicion that we are sliding back to a colder and wetter period is re-born. No doubt for a few of my hard-earned guineas a smart psychiatrist would delve into my subconscious and discover a relationship between this and my lack of interest in portable receivers. Only once have I ever risked taking one on a picnic—then, the wretched thing got waterlogged!

Young at Heart

A few generations back it was generally believed that every high-spirited boy cherished the ambition to drive a railway engine. A few years later it became racing motor cars, then to fly aeroplanes and so on, following whatever was the latest scientific or engineering development. To-day it is Space Travel that stimulates the imagination of the younger generation, and a large number of our more youthful readers have shown a keen interest in the subject or one of its associated branches. In my case, ideas of a probable imminence of space travel came rather too late to spark off the dynamic enthusiasm of youth.

When I first touched upon the subject a few months back in a mildly academic sort of way, several letters resulted, pointing out that interplanetary travel would come far sooner than I thought and (what was vaguely disturbing) that I was falling behind the times and out of touch with recent developments. Perhaps it was partly due to the fear of being considered old-fashioned that I began to re-examine my ideas, and tried to get a better grasp of the state of advancement to the practical solution of the many problems involved. In the last century our increase in knowledge has come at an ever-accelerating pace. Progress which was once spread over generations now comes in the course of a few years. Yet even the new sciences, such as radio and heavier-than-air flight, had comparatively slow and painful infancies. I began to wonder whether the rate of advancement was accelerating faster than I anticipated and whether the Space Age would overtake me before I realised it. So far I still remain unconvinced and believe that I shall be a very, very old man before the first successful journey is made. Not so with the Vanguard Project—I feel that that has a very good chance of being at least partially successful.

Popular Appeal

Despite these unshaken convictions, I have found great fascination in the more detailed study of the many problems still to be solved—problems of which we have no parallel in our experiences upon which to draw. These, of course, involve the work of specialists in many fields and they, because of necessity to express things to a nicety, talk and write of their work as though solely for the benefit of other specialists. All of which is rather hard on the non-specialist who begins to despair of comprehending many of the major points.

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

Happily, the 23-year-old British Interplanetary Society has recently countered this difficulty by starting a new periodical *Spaceflight*, aimed to give the layman accurate up-to-date information of contemporary progress. The first issue is a 48-page, large format, glossy number, containing many informative and readable articles by experts in a popular technical form. For many years the B.I.S. have had a bi-monthly *Journal* which has proved of considerable value to research workers and those professionally engaged in the various problems which must be successfully solved before space travel can be attempted. Its companion book *Spaceflight*, because of its non-specialised approach, makes an excellent start in providing a medium to promote well-informed public opinion. At the same time it provides a well-balanced and very readable interpretation of what has already been achieved and of current lines of research, without ignoring the fundamentals.

Enthusiasm

While on the subject of periodicals, I am reminded that *CQ-TV*, the bulletin of the British Amateur Television Club, has recently taken on a more professional look. Its compression rather reminds me of a wartime newspaper. The editor, Mike Barlow, is to be congratulated on managing to cram so much in its twelve pages. The B.A.T.C. have certainly made a good show every time they have put on a public occasion, and the great enthusiasm of their members recurringly exemplifies what amateurs can achieve with a few bits of surplus gear. A number of new Groups are being formed (or enlarged) and both helpers and keen beginners will be welcomed.

Another organisation with lots of enthusiasm is the Radio Amateur Invalid and Bedfast Club, copies of whose cheerful, nicely typescripted *Bulletin* occasionally come my way. The cheerfulness of their members, often struggling against all sorts of obstacles such as physical pain, financial stringency and even council landlords who don't like aerials, puts most of us to shame. Perhaps as a thanksgiving for the blessings of health and financial security you might feel you could well give a little practical help. If so, please write to Bill Harris, 25 Playford Lane, Rushmere, Ipswich, Suffolk. Maybe you have some gear; not so much from the junk-box, but things that as a present would bring you real pleasure. There is no generosity in giving away what you don't want. Please, by the way, remember this is not a cadging appeal. The R.A.I.B.C. have not asked for an appeal on their behalf, but it's something that radio hobbyists who have a long tradition of good fellowship would wish to do. Don't forget it is not the monetary value that matters. An occasional letter to a bedridden amateur and perhaps a few radio magazines may well bring much pleasure to someone less lucky than yourself.

A USEFUL GADGET FOR THE AMATEUR

by **F. A. GRANT G3FTV**

1. 100 kc/s oscillator
2. Xtal checker
3. Band Edge marker
4. Morse Practice Unit
5. Valve Tester

BASICALLY, THIS UNIT IS THE WELL-KNOWN and well-tried Pierce Oscillator, and it was originally built as a 100 kc/s marker unit. It was later adapted, in the manner of all amateurs, for other purposes.

The first extra requirement was to check another crystal which had a different base, so a 5-pin U.X. valveholder was placed in parallel with the original Octal valveholder, which carried the 100 kc/s bar. This U.X. holder accepted the normal spaced crystals across pins 2 and 4, and later it was found that pins 2 and 3 would take the ¾in holder, so pins 3 and 4 were connected together.

Later, a 3.5 kc/s Xtal was placed in the Octal holder, and this gave Band Edge markings for all bands from 3.5 to 28 Mc/s.

Another use was found for the unit when a young friend required some morse practice, so an Igranic jack was wired into the g_3 lead and the unit used in conjunction with the station communications receiver. Later this jack socket was moved into the anode lead in order to bring the unit into use for still another purpose. A 6L6 valve in use in an amplifier was suspect, so the valve was placed in the unit and the station multimeter switched to the 100mA range and connected across the key terminals, thus checking the anode current. By altering the bias resistor to match the maker's recommendation, the correct state of the emission can be checked. It was later found necessary to check an SP61 for anode current, so a Mazda octal valveholder was wired in parallel with the original international one, and as an afterthought an EF50 valveholder also. By this means most pentodes and triodes can be checked.

More recently yet another use for the unit has been found. The transmitting aerial was connected to C_5, and using the KTW63 a QSO was made, on 3.5 Mc/s CW, with G3CGD at Cheltenham, Glos., a distance of some 200 miles.

Construction

The unit is built on an aluminium chassis 6in × 4in × 2in (also home made). The three valveholders, EF50, IO, and Mazda Octal are fitted on the top of the chassis, and the 5UX and IO for the crystals on one end, together with the Igranic jack socket.

All three valveholders are connected in parallel, viz. all anodes, all screens, all grids, etc., and the Xtal holders connected as shown in Fig. 4. From the grid terminals a flying lead is fitted, with a crocodile clip at the loose end. An insulated anchoring pillar is arranged for the clip to be fastened to when checking triodes, EF50, etc.

A four-core cable terminated in the base of a burnt-out 4-pin battery valve draws power at 250V and 6.3V from a bench power pack, and the leads are connected directly to the appropriate tags on the unit.

By this time the unit was looking a bit "raggy," so it was rebuilt in the manner shown in the illustrations.

Component List

Resistors	
R_1	50kΩ 1W
R_2	1kΩ 1W
R_3	47kΩ 1W
Capacitors	
C_1, C_3, C_4	0.01μF
C_2	0.001μF
C_5	50pF
RFC	any RFC. The one in use came from a T.U. 5B

Note. Other types of valveholder can be fitted (B7G, B9A, etc.) in order to check the modern types of miniature valve.

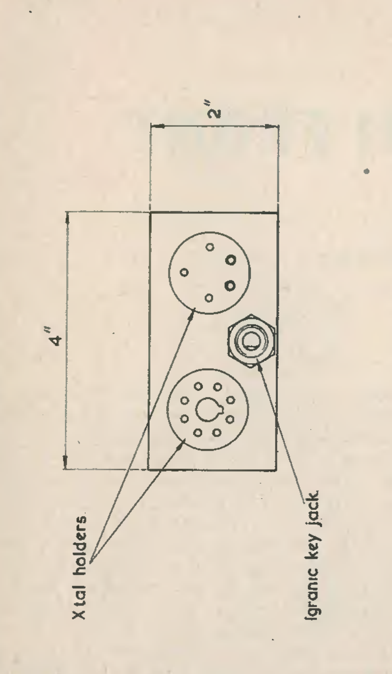


FIG.3. End View in Direction of Arrow 'A' (FIG.2)

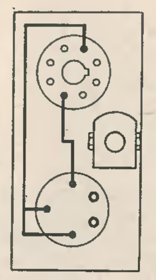


FIG.4. End View Inside, showing connections for different Xtal bases.

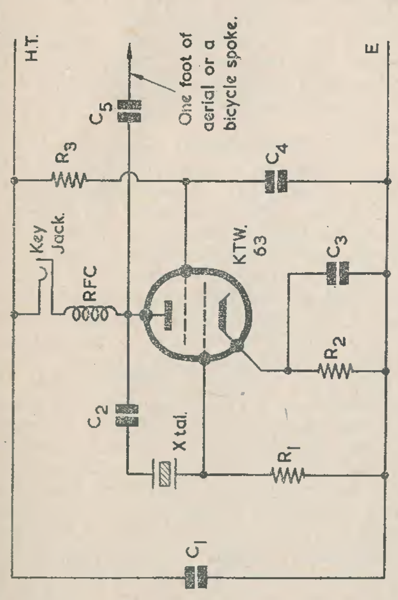


FIG.1. Basic Circuit.

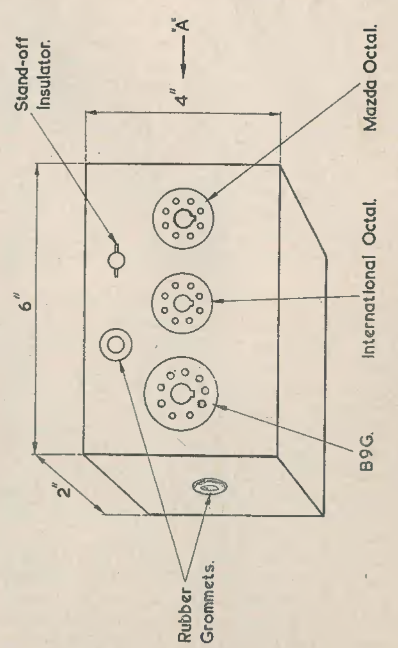


FIG.2. Top View.

STRAIGHT IN FRONT

by **A. S. CARPENTER**

As is well known, the "straight" receiver (where either a diode or infinite impedance demodulator is used for signal rectification) gives considerably better quality than the superhet. The background is quieter; and whistles, which are often evident in superhets, are absent.

As a complete receiver or for feeding into a quality amplifier, this type of circuit has many recommendations if one is content to listen to B.B.C. transmissions. Also, it is simpler and more economical to construct. To the tyro, superhet construction can be a headache.

Many " beginners " t.r.f. circuits use leaky grid rectification in conjunction with regeneration or feedback, but in my experience the more advanced one becomes in radio construction, the less one likes this horrible thing called reaction, or regeneration, or feedback; whichever term you prefer. When used in a superhet where pre-setting is possible, it can oftimes be used advantageously, but if it has to be adjusted for each station (as in many t.r.f. sets) it is definitely a nuisance. It is difficult to adjust—almost an impossibility for the inexperienced, and let's face it—out of date.

But take away this horrible thing from leaky grid t.r.f's and what have you?

Yes, I know—an unselective, insensitive jumble.

Now I am not decrying the leaky grid demodulator. On the contrary, I use it frequently, and it can, if operated correctly, give very efficient demodulation (better in some cases than a diode, as even diodes distort weak signals). It does, however, impose considerable damping on any tuned circuit connected to its input.

This is where the infinite impedance demodulator comes in useful, as its damping effect is negligible. Unfortunately, once again there is a snag—it gives a positive output—and if we want a.v.c. a negative one is needed.

How about using a cathode follower to prevent damping, following it with a diode for demodulation and a.v.c. purposes?

Consider Fig. 1. A tuner suitable for the Medium waveband is shown, but other bands may be added by inserting the necessary coils and switching. The first valve is a normal r.f. amplifier coupled aperiodically to V_2; and, due to the voltage drop across R_6, this valve offers a high impedance. In fact, as you will probably notice, if L_3 were omitted and C_8 altered to a smaller value, it would be an infinite impedance demodulator. In this case R_6 is used to make the grid sufficiently negative with respect to the cathode, but to prevent the diode from being biased this resistor is not used as the signal load. Instead, L_3 is included for this purpose. The voltage drop across it is negligible, but it does offer a high impedance to r.f., which is what we want.

A normal filter follows the diode and C_{12} blocks off the d.c. in passing on the a.f. to the volume control R_{10}. This is usual practice. A.V.C. is available at the "hot" end of R_7 and can be fed back to preceding valves; in this case V_1 only. The inclusion of a.v.c. is not so much to counteract fading as to prevent "blaring" when tuning from one station to another. In some cases it might be advisable to split R_7 into two 500 ohm resistors and to take the a.v.c. from their junction.

This is not entirely a "paper" circuit. It has been made up experimentally and works well, selectivity and quality being excellent. In the prototype a two-valve amplifier followed, consisting of an l.f. amplifier and a class A output stage. By adding these two valves to Fig. 1, a complete receiver would result, or alternatively Fig. 1 may be fed into an existing amplifier. Incidentally, as you probably already know, feedback can be obtained in this type of receiver by soldering a short length of P.V.C. wire to each section of the fixed vanes of C_2. The dial should then be set to the high frequency end and the two

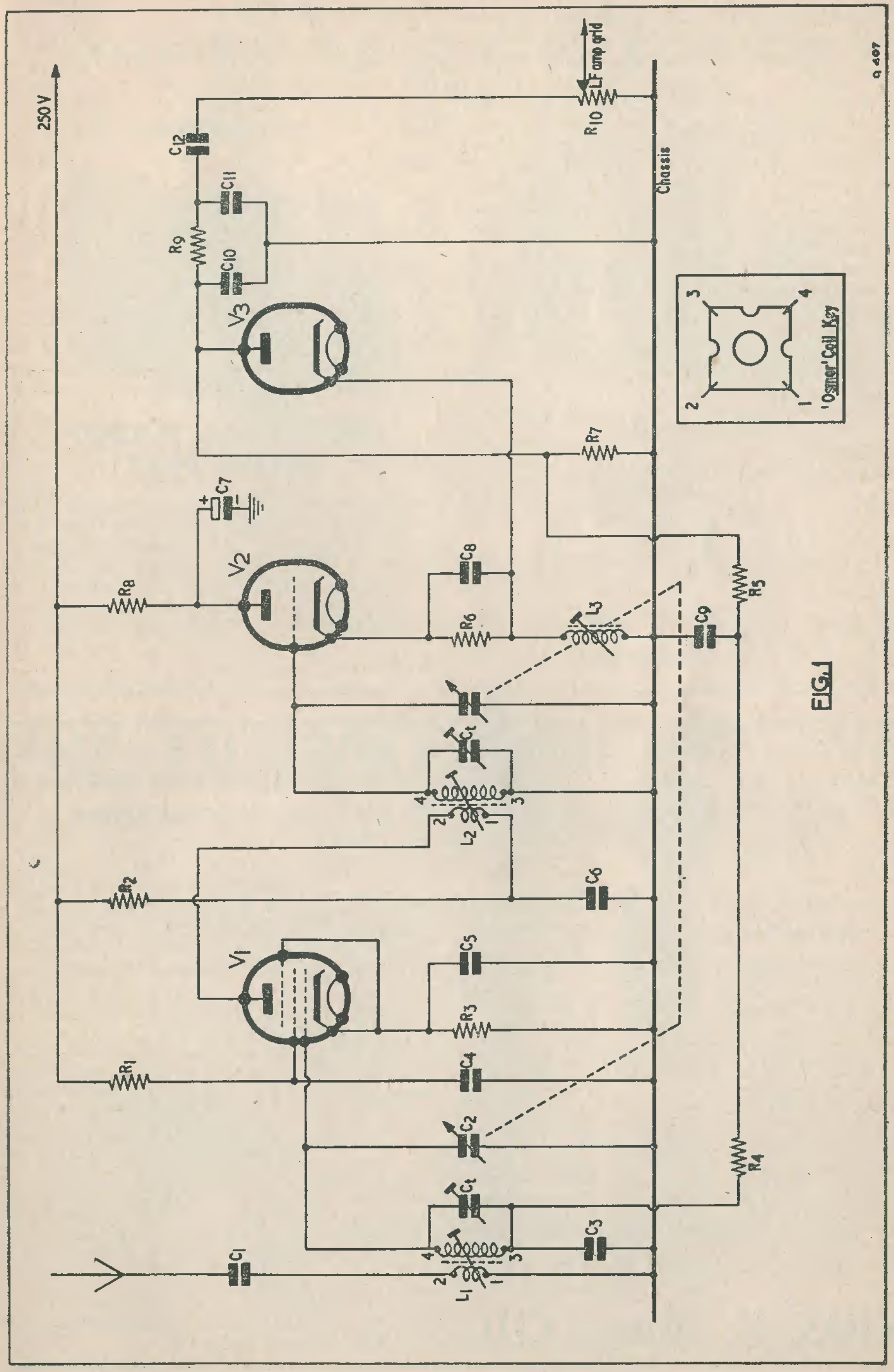


FIG. 1

wires (not bared) should be twisted together until oscillation commences. They should then be untwisted until oscillation just ceases, and left.

Regarding the valves: V_1 should be a high-slope vari-mu type if a.v.c. is to be used, otherwise it may be a short grid type. Any medium-impedance triode of the L63 class can be used for V_2. The diode is not critical, and a germanium crystal diode can be employed if chassis space is at a premium, the red end being treated as the cathode.

In the interests of tidiness a complete list of components is given, The resistors R_1, R_3 are about the only ones likely to require modification if a different type of valve is used for V_1. The capacitor C_1 *must* be included if no mains isolating transformer is included in the power supply.

Components List

Capacitors

$C_{1, 10, 11}$	100pF mica
C_2	500pF variable
$C_{3, 4, 5, 6, 8, 9, 12}$	0.01µF, 350V
C_7	2µF, 250V
C_t	50pF trimmers

Resistors

R_1	47kΩ (see text)
R_2	5kΩ
R_3	220Ω (see text)

Resistors—continued

$R_{4, 5, 7}$	1MΩ
R_6	1kΩ
R_8	10kΩ
R_9	47kΩ
R_{10}	2MΩ Pot

Coils

L_1	Osmor QA11
L_2	Osmor QHF11
L_3	Osmor QC1

Valves

V_1	EF39 (see text)
V_2	6C5, L63, 6J5 (see text)
V_3	EA50, 6D1 (see text)

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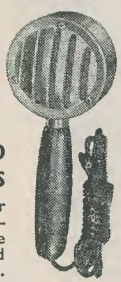

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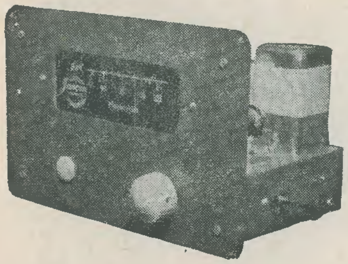

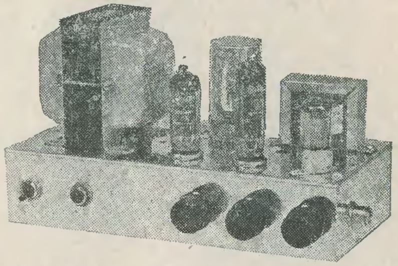

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6AL5	6/6	12AT7	9/–	ECC81	10/6	PL81	10/6
6AT6	8/–	12AU7	9/–	ECH35	9/–	PL82	10/6
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6SA7	8/–	DAF96	9/–	EF41	10/–	UY41	8/–
6G6G	4/9	DF91	7/6	EF55	9/6	UBC41	10/–
6J5G	5/6	DF96	9/–	EF80	9/6	ECF82	11/–
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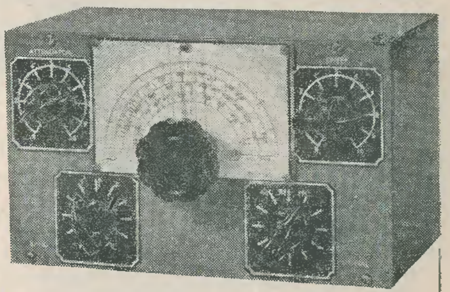

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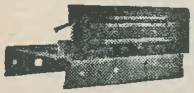

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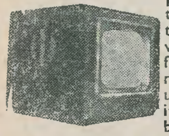

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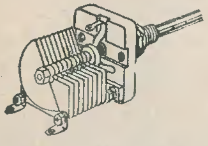

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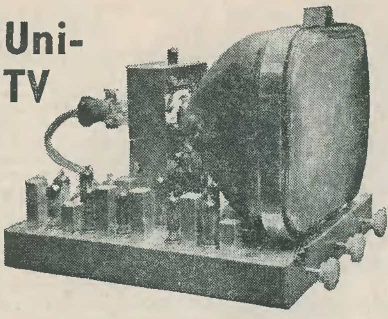

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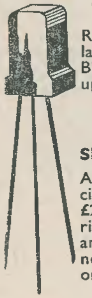

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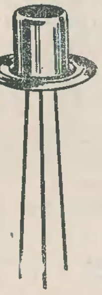

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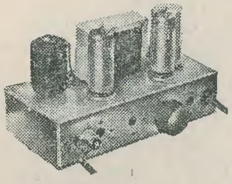

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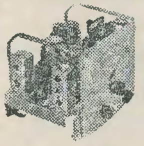

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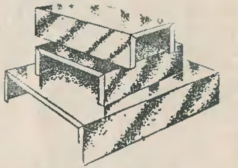

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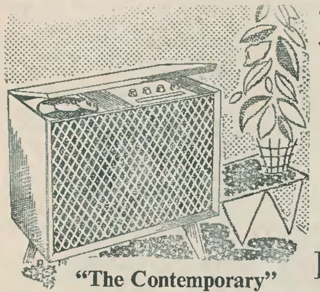

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continued from page 429

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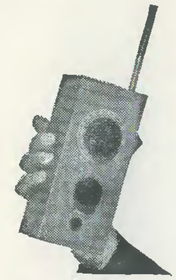

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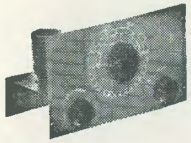

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