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WORKING FROM A CIRCUIT DIAGRAM

VOLUME 10
NUMBER 3
OCTOBER
1956

The RADIO Constructor

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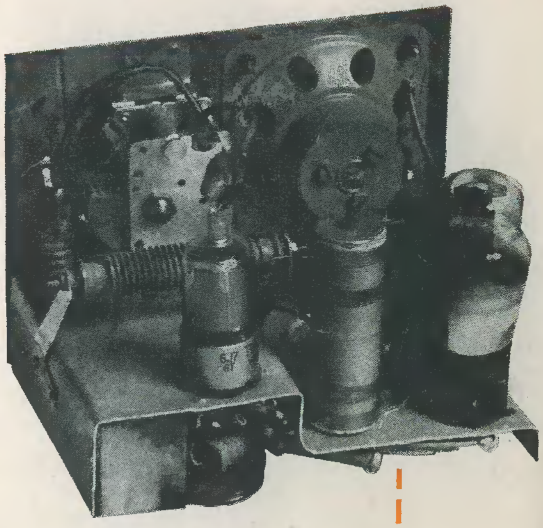
by
F. G. RAYER



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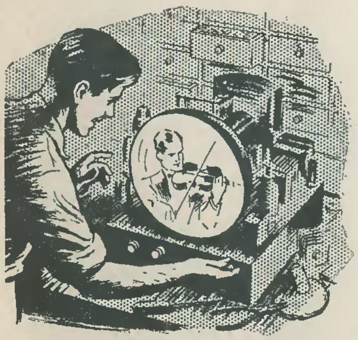

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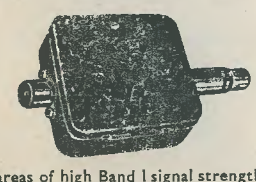

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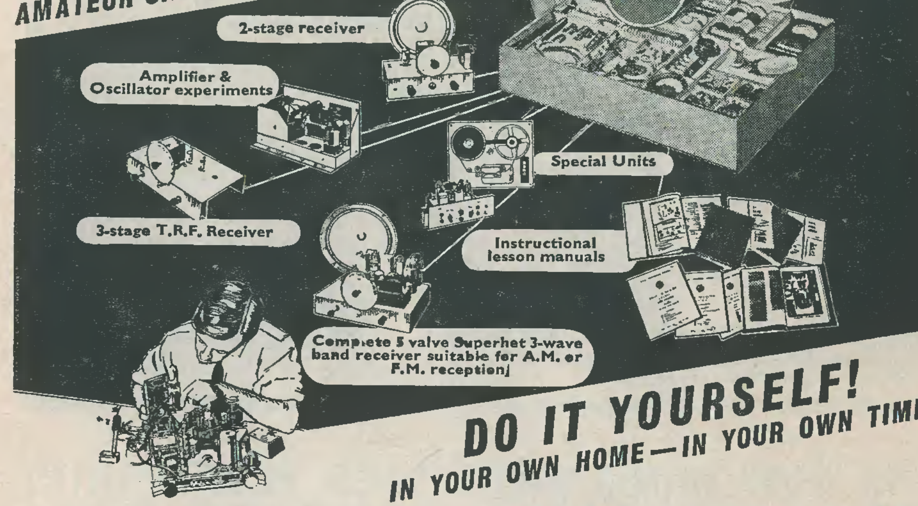

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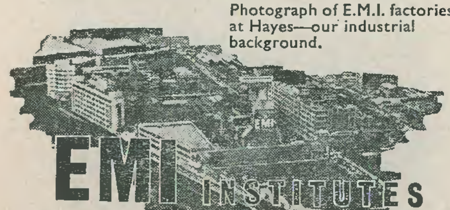

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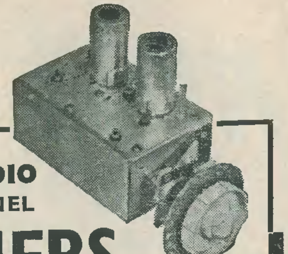

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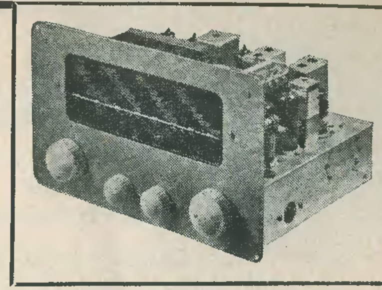

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CONTENTS FOR OCTOBER

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

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

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

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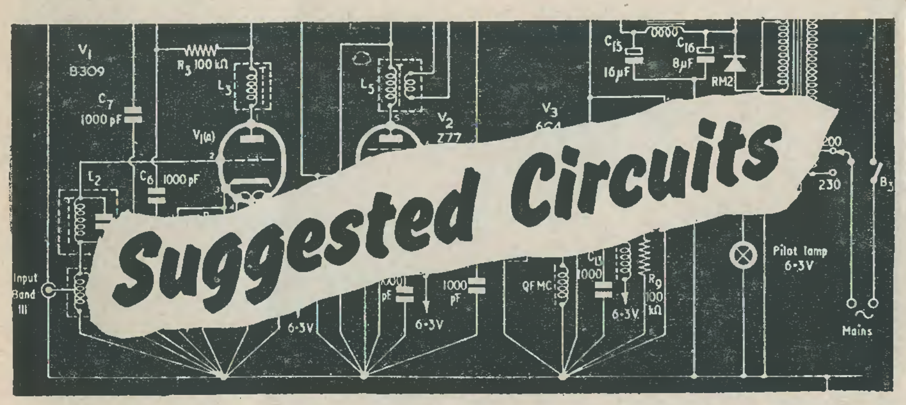


The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data*

No. 71. A VERY HIGH GAIN LOW-COST A.F. AMPLIFIER

THE *raison d'être* OF THE SUGGESTED Circuit series is that it presents and discusses circuits which are intended to be of interest to the enthusiast and the experimenter. Because of their nature, circuits are sometimes published in this feature which approach their subject with a bias to the theoretical point of view. A further, and somewhat similar, point is that it is occasionally necessary to provide each circuit with certain theoretical "safeguards" (such as, say, adequate decoupling or filtering), even when it is possible that these safeguards may not be necessary in every practical instance. However, precautions of this type help to guard against the case in which a circuit is built up with insufficient regard to such things as layout and screening. The circuits themselves are developed theoretically and checked, where applicable, in a practical rig. And, as was stated above, the circuits occasionally include features which are desirable theoretically but which may be deleted, without detriment to performance, in *some* practical versions.

The writer has raised these points because he has received a number of letters over the last few years from readers who have asked for practical layouts of particular circuits, plus lists of specified components and so on. One or two correspondents have asked for such things as winding details for coils, even when the text has quoted particular types which may be employed in the circuit concerned. The writer is very happy to hear from readers, but he does hope that he will be excused if he points out that such queries are really just a little outside the context of this particular series of articles.

This Month's Circuit

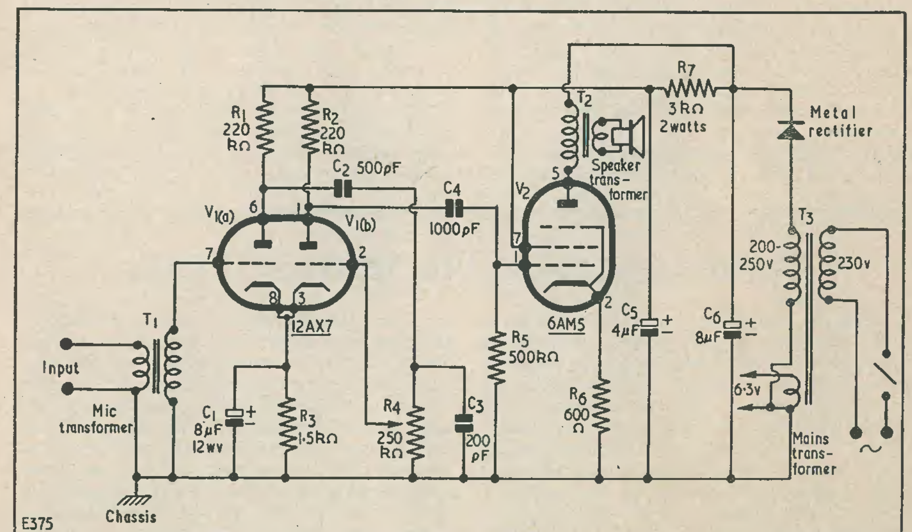
The above remarks, whilst helping to enlarge on the introduction at the head of this page, also introduce, in a somewhat contradictory manner, the circuit discussed this month. The circuit itself is that of a rather novel a.f. amplifier. It has the feature that, contrary to usual practice here, quite a number of theoretically desirable points have been purposely omitted in order to realise two practical advantages, those of high a.f. gain and low cost. This particular arrangement has been the subject of quite considerable practical development, during which much component pruning took place. As it stands, the circuit employs almost the absolute minimum of component parts, yet it should still be capable of functioning very reliably so long as reasonable care is taken in its construction.

Operation

Basically, the circuit is that of a very sensitive amplifier in which the lowest possible number of decoupling and smoothing components are employed. Attenuation of the lower a.f. frequencies is provided in order to prevent hum difficulties. Despite this, the circuit is still capable of reproducing music without excessive frequency distortion. For speech amplification it is ideal; and it is capable of providing more than enough gain for such functions as intercoms, baby alarms, and the like. When the practical version was checked by the writer it was found possible to hear, at good volume from the loudspeaker, the breathing of a person standing some ten feet or so away from the microphone! The microphone employed, incidentally, was a small moving-coil loudspeaker. Since the most useful function of the amplifier is that of speech amplification, it will be assumed that the required input impedance is that needed by a moving-coil microphone, or by a loudspeaker used as a microphone. Other inputs can, of course, be employed when desired.

The double triode V_1 forms a high gain voltage amplifier giving a gain of some 70 dB. A high-mu valve such as the 12AX7 is essential here, not only to provide the gain required but also to enable the simple decoupling arrangements employed to function satisfactorily. As will be noted, a single electrolytic condenser of quite low value, C_1, bypasses both cathodes to chassis, even though these work in anti-phase to each other. A single cathode bias resistor is employed. Similarly, no decoupling at all is provided in the h.t. feed to V_1.

V_2 is a low-power output valve which functions in conventional fashion. It has the advantage of requiring low anode and screen grid currents, thus enabling a very simple power supply and smoothing arrangement to be employed. A cathode bypass condenser is not employed at all with this valve, it being found that the loss in gain sustained by its omission is relatively small. The primary impedance presented by the output transformer into which V_2 feeds should be approximately 20 kΩ.



The input connection to the amplifier is made to the grid of $V_{1(a)}$ via the input transformer T_1. Assuming the microphone input connection just mentioned, T_1 should be a microphone transformer having a ratio of 100:1 to 150:1. $V_{1(a)}$ amplifies in normal fashion, its anode being connected to the volume control R_4 via C_2. The slider of R_4 connects to the grid of $V_{1(b)}$, whose anode then couples, in its turn, to the grid of V_2 via C_4.

The power supply also uses very few components. Due to the high gain of the amplifier (as well as the safety question incurred by possibly long microphone leads) an isolating mains transformer is advisable. Since the h.t. current is less than 30mA, however, the mains transformer required need not be an expensive component at all. That shown in the circuit has a single half-wave secondary supplying some 200 to 250 volts. The heater supply needed is 6.3 volts at

0.5 amps. Transformers of the type shown in the circuit and capable of supplying low powers of this nature are fairly readily available these days, they being employed mainly in Band III converters and similar equipment. The h.t. rectifier can be a single half-wave component.

Hum

The greatest difficulty encountered in high gain a.f. amplifiers is that of keeping hum to low limits. In this instance much of the hum problem has been obviated by attenuating the lower audio frequencies. This attenuation has been achieved by using low values for the coupling condensers C_2 and C_4.

The grid input wiring to $V_{1(a)}$ is especially liable to hum pick-up. It is for this reason that the volume control has been connected in the grid circuit of $V_{1(b)}$. It is extremely doubtful if $V_{1(a)}$ will be overloaded by excessive inputs under the conditions of service to be expected, and the use of the volume control in the following grid circuit is consequently justified. The position which the volume control occupies in the circuit enables it to be connected up by fairly long leads, thereby simplifying the chassis layout.

The wire connecting the grid of $V_{1(a)}$ to the secondary of T_1 should be kept short and clear of heater leads, and may even have to be screened in some cases. The microphone transformer should not normally need screening, although trouble may be given if it is mounted close to the mains transformer. If hum induction from the mains transformer arises, one of the transformers should be rotated until the hum is at a minimum. In the writer's version no difficulty was experienced from this particular cause, despite the fact that the two transformers were spaced apart by only five inches, and that the microphone transformer was unscreened.

The input connection to the microphone transformer may consist of twin unscreened, or single screened wire, according to the incidence of radiated hum in the route covered by the leads. If hum induced in twin unscreened wire is objectionable, then screened wire will be necessary. Television co-axial cable will function excellently for this purpose.

Conclusion

There is little else in the circuit that needs further comment. As was mentioned at the beginning of the article, the circuit differs from many of those previously discussed insofar that it has few technical "safeguards." Instability should not occur in any built-up unit so long as the common-sense rules of construction and layout are employed. If instability *does* occur, then it will be necessary to increase the value of C_1 or C_5 experimentally. It is essential, of course, to keep output and input wiring well separated.

The condenser C_3 is employed as a tone correction condenser, although it may also help, in some versions, to prevent instability at high frequencies due to phase shift.

Communication Via Meteor Trails

What is described as a revolutionary communications system is the subject of a news release recently received from Redifon Ltd. This new technique employs reflections given by the ionised trails of meteors entering the earth's atmosphere to enable transmissions in the 30 to 60 Mc/s range to be received at distances up to 1,000 miles. The system has been employed successfully by the Canadian Defence Research Board and will be used in the future by British and NATO Governments.

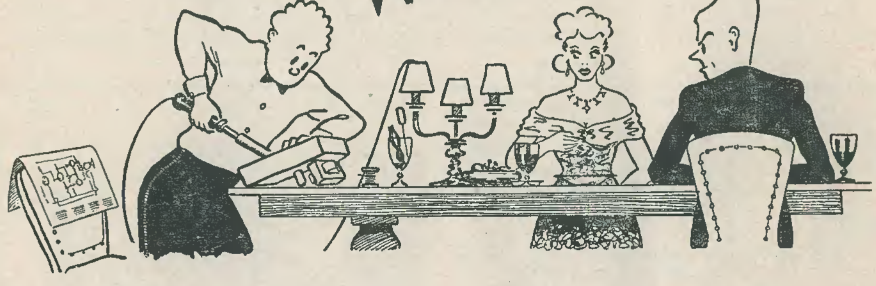
Billions of tiny meteors no larger than grains of sand enter the earth's atmosphere every hour. Each one, as it flashes through, leaves a long trail of ionised particles some 60 miles up from the earth's surface. The new technique employs these trails to reflect transmissions around the curvature of the earth.

Due to their spasmodic appearance, the reflections from the meteor trails do not enable continuous reception to be obtained. Communications circuits, in consequence, employ a transmitter and receiver at each of the two ground stations forming a circuit. When, due to the presence of a meteor trail, a circuit becomes available, message-feeding devices are automatically switched to the appropriate transmitter. As the trails can only be used for periods ranging from milliseconds to a few seconds, the messages have to be recorded and stored before transmission, then sent at very high speed in short "bursts." These are received on special recording equipment which later reproduces them at slower speeds for normal communications equipment.

The "meteor trail" technique affords an attractive new departure, as it relieves the heavily overcrowded conventional short-wave bands, and because it dispenses with the very high transmitter powers required for Ionosphere Scatter systems.

The transmitters employed for the pilot Canadian scheme were designed and built by Redifon Ltd. This company is also building the transmitters for future circuits.

IN YOUR WORKSHOP



Once more, in response to readers' requests, Smithy the Serviceman takes over "In Your Workshop"

SMITHY, THE SERVICEMAN, WAS IN A BRISK and business-like mood when, one summer morning, Dick entered his workshop.

"Hallo," he said, looking up from the bench, "you're just the chap I need to help me out of trouble! I've got a whole pile of work to get through and there are only a few days left before I go off on my holiday. Do you think you could give me a hand?"

"Certainly," replied Dick, "I'm only too happy to get the chance of some experience."

"Good show," said Smithy. "Well, if you like, you can start right away on those two sound receivers in the corner of the bench over there. So far as I know they've both got routine faults. The electrolytics have dried out of one, and the dial cord has broken on the other. If you run into any snags just let me know."

Knob Removing

Smithy returned to his own work and Dick enthusiastically set about the two receivers Smithy had pointed out. They were both small sets, and had both seen quite a few years of service. The tuning cursor of the first set Dick examined was reclining at a drunken angle, and could not be shifted along the dial by what, due to its unrestricted movement, was obviously the tuning control. This receiver was obviously that with the broken dial cord Smithy had referred to, and Dick commenced to remove the knobs.

After some moments Dick turned round to Smithy.

"I'm sorry to trouble you so soon," he said, in a rather crestfallen voice, "but I can't get one of these dratted knobs off. I daren't start levering at it with a screwdriver or anything like that, in case I scratch the cabinet."

"Not to worry," said Smithy, "I'll come and have a look at it."

He walked over to the set. The knob was of the type which was held to its spindle by a spring, and its shape was such that it was extremely difficult to obtain any purchase on its surface with the fingers. Smithy made several experimental tugs without success.

"Why do they make knobs these weird shapes?" asked Dick, disgruntedly. "You just can't get a grip on them anywhere!"

"I don't know," said Smithy, shortly; "too many budding Picassos in the factory design department, probably. Anyway, I've never had a knob beat me yet! I'll show you a little dodge I use for obstinate cases like this."

He pulled a handkerchief out of his pocket.

"All you need for these awkward knobs is a handkerchief, or a clean rag with a strong hem. First of all you bring the hem of the handkerchief up under the knob like this (Fig. 1(a)). Then, keeping the ends of the handkerchief close to the panel of the set, you bring them round until they overlap each other by 90 degrees or so. Next, you bring the two ends away from the set, grip the whole handkerchief so that you have even tension round the knob and pull gently. (Fig. 1(b)). And there you are!"

Triumphantly, Smithy pulled the knob off its spindle and retrieved it from the folds of the handkerchief.

"Well, I live and learn!" remarked Dick, impressed. "Why did you say that you should pull gently? Surely a sharp tug will do the trick just as well."

"It doesn't always, I'm afraid," replied Smithy. "You see, although in most cases a knob which is difficult to remove is the result of a tight spring, it occasionally happens that the spring and the spindle may have rusted. Steel spindles are usually cadmium plated, but this plating may be quite thin in some instances. Also, the plating may have been partly scraped away by the original process of putting the knob on, plus that of taking it off and on during later servicing. The same applies to the spring as well, which should also have been given a protective coating when it was made. If the surfaces of the spring and the spindle are rusty it becomes extremely difficult to slide the knob off smoothly. A sharp tug would most probably break the moulding of the knob."

"I see," commented Dick, "I shall remember that in future."

Smithy was examining the guilty knob and spindle.

"These look a little rusty, themselves," he remarked, "I should put a little grease on that spindle before you fit the knob back on again. It'll make it easier next time and may possible slow down any future rusting."

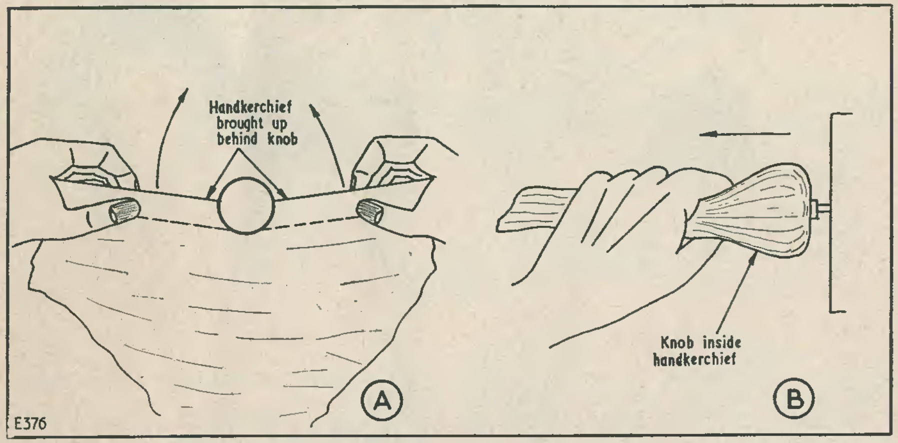


Fig. 1. Two successive steps in removing a difficult knob. The handkerchief is wrapped around the knob, after which it is carefully pulled from the spindle. (See text)

Crackles

Smithy returned to his own job and Dick continued with his removal of the chassis from the cabinet. He replaced the broken dial cord, having first made a careful check, as far as he could, of its route through the chassis, and having noted the number of times it was looped around the tuning drive spindle. These precautions were the result of previous advice from Smithy.

"I've got it all fixed up now," he remarked to Smithy, "but I'm not quite certain how I should align the cursor with the tuning condenser."

Smithy walked over once more. The set had a rectangular scale and the cursor moved horizontally along a slide at its top. The cursor carriage had slots which enabled it to be located anywhere along the dial cord.

"Locating the cursor *is* a fiddling job sometimes," remarked Smithy, "and I've had a little difficulty with it myself when the ends of the pointer travel are not clearly marked. However, most manufacturers put a calibration marker somewhere on the scale and it can usually be found after a little hunting. For instance, some scales have a spot, or row of dots, at the maximum tuning capacity end of the cursor travel. Others have an extra division mark, similar to those used for wavelength divisions, and also at the maximum capacity end. Ah, there's a mark of that type here! It's on the long-wave section of the dial, and it's the same sort of mark that is used in that section for subdivisions. It obviously isn't a wavelength subdivision because it is very close to the '2,000 metres' point. We'll put the tuning condenser to maximum capacity, set the cursor to this mark, and the job is done.

"Practically all reputable sets have some means of cursor calibration on the scale or scale backing, but these are not always very obvious. If you haven't a service manual, or if it doesn't give the required information and there is no end-marker on a particular set, then you have to make a guess at it. In such cases I usually assume that the set is correctly aligned on medium waves, tune in a low-frequency signal, and set the cursor to that frequency. It's guesswork, I know, but it works in most cases."

Whilst Smithy was talking, Dick had switched on the chassis and was checking its performance. He had not refitted the knobs, and as he turned the tuning control spindle, the set gave forth a continual loud crackling.

"This must be my unlucky day," he moaned. "I thought I had taken on an easy job, and now there's something else wrong with the set. Just listen to those crackles! Either there's a poor connection to the tuning condenser, or its vanes are shorting."

"Well, that's possible," chuckled Smithy, "but I doubt it. I think you've fallen into a little trap that happens with quite a few sets. Just say to yourself that there's a difference between the way you're operating the set now and the way it will be operated by the customer."

With which remark he left Dick to his task.

Dick scratched his head and looked at the offending set. Absentmindedly he picked up a pair of pliers and scratched the metal-work of the chassis with it. A loud crackle came from the speaker as the pliers rubbed along the metal. Suddenly a light dawned in his eyes and he quickly fitted the knob to the tuning control spindle. As he turned the knob the set worked exactly as before, but the crackling had now ceased completely.

"I see that the penny has dropped," laughed Smithy, who had been quietly watching him.

"Why, of course," replied Dick, "in fact, I can't think why I didn't see it before. The crackles are caused because the chassis isn't earthed, and when I touch it with a piece of metal my body is acting as a counterpoise to the aerial. The tuning control spindle is making intermittent contact to its bush, and so there is a crackle whenever I turn it without the knob. If I put the knob back on I'm insulated from the spindle and the crackle clears."

"Exactly!" said Smithy. "And you've beaten just another of those little puzzlers that happen every now and again. Incidentally, I'm a great believer in putting the knobs on any chassis I'm working on, because I think it saves time in the long run. There is nothing that annoys me more than to see someone scratching away at, say, a wave-change spindle with a pair of pliers, when the appropriate knob is sitting on the bench right by the side of the chassis."

"Well, that is sensible enough," said Dick; "I didn't expect, though, that my first service job for the day would consist of clearing troubles caused by such simple things as knobs."

An Intermittent

The workshop became quiet once more as Smithy and Dick worked on. Dick returned the first set to its cabinet and replaced the electrolytic condensers in the second without mishap. This done he wandered over to Smithy, who was looking unhappily at the television chassis in front of him.

"Why so glum?" he asked.

"I've got an intermittent," remarked Smithy, "and, although I think I know where the trouble is, I'm not certain. The set has flywheel sync and has a habit of going out of horizontal lock every now and again. I've replaced several components which *might* have caused the trouble, but they didn't clear it. Now I have a hunch that it might be the electrolytic condenser decoupling the oscillator h.t. feed."

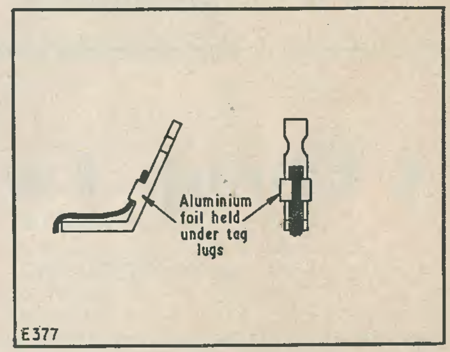


Fig. 2. The type of condenser connection referred to by Smithy when discussing intermittent faults

Dick noticed that Smithy had two test leads clipped to an electrolytic condenser lying on the bench.

Suddenly the picture given by the chassis fell out of sync. Quickly Smithy applied his test prods, one to chassis, and one to the terminal of the condenser he suspected. The picture immediately returned to normal.

"Do you think that the electrolytic in the set is intermittently open-circuit?" asked Dick.

"Well, it might be," replied Smithy, "the only trouble is that applying the second condenser momentarily causes a sudden change in the circuit potentials. That change *could* result in an intermittent connection somewhere else becoming good again for a short while."

"There was hardly any spark when you connected the second electrolytic. Why was that?"

"I was keeping it charged up to h.t. potential every now and again," replied Smithy, "in order to keep the circuit disturbance as small as possible when it was applied across the condenser in the set. Fortunately, the set is going faulty fairly frequently, so I could use a technique like that. Dash it, it's gone again!"

Once more the picture had gone out of lock and again, by applying his test prods, Smithy brought it back to normal again.

"Well, the best thing I can do," he decided, "is to replace the suspect condenser temporarily with another and just wait and see if the fault re-appears. Luckily I won't have to keep an actual eye on the chassis all the time; I have developed a trained ear for 10 kc/s line transformer whistle. I'll be able to *hear* it if it goes off sync again!"

"Do electrolytics become intermittent very often?" asked Dick, as Smithy hooked in the temporary replacement.

"In my experience modern electrolytic condensers very rarely give trouble," replied Smithy. "In fact, over the last year I've only had two, so far as intermittents go. In one of these the trouble was caused at the tag itself. The condenser had a strip of aluminium foil coming out of the body which was then held under pressure by two folded lugs on the tag (Fig. 2). So far as I could tell, the joint between the foil and the lugs was intermittent. At any rate, I squeezed the lugs down tightly on the foil with a pair of pliers, and the intermittent cleared. The set hasn't given any trouble since, so I must have cured the fault."

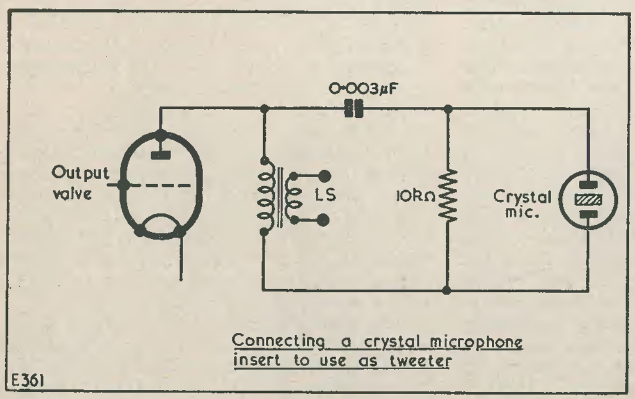
"You sound rather doubtful about it," commented Dick.

"Well, I am always doubtful about intermittent faults, because one has to rely so much on guesswork," said Smithy. "As a matter of fact, intermittents are the bane of the serviceman's life. In this case I'm going to leave the set on for a couple of days with the temporary condenser, and keep my fingers crossed.

"Which reminds me that, by then, I'll be ready to go off to the sea on my holiday. I could do with a little ozone in advance, so in the meantime let's have a look at that television set on the shelf. When I checked it in the customer's house it was giving the best corona display I've seen for years!"

A Cheap Tweeter

by W. SCHROEDER



Connecting a crystal microphone insert to use as tweeter

The performance of a high-fidelity receiver is often marred by the shortcomings of the loudspeaker, which does not reproduce the high notes at sufficient volume. A tweeter will remedy this, but it is rather a costly item. A cheap, yet efficient, substitute is a crystal microphone insert if it is connected as shown in the circuit diagram. The inserts can stand up to about 30 volts a.f. only; the condenser, therefore, must possess a high-voltage insulation, as a breakdown would destroy the crystal cell.

TELEVISION for the HOME CONSTRUCTOR

PART 4. *by* S. WELBURN

This month our popular contributor on television topics devotes his space to video amplification, this being examined from the viewpoint of maintaining the d.c. component in the reproduced picture. He also describes modifications which may allow d.c. re-insertion to be given in receivers employing a.c. couplings.

When the idea of a commercial television service was originally launched in this country, an argument immediately raised against its inception was that no effective safeguards could be made to ensure that advertisements of an offensive nature might not be shown to the innocent viewing public. In one particular sense, it can now be said that nothing of this nature has occurred. Indeed, it is possible that I.T.A. advertisements represent the cleanest fare to be seen on any television screen, insofar that they consist almost exclusively of presentations extolling the virtues of soaps, soap-powders, detergents and washing machines. So frequently do cleansing products appear on our screens that it must be difficult to plan advertising schedules such that the whiteness of one particular detergent is not followed immediately afterwards by the even whiter whiteness of a rival product; and one could sympathise with the difficulties of those responsible for avoiding clashes of this type were it not for the fact that the two products concerned would probably be made by the same combine in any case.

The writer must apologise for commencing a technical article with this rather irrelevant paragraph, and he can only excuse himself on the grounds that it offers a fairly useful introduction to his main subject: that of d.c. coupling and re-insertion in the video stages of television receivers. The lack of d.c. coupling in one particular commercial set was brought home very forcibly to him some time ago as he watched an I.T.A. programme at a friend's house. During one advertisement for soap powder the commentator's voice said, "This is white"; whereupon the whole screen flashed white. He next said, "And this is black." However, instead of becoming black the screen just became light grey; only slightly darker, in fact, than the first picture. The writer's friends were puzzled at this, but he did not attempt to explain that their set was one of the very many in use these days which are quite bereft of d.c. coupling in any shape or form, and that the advertiser had not been advised very well by his technical staff in attempting to put over such a presentation on television.

D.C. Coupling

The above instance represents an extreme case of the picture quality which can be lost by inadequate d.c. coupling. Less obvious instances are given in plays, or similar features, wherein the producer attempts to heighten the impact of a particular scene by reducing the stage lighting. All that happens in a set without d.c. coupling is that the brightness of the picture as a whole increases automatically and the effect becomes cancelled out. It is, fortunately, a fairly simple and inexpensive job to introduce d.c. coupling, or d.c. re-insertion, into a particular receiver, and this might afford an interesting task for the amateur who feels prepared to carry it out. The use of d.c. coupling or re-insertion in a contemplated home-designed receiver is a factor which is also worthy of attention.

Before carrying on to details of circuits or modifications, however, it would be advisable to commence by examining the necessity for d.c. coupling in the first place. Since, in these columns, we are primarily interested in tele-

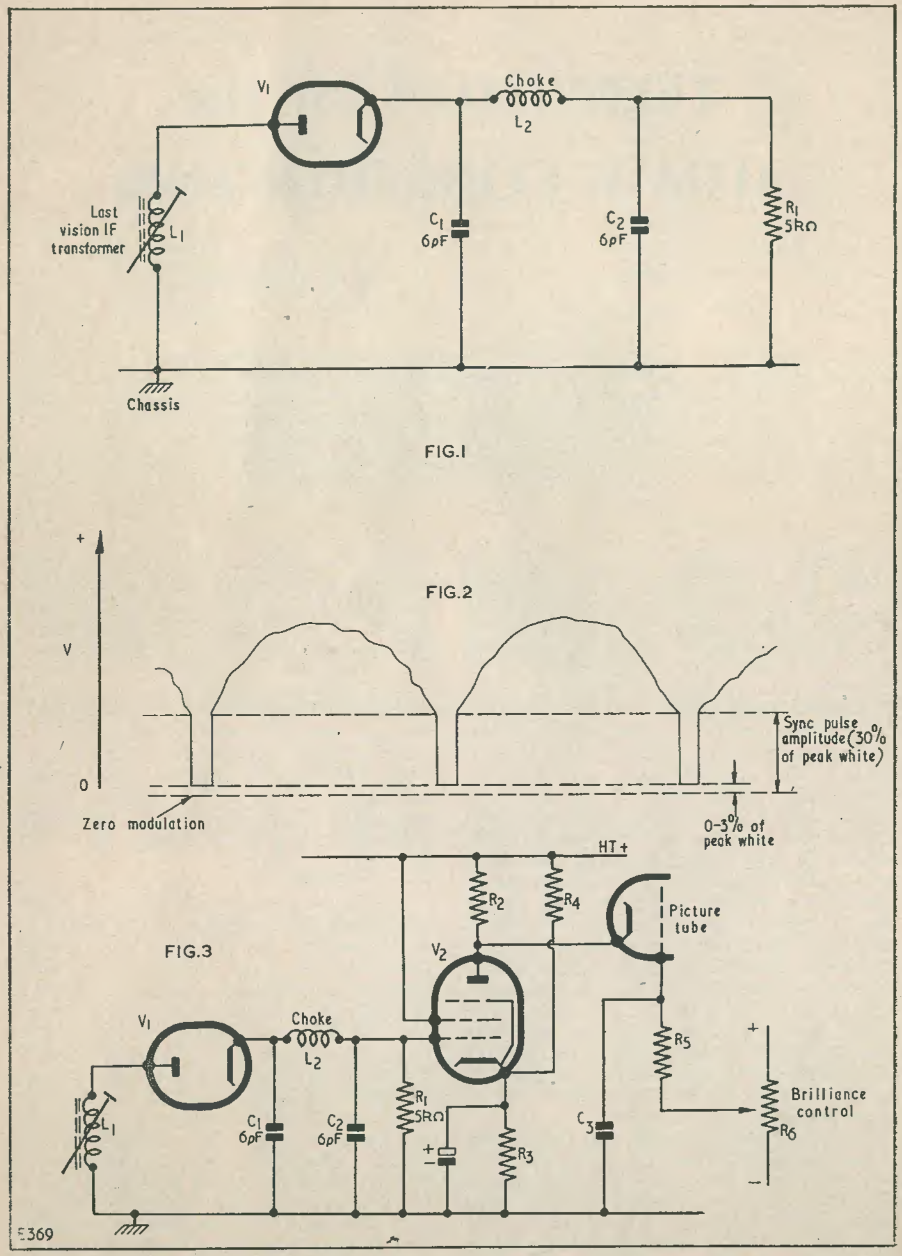


Fig. 1. A typical video detector circuit, showing conventional component values.

Fig. 2. The positive-going waveform appearing across R_1 of Fig. 1. Fig. 3. How a direct coupled video amplifier may be employed to follow the video detector of Fig. 1. The practical disadvantages involved are discussed in the text

vision from the practical point of view, it would, in addition, be to advantage to discuss d.c. coupling in terms of the circuits employed for video detection and amplification in conventional modern television receivers.

Fig. 1 illustrates a typical video detector circuit. The diode shown in this diagram may be a valve or a low-impedance crystal diode. The low value shown for the diode load resistor, R_1, is necessary because it is desirable for the load to be largely resistive at the highest modulation frequency of 3 Mc/s. R_1 requires, in consequence, a value lower than the reactance of the stray and decoupling capacities in the circuit. The choke L_2 and the condensers C_1 and C_2 are merely i.f. decoupling components.

With the diode connected in the manner shown, the rectified i.f. appearing across R_1 will assume the shape illustrated by the waveform of Fig. 2. This diagram shows several cycles of line information together with the synchronising pulse at the end of each line. Since the bottom of each sync pulse corresponds to minimum r.f. (actually 0–3% of peak white amplitude) this part of the waveform is represented by minimum d.c. across R_1. The height of the sync pulse occupies 30% of peak white amplitude, and the sync pulses take up this height in each consecutive cycle. It is important to note that the sync pulses are always a constant part of the waveform; whatever happens during the line scanning cycle, the amplitude of the sync pulses at each end remains unaltered.

of the picture tube. A stage of video amplification is almost always necessary.

A typical video amplifier stage is shown in Fig. 3, this following the video detector circuit of Fig. 1. It will be seen that the diode load of Fig. 1 is coupled *directly* to the grid of the video amplifier, V_2, and that the anode of V_2 is coupled *directly* to the cathode of the picture tube. No coupling condensers are employed.

It so happens that, having connected our diode the way we did in Fig. 1, the detected waveform applied to the grid of V_2 is positive-going with respect to chassis. In other words, maximum signal corresponds to maximum positive potential. (If we turned the diode round we would have exactly the same waveform, but it would be negative-going with respect to chassis.) Since we want to apply the positive-going video waveform from the diode load to a linear part of the I_aV_g curve of V_2, we would have to ensure that this valve had a standing bias which kept the grid at the negative end of this linear part of the curve. Such a bias is applied in Fig. 4, in which diagram the line AB corresponds to the standing potential applied between cathode and grid. Since the incoming signal goes positive, this then causes excursions to be made along the linear part of the valve's curve, and results in the anode waveform shown to the right of the diagram.

Due to the fact that the grid of V_2 (Fig. 3) is connected directly to the video diode load, and thence to chassis, it would be preferable

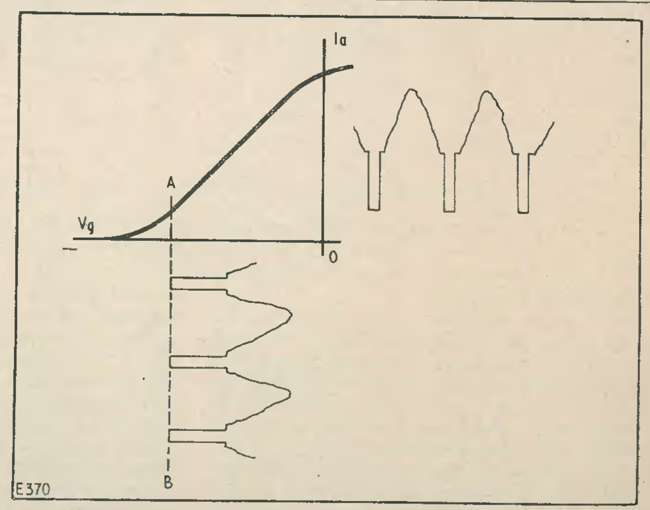


Fig. 4. The I_aV_g curve of a typical video amplifier

It is very rarely that the case occurs in television receivers where sufficient signal appears across the video diode load to enable it to be applied directly to the grid, or cathode, to apply the requisite bias to the cathode of the valve. There is a slight snag in this process, however, because, since the signal is positive-going, the average anode current (and, hence, cathode current) passed by the valve will increase as signal amplitude increases. This will result in the undesirable feature of a bias voltage which changes for different average signal levels. One of the easiest ways of overcoming this problem consists of stabilising the cathode bias voltage as far as is possible by tapping it into a fixed potentiometer connected across the h.t. line. A potentiometer of this type is employed in Fig. 3, and is formed by R_3 and R_4.

liance control such that the black level of the signal corresponds to cut-off level in the tube. In consequence, an amplified copy of the video information across R_1 of Figs. 1 and 3 is reproduced by the tube with as little distortion as it has been found possible to achieve.

An important fact to note about Fig. 5 is that the sync pulses shown in the tube input waveform will always assume the same potential at the cathode regardless of the

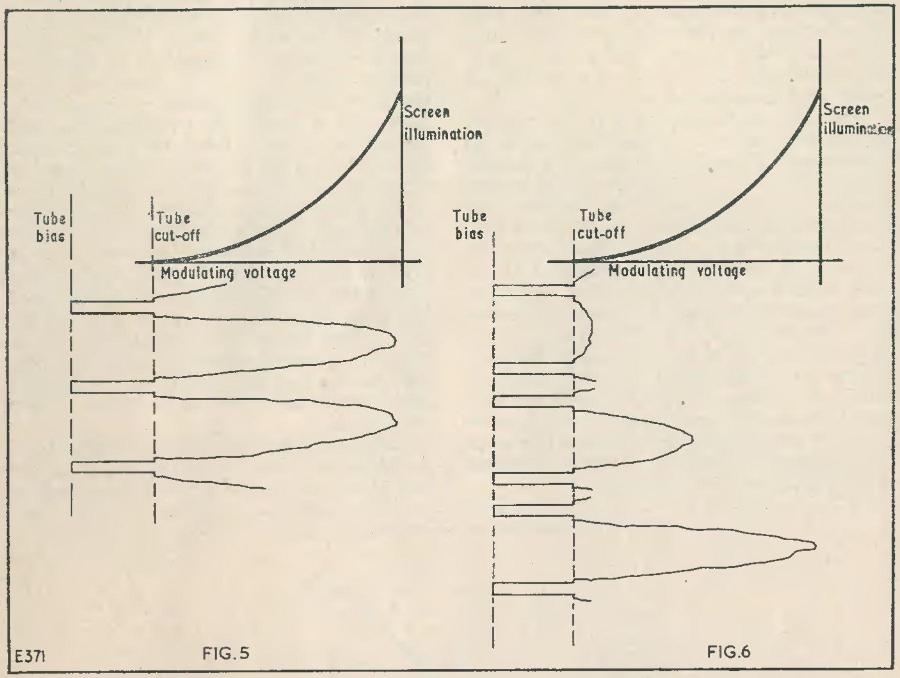


Fig. 5. The waveform applied to the picture tube when direct coupling is employed.

Fig. 6. Direct coupling ensures correct reproduction, even when the signal amplitudes vary as much as do those shown here

The Anode Waveform

The video amplifier anode waveform of Fig. 4 is negative-going, and is therefore of the right polarity to be applied to the cathode of the picture tube. Assuming the grid of the picture tube to have a fixed potential, the screen will then become brighter as the cathode becomes more negative.

The effect is shown pictorially in Fig. 5, in which the video waveform is applied to the modulating-voltage/brightness curve of the tube in something of the same manner as the video detector load voltage was applied to the I_aV_g curve of Fig. 4. As may be seen, the grid bias of the tube is adjusted by the brilliance

amount of video information present in the line scan period. Fig. 6 shows three typical examples of video waveforms, the first having little line information amplitude, the second having average amplitude, and the third having heavy amplitude. In each case the sync pulses occupy the same position with respect to the cut-off point of the tube, and the picture information reproduced is in the same form as it appears across the diode load.

The reason for this consistency is provided, of course, by the direct, or d.c., coupling which exists in the circuit of Fig. 3. If the bottom of the sync pulses were represented by, say, zero volts, and the black level by, say 3 volts across R_1, then the amplified voltages corresponding to these at the picture tube cathode would always be the same, due to the fact that direct coupling had been employed.

Reversing the Diode

Before proceeding to examples of a.c. coupling it would be worth while mentioning, in passing, that a direct-coupled circuit would also be feasible had we decided to start with the diode of Fig. 1 or Fig. 3 connected the other way round. In this case the video voltage applied to the grid of V_2 would have been negative-going, and that at its anode positive-going. The video anode would, in consequence, need to be connected to the grid of the picture tube, and the brilliance control to its cathode.

Arrangements of this type are perfectly practicable, and have been used quite frequently. The only difficulty presented is that, since the video applied to V_2 grid is now negative-going, that valve requires a small standing bias voltage only. As a result it is liable to draw rather a heavy anode and screen-grid current when no transmissions are being received.

A.C. Coupling

Whilst the circuit of Fig. 3 is attractive theoretically, it can raise difficulties in practice. The first of these is that the potential of the picture tube cathode is fixed to that existing at the anode of V_2. This anode potential may be high with respect to chassis, especially during warm-up time before the line output stage has commenced operation. H.T. rail voltages are often markedly higher than normal during this period. The anode voltage of V_2 can, indeed, become equivalent to the h.t. rail voltage itself if the latter appears before the valve warms up. It is possible to visualise a number of other combinations which could also result in a relatively high positive voltage, with respect to chassis, being applied to the picture tube cathode when the circuit of Fig. 3 is used.

Such high voltages may cause considerable difficulties due to the high cathode-heater potentials caused thereby. With normal h.t. rail voltages, these potentials would be quite liable to exceed the manufacturer's recommended maximum. (It is assumed here that the picture tube heater is at chassis potential, the condition which exists in all conventional receivers.) A second, but less important, disadvantage of a high cathode potential is that it necessitates a similarly high first anode potential when tetrode or pentode tubes are used.

In the case of a grid modulated tube, wherein the grid is connected directly to the video output anode, the same difficulties still arise. This is due to the fact that, to achieve a correct picture, the cathode must be held slightly positive to the grid by the brilliance control. The disadvantages of a high cathode potential appear once more.

To overcome these troubles it is usual to operate the cathode of the picture tube at a positive potential lower than that at the video output anode. A typical method of doing this consists of supplying the cathode from a fixed potentiometer connected across the h.t. supply as in Fig. 7. The voltage appearing at the tap in this potentiometer is considerably lower than at the video output anode. The video signal appearing at that anode is then applied to the picture tube cathode via the blocking condenser C_4.

The circuit of Fig. 7 represents an example of a.c. coupling, and the writer has introduced it in this way because it represents the type of a.c. coupling most frequently met in conventional television receivers. However, it should be pointed out that, whenever a purely capacitive coupling is employed anywhere in a video amplifying chain, an a.c. coupling results.

The effect on the video signal caused by an a.c. coupling can be clearly seen by examining the three signal waveforms which were shown in Fig. 6. If these three video signals were coupled to the cathode of the tube via a condenser, their *average* potentials would correspond to the bias applied to this electrode. The resultant effect is illustrated in Fig. 8. In this diagram the three waveforms are shown in relation to the picture tube modulating-voltage/brightness curve. As may be seen, the picture information of the low amplitude signal is applied to an incorrect part of the curve; whilst some of the picture information of the high amplitude signal appears below cut-off, with the result that it does not even appear in the picture at all.

Whilst it is possible to adjust the contrast control of a televisor such that the high-level signal of Fig. 8 gives a reasonably good result, the low-level picture would become even worse, consisting of a grey image with low contrast.

Partial D.C. Coupling

A partial cure for the lack of d.c. coupling shown in Fig. 7 can be found by providing a "fraction" of d.c. coupling, such as is done in Fig. 9. This diagram shows the circuit of Fig. 7 with a resistor connected across the coupling condenser. The values of R_7, R_8 and R_9 in this circuit are arranged such that the same d.c. voltage appears at the tap in the potentiometer across the h.t. supply as was given in Fig. 7.

Assuming the value of the video anode load, R_2, to be negligibly low in comparison with

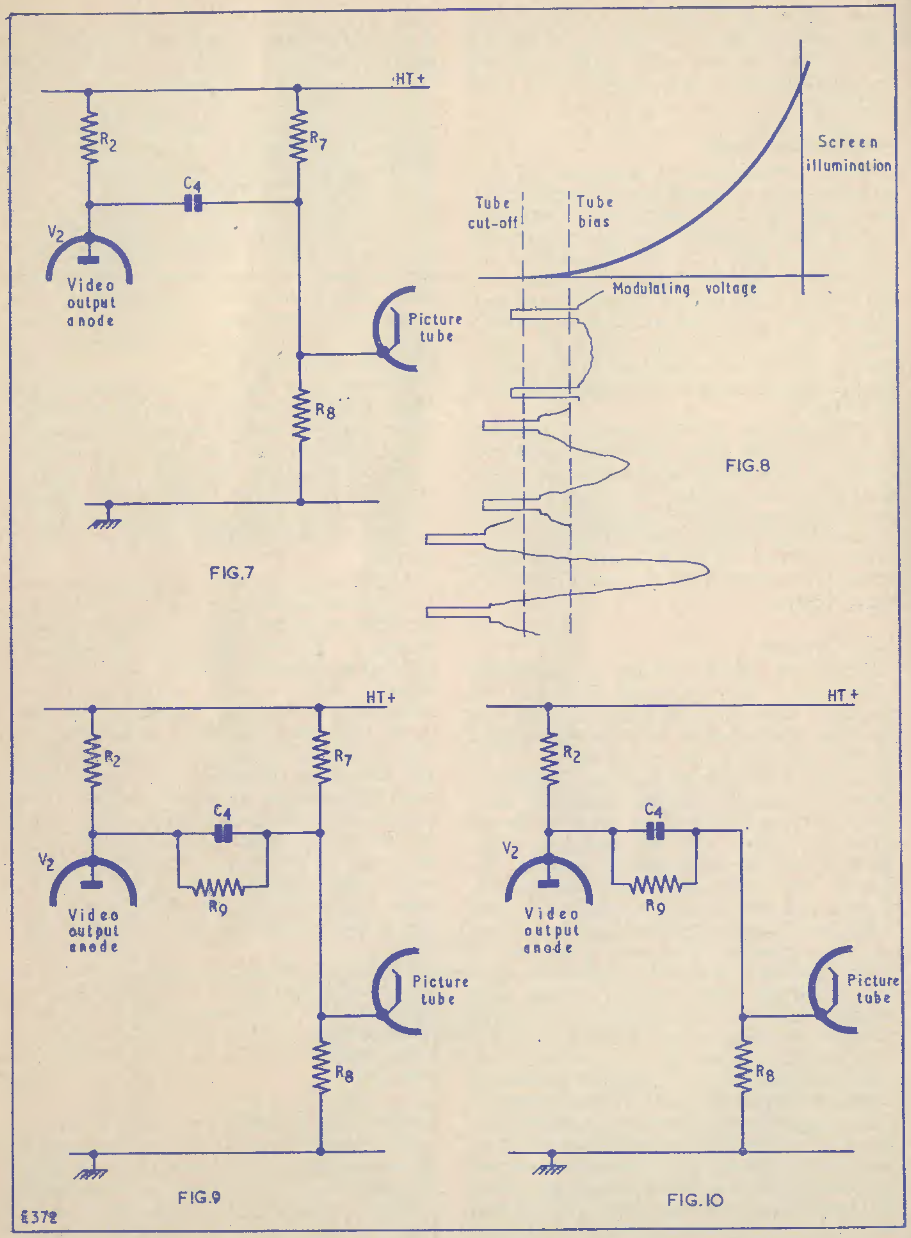


Fig. 7. An a.c. coupling between the video output anode and the tube modulating electrode. Fig. 8. An a.c. coupling results in the average voltage of the input signal becoming equal to the tube bias voltage. Compare this diagram with Fig. 6. Fig. 9. How partial d.c. coupling may be achieved. Fig. 10. A simpler version of Fig. 9, which may be employed in some instances

the other resistors (which would normally have values in the range 75 to 500 kΩ), the "fraction" of d.c. coupling provided by the circuit then becomes equal to the value of R_7 and R_8 in parallel divided by that value plus R_9. Even when this "fraction" is as low as one-third, the resultant picture is still noticeably superior to that given by Fig. 7.

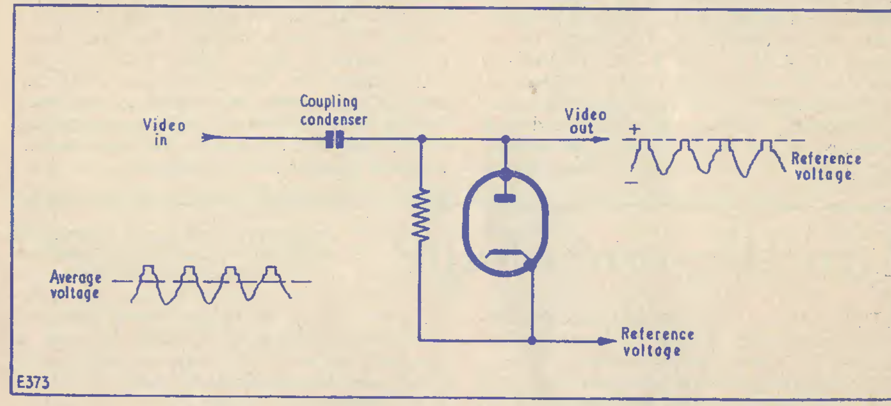


Fig. 11. The basic d.c. re-insertion circuit

An alternative, and simpler, version of Fig. 7 is shown in Fig. 10. When this circuit is employed, care should be taken to ensure that the potential of the potentiometer tap does not rise too high during warm-up time, etc.

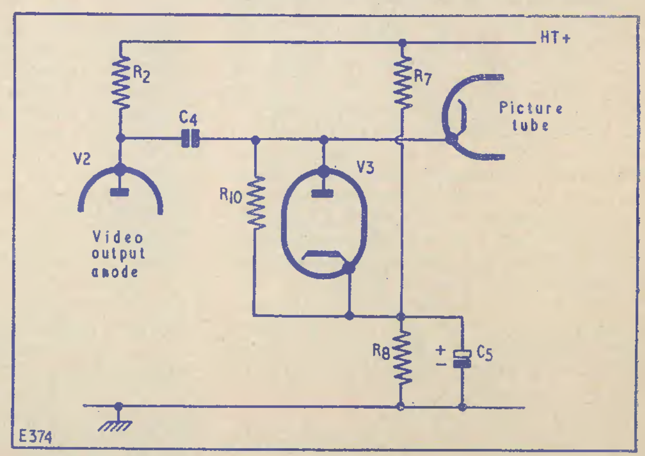


Fig. 12. How d.c. re-insertion may be obtained by modifying the circuit of Fig. 7

D.C. Re-insertion

An alternative, and better, method of ensuring that the correct d.c. video signal is applied to the picture tube is provided by d.c. re-insertion. D.C. re-insertion can be obtained by simply employing a diode after the coupling condenser in the manner shown in Fig. 11. The diode is connected such that it conducts on the bottom of the sync pulses, whereupon the coupling condenser takes up a charge which ensures that the sync pulse bottoms always assume the same potential as that to which the remote electrode of the diode is connected. As a result, the video signal assumes the same relationship to the diode reference voltage as it does to chassis at the video diode load. The d.c. component has, in other words, been "re-inserted" or "restored." The diode of Fig. 11 is connected to provide d.c. re-insertion for a negative-going video signal (sync pulses positive-going).

A d.c. restorer circuit may be added to Fig. 7 by employing the arrangement shown in Fig. 12. The reference voltage is, in this case, supplied by the tap in the potentiometer R_7, R_8, and has a low reactance to chassis via the additional condenser C_5. (The latter may have a value of some 4μF or more.) The time constant of R_{10} and C_4 should be somewhat greater than that of a single frame. Values of 470kΩ and 0.1μF respectively should give quite good results in practice. The diode may be a valve or a high impedance crystal diode, such as the OA71, and it is connected such that it conducts on positive sync pulses. This method of connection is consequently suitable for a cathode modulated picture tube. The presence of the diode will cause the average voltage on the picture tube cathode, when a signal is being received, to drop by some 15 volts or so below that given at the tap into R_7, R_8. If the tube is grid modulated the diode of Fig. 12 should be reversed. The average grid voltage will then increase by some 15 volts above that at the tap into R_7, R_8 for normal signals. This voltage will increase further if the video input is accidentally made higher than normal. Care should be taken to ensure that the changes in potential introduced by the diode do not upset the power supply arrangements of the tube, nor cause any maximum recommended voltages to be exceeded.

Can Anyone Help?

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

N. D. Bonnett, 1 Chorley Old Road, Whittle-le-Woods, Chorley, Lancs, wishes to obtain an ex-R.A.F. Air Radar Fitter's note-book on radar circuits and techniques, and also manuals and circuits on the A.I.Mk.10, A.P.S.57, A.P.Q.9, I.F.F., Gee Mk.2 and Mk.3, and Rebecca Mk.4 and Mk.7.

* * *

L. A. Sellen, 35 Second Avenue, Sheerness, Kent, would like to borrow or buy the circuit and data of the transmitter/receiver TR.3510 with ASV transmitter-receiver system.

* * *

W. E. Thompson, 8 Coventry Road, St. Leonards-on-Sea, Sussex, has a 5FP7 long-persistence c.r.t. fitted in an aluminium housing which contains deflector and focus coils. He wonders if anyone can supply the base connections and data for the 5FP7, details of the deflector coils and connections, and the ampere-turns for the focus coil.

* * *

B. Sneller, "C" Ward, Southern Hospital, Dartford, Kent, would like to beg, borrow, or buy any copies of *The Radio Constructor* (especially June and July 1956 and August 1954) and *Practical Wireless* (especially June to December 1955 and July 1956).

* * *

Ali Bin Roslani, 965 Jalan Lermit, Pontian, Johore, Malaya, would like to obtain, on sale or loan, the service sheet or data on the G.E.C. receiver BC.5541.

* * *

N. Andreadakis, 49 Money Lane, West Drayton, Middlesex, would like to borrow or buy the circuit data for a Pye 9-in t.v. receiver, model unknown, but using the following valves: M.W.22–7 c.r.t., EL38, EL33, ECC34, GZ32, HVR2, EB91, EB34 and EF50.

R. Rossington, 45 Belper Street, Ilkeston' Derbyshire, wishes to buy or borrow a service sheet or the circuit diagram of the Ecophone Commercial receiver (6 valves, 110V mains).

* * *

A. Woolridge, 38 Stannard Road, The Avenue, Norwich, Norfolk, would like to purchase or borrow the circuit of the Denco T.M.1099 t.v. receiver.

* * *

W. W. Morris, 90 Middleton Road, Morden, Surrey, would like to buy or borrow the circuit of the Alba receiver model 472.

* * *

F. Collinge, 6 Harton Close, Shaw, Oldham, Lancs, would be grateful for information on the ex-A.M. oscillator, type 37. Details of the present oscillator and amplifier frequencies and of conversion to an amateur bands transmitter would be most helpful.

* * *

C. Moby, 2 New Cottages, Cliftons Lane, Reigate Heath, Reigate, Surrey, wishes to obtain data on the Delco vibrator type 5041245, and to know of any equivalent.

* * *

P. L. Grieveson, 46 Clarence Crescent, Sidcup, Kent, is trying to obtain the circuit for a power pack suitable for the 1124 and 1125 receivers.

* * *

H. G. Swan, 452 Wortley Road, Rotherham, Yorks, would like to contact anyone who has a Soundmaster tape recorder, with a view to comparing results and exchanging ideas for improvements. He would also like to contact anyone who has built the Magna-View (Holme Moss) with Valradio converter.

Working from a Circuit Diagram

by V. T. ROLFE

There are a large number of home constructors who have built up radios—or even t.v. sets—for themselves, either from a kit of parts, or from a wiring diagram, but who would be diffident about constructing even a two-stage a.f. amplifier from a circuit diagram only. It is therefore thought that the following notes may be of interest to constructors who have reached this point and wish to proceed a little further with this fascinating hobby.

For simplicity, the procedure for converting a circuit diagram to the actual piece of equipment has been broken down into a number of discreet steps, and if this "drill" is followed, no trouble should be experienced with the vast majority of circuits.

It is as well, of course, to start with a simple circuit such as a two-stage amplifier. The beginner is warned against trying to jump a step by, for instance, cutting his chassis before assembling all the components. He will usually find that there is insufficient space for everything!

First Stage

Starting with the circuit diagram, the first stage is to check that all the necessary information is given. There are certain details of each component which must be known, and these may be summarised as follows.

(a) *Valves*. Type numbers—these should be shown on the circuit. Type of base used —this can be obtained from the valve manufacturer's data. Most valve manufacturers publish small pocket books or broadsheets, which will, in general, give sufficient information for the home constructor's purposes. The pin connections will be given, and it is a good idea to write these opposite the appropriate electrodes on the circuit diagram.

(b) *Resistors*. In addition to the resistance value, it is also necessary to know the tolerance and the wattage rating. Where the tolerance is not quoted, it can generally be assumed to be ±20%. Where the wattage rating is not given it is generally ¼W, but it is as well to check by calculation if in doubt. The bias resistor of the output stage, and any voltage dividing networks across the h.t. supply, should certainly be checked. It is always as well to have a safety factor, so if the dissipation in a resistor works out to ½W exactly, it is advisable to use a 1W resistor, as due to tolerances on various components the dissipation could be slightly higher than calculated. The electrode currents of the valves can again be found from the valve data.

(c) *Capacitors*. The value of these must, of course, be known, and also the voltage rating. Providing this is higher than the voltage applied to the capacitor when in circuit, no trouble should be experienced, but it is uneconomical to use a 450V component where a 50V one would suffice. Some calculation may be necessary to find the voltages, but in most cases it is usual to specify the full h.t. voltage, except in the case of electrolytics used for h.t. smoothing and cathode decoupling. In the latter case the voltage can be calculated, and again a safety margin should be allowed. Electrolytics connected to the h.t. line should be capable of withstanding a voltage of 1.4 times the r.m.s. input to the rectifier (i.e. approx. 350V for a 250V input, or 500V for a 350V input). In some cases it may also be important to know the type of construction used (paper, ceramic, mica, etc.).

(d) *Transformers*. In the case of the mains transformer, the voltage and current ratings of the various windings must be known. The voltages are usually given, and the currents—if not shown—can be readily calculated from the valve data, etc.

In the case of the output transformer, the most important factors are the ratio (or primary impedance) and the current rating of the primary. Circuits for high quality amplifiers will usually specify the make and type number of the transformer, but for other cases, remember that the primary impedance and turns ratio are related by the formula:

$$\text{turns ratio} = \frac{\text{primary impedance}}{\text{speaker impedance}}$$

$$= \sqrt{\frac{\text{optimum load}}{\text{speaker impedance}}}$$

The current rating required will be the anode current of the output valve under working conditions.

The circuit in question will probably be in a magazine, or book of some description, and before proceeding any further it is as well to prepare a large pencil drawing of the circuit. On this should be entered all the relevant information as mentioned above, the pin connections of valves, resistance tolerance and wattage of resistors, and capacity and working voltage of capacitors. Whilst transferring these values to the circuit diagram they should also be added to the shopping list. (Don't forget the valve bases!)

Second Stage

The next stage is to assemble all the components together to try and arrive at a layout. It is fatal to attempt this without all the components to hand, as this inevitably ends with a lack of space on the chassis for some component or other.

Unless there is a good reason for doing otherwise, the beginner is well advised not to try to pack everything into as small a space as possible, as hum and instability are more likely to occur with cramped layouts.

To avoid hum, the power components should be mounted at one end of the chassis away from the other components. The smoothing capacitors should not, however, be in such a position that they are heated up by the mains transformer.

To avoid instability, work to a "signal-path." Starting from one end, plan the position of the valves in order from input to output along the chassis (V_1, V_2, V_3, etc.). At the moment, of course, there is no chassis, and a large sheet of drawing paper spread on the bench will serve our purpose.

Use the valve bases to indicate the positions of the valves, and fit the other components in accordingly. Remember input leads to the grids should be kept as short as possible, and it is a good idea to note which are the grid and anode pins on the valve bases and orientate them accordingly.

It is worth spending some time juggling with components in this way, as it may avoid a lot of disappointment later on. Some consideration should be given to what type of construction is to be used, e.g., whether to mount the components on tag-boards, or wire direct to the valve bases.

In the former case, some idea of how many contacts will be required on each tag strip is necessary, and it is a good plan to sketch out various arrangements, taking care to avoid putting input and output circuits adjacent on the boards. A circuit and a tag board arrangement of the circuit are shown in Fig. 1. In this case the screen grid components have been used to separate input and output circuits.

Tag board assembly gives a very clean layout to a unit, although it takes up rather more room. If grid or anode stoppers are used in the circuit, these should be connected directly to the pins, and not wired on the tag boards.

The alternative method is to wire directly to the valve pins. The main difficulty here is found to be the h.t. line, which must be fairly accessible to each valve base. As there is not always a spare valve base pin which can be used as an h.t. point (I.C.'s must *not* be used), it is usually necessary to run a tag strip down the chassis, and use various tags on this.

With this method of construction, stray capacitances and lead inductance can be kept to a minimum, and it is, therefore, particularly necessary for i.f. and r.f. circuits, especially at v.h.f. Some consideration should be given to the provision of earthing points. In the case of audio circuits, it is preferable to connect all earth returns to a bus bar which is only connected to the chassis at one point. This will reduce hum due to chassis currents to a minimum.

With r.f. circuits, however, earth wires should be kept as short as possible to avoid stray inductance, and the best plan is to provide an earthing tag for each stage, usually on one of the screws holding the valve base in position.

Having finally decided on the layout, a sketch should be made. This can most easily be done by marking out the positions of components on the drawing paper. The positions of all the components need not be marked; but whenever holes have to be made in the chassis, the position must be marked fairly accurately. Wherever wires have to pass down through the chassis, remember to mark a ⅛in hole on the drawing.

Dimensions should be standardised as far as possible—the valves mounted in one line, preferably equally spaced. The control shafts should also be mounted in one line, and equally spaced, 2in being a fairly standard dimension for the spacing.

Third Stage

The next step is the chassis. This will depend on what metal-working facilities are available. The more the constructor can do himself the cheaper the finished article will be, and it is, therefore, advisable to obtain a few drills and chassis cutters if much work of this kind is envisaged. The chassis can be bought already folded, and the remaining work is quite simple. The drills required will be:

No. 32 for 6BA screws (used for valve bases, etc.)

No. 26 for 4BA screws (heavier components, e.g. transformers, chokes)

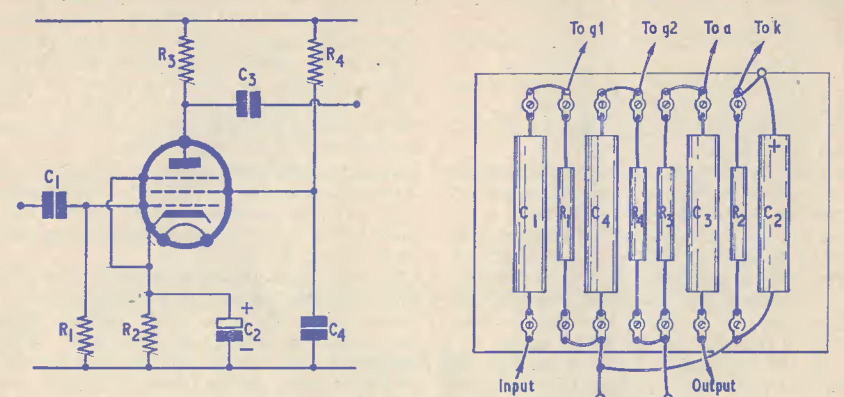


FIG. 1
Circuit and corresponding tag board arrangement

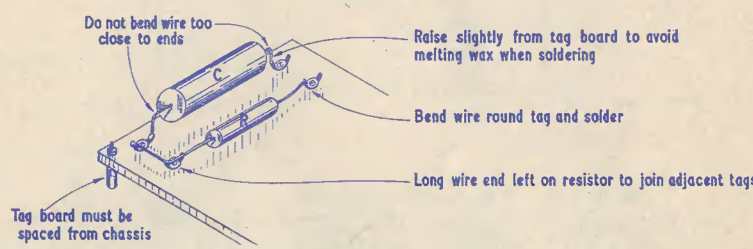


FIG. 2
Detail of tag board showing how to mount resistor and capacitor

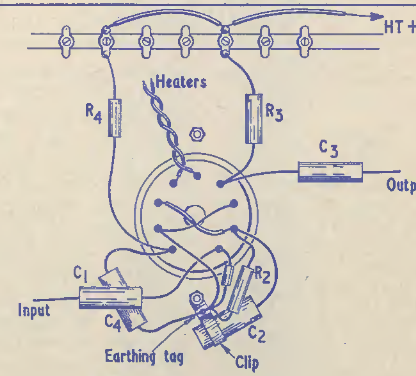


FIG. 3
Layout using direct wiring
(Circuit as in Fig. 1)

$\frac{1}{4}$in, useful for holes to pass wiring through

$\frac{3}{8}$in, for volume controls (and also chassis cutters).

The sizes required for the various holes should be marked on the chassis drawing, and the necessary points should then be marked out on the chassis.

To simplify working, all holes of the same size should be drilled at once, starting with the smallest. This allows "pilot" holes to be drilled for the $\frac{3}{8}$in holes, and the larger drill can then be used to remove the burr on the underside of the smaller ones without marking the chassis, as is the case if a file is used for this purpose. A file must, however, be used to remove the burr on the larger holes.

If all the mechanical work is carried out first in this way, much time can be saved, and the somewhat precarious business of drilling holes in a half-completed chassis avoided.

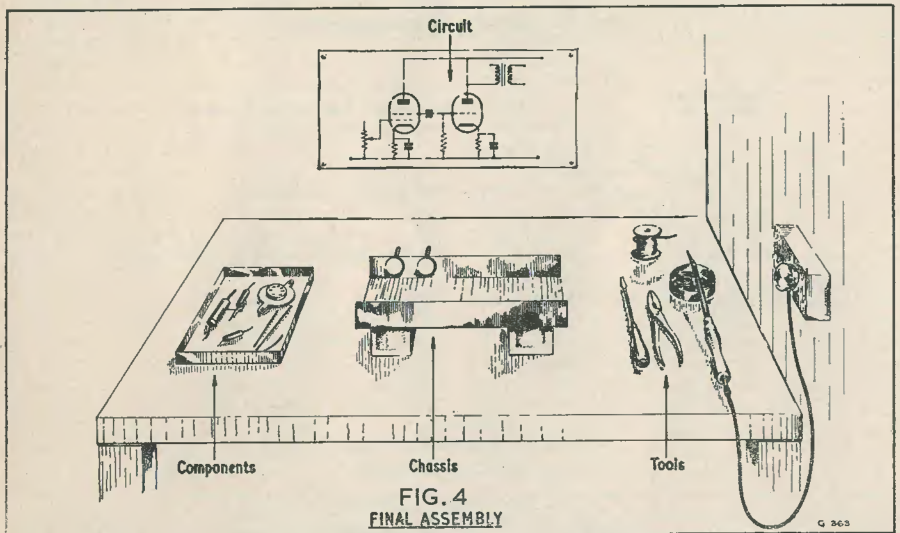


FIG. 4
FINAL ASSEMBLY

Fourth Stage

We are now ready to assemble the unit. All drills, chassis cutters and files may be removed from the bench and loose pieces of metal brushed off. The chassis can then be placed in the centre of the working area with tools on the right and components on the left. The pencil drawing of the circuit should be in a prominent position on the wall at the back of the bench. It is as well to have a small tray to keep components in. They can then be readily picked out, and are not in danger of being crushed under a heavy transformer.

If a similar tray can be provided for the tools, so much the better. A ball-point pen should be included amongst the tools.

The large components should be mounted first, then the valve bases, tag strips, etc. Grommets are fitted to the lead-through holes. During this time the soldering iron may be warming up ready for the wiring up to begin. When this part of the construction is complete, it is as well to check that every hole in the chassis is being used; a blank hole may indicate a mistake somewhere!

Start wiring the heater circuit first. The pin connections should be on the circuit diagram, so it won't be necessary to hunt out that valve book! Use twin twisted wires and press down close to the chassis.

Once this is completed the remainder of the wiring can be tackled. It is a good scheme to tackle one stage at a time, working either from input to output or vice-versa. Work systematically, wiring up the various electrodes in turn. Before leaving a stage it is as well to check quickly round the valve pins in order, seeing that each is connected to the correct point in the circuit.

In some cases, where tag boards are to be used, it may be easier to wire the components to these before mounting them in the chassis.

As each stage is wired up, it should be inked in on the pencil circuit. This provides a useful check against the possibility of an error in the wiring.

Finally connect up all h.t. feed points, and the work is complete. Before switching on, it is just as well to make a resistance check between h.t. + and earth, as any short in this circuit might produce spectacular results!

To summarise, the "drill" is as follows:

(1) Draw the circuit out clearly in pencil, marking in all relevant data:—

(*a*) *Valves*: types, bases, pin connections

(*b*) *Resistors*: resistance, tolerance, wattage

(*c*) *Capacitors*: capacitance and voltage rating (also type in some cases).

(2) Prepare a chassis drawing from the assembled components.

(3) From the chassis drawing, prepare the chassis.

(4) (*a*) Mount all components

(*b*) Wire up, from circuit diagram, "inking in" connections after they have been made.

MUSICAL ELECTRONICS with a HAWAIIAN GUITAR

Additional Notes

AN OPTIONAL REFINEMENT *by* **G. F. WEBSTER**

MANY READERS WILL WELCOME THE IDEA of a compensator that will bring the output under closer control and allow more freedom for experiments, even at the cost of a little extra work. This can be done by drilling and tapping six holes in the top of the coil pole piece to take six small iron grub screws, one under each string.

The coil pole piece is $2\frac{1}{8}$-in by $\frac{1}{4}$-in and made up from two pieces $\frac{1}{8}$-in thick, riveted or screwed but countersunk to let the coil bobbin slip on. Use three rivets and place them $\frac{1}{2}$-in below the top of the pole piece to clear the grub screws. Make sure they are firm. Drill six tapping holes on the centre line formed by the two pieces and space them $\frac{3}{8}$-in apart, starting $\frac{1}{8}$-in from one end to finish $\frac{1}{8}$-in from the other end. Make the holes $\frac{3}{8}$-in deep and the correct drill size for tapping to make a tight fit. The iron grub screws should not be more than $\frac{3}{8}$-in in length, and the tapped holes should keep them tight in all positions. Screw them in until only one-sixteenth of an inch is showing above the pole piece, then assemble the unit. It will now be necessary, when setting the completed unit into the recess, to adjust the fixing bolts so that the bridge pole is up and the coil pole is down (maximum gap position). When the strings are in position the flux will be concentrated in the six areas between the strings and the grub screws. The gap in each is now three-sixteenths of an inch. Individual adjustment is completed with the amplifier connected (a special amplifier for the guitar will be described later). Readers who can borrow or make an oscilloscope will find much interest in the waveforms produced, and incidentally be able to arrange perfect tuning. For similar experiments the writer once made a simple projection oscilloscope covering only sound frequencies which produced waveforms 10ft by 4ft and supplied a mine of information.

If iron bolts are used to clamp the pole pieces to the magnets, they will act as keepers and short circuit the magnetic flux, so use brass or stainless steel or any other non-magnetic metal for these and the adjusting bolts.

"Eclipse" Magnets

We are informed by James Neill & Co. (Sheffield) Ltd., the manufacturers of the magnets used in this instrument, that, contrary to the statement made in paragraph 2 of page 46, August 1956 issue, they are unable to supply direct to readers, although they are always prepared to put readers in touch with a local tool dealer who can supply his requirements. As previously stated, the magnets—and all other "Eclipse" products—are available from all good tool stores.

A CONSTRUCTOR VISITS THE

1956 NATIONAL RADIO SHOW

WHENEVER ONE APPROACHES THE RADIO Show via the subway from Earl's Court Tube Station, one always experiences a pleasant feeling of anticipation. This is due not only to the fact that one is normally in company with a crowd of people who are similarly intent on seeing the show, but also because the walls of the subway are plastered, to the exclusion of everything else, with radio manufacturers' posters. So far as these posters are concerned, the drill seems to be for one manufacturer to take over a long and unbroken expanse of wall space, and to use it to display the same poster over and over again. Because of this, one walks past the same bold, Dayglo-ing message dozens of times before reaching the final escalator. There, the corset advertisements, so familiar to the London Tube traveller, are replaced by the repetitive legend: "Fine Sets these Fergusons"; this being expanded along the sides of the escalator to approximately the 25th power.

However, all this is to the good, as it emphasises the lively and highly competitive nature of the British radio industry. Inside the show, the writer's first call is always to the Press Office, to "sign on" and to pick up the latest news from the R.I.C. Press staff. Signing on is sometimes an interesting operation. This year the writer's signature followed half a dozen long and indecipherable names from "Radio Moscow"; these representing the members of one of the many delegations visiting the show.

New Trends

Of the show itself, perhaps the best comment would be to say that, whilst no outstanding developments were to be seen, there was evidence of significant advance in design technique within the framework of current electronic requirements.

Neverthless, there was one rather notable difference from last year's show, this being apparent in the field of transistors. At last year's show there were few exhibits employing transistors. Indeed, the writer feels that he would be correct in saying that the only transistor receiver to be seen then was the prototype of the "Transistorette" on the Standard Telephones and Cables stand, this being the set pioneered for the home-constructor by this magazine. This year there were several transistor receivers, although few employed transistors throughout. Most sets used transistors for a.f. and output stages, retaining valves for r.f. and i.f. amplification. An exception was the Pam Model 710, which is an all-transistor portable with normal tuning on medium-waves and single station pre-set tuning (to the Light Programme on 1,500 metres) on long-waves. This receiver employs eight transistors as follows: frequency-changer, local oscillator, two i.f. amplifiers, detector, a.f. driver, and push-pull (Class B) output stage. The latter is directly coupled to the high impedance voice coil of the speaker. The i.f. is 315 kc/s and a.g.c. is applied back to the first i.f. amplifier. A ferrite frame is employed and the whole receiver consumes 35mA from a 6 volt power supply. The latter is intended to be four U.2 batteries in series. The makers claim that, if the set is used for a period of four hours a day, the cost of battery replacement will be only 2s. 4d. (for a new set of batteries) after six months.

Philco showed a battery operated transistorised record player which takes advantage of the low current consumption of its amplifier by making it perform functions outside that of normal record reproduction. This amplifier can be used in conjunction with a microphone as a baby alarm or intercom. Alternatively, it can be made to operate as an a.f. oscillator/amplifier for morse practice and similar functions.

Printed circuits are becoming increasingly more common in small assemblies intended for domestic equipment. For complete chassis, however, reliance is still placed, with only a small number of exceptions, on conventional wiring. It seems possible that printed circuitry will not be taken up so extensively in this country for complete chassis as it has been in the States; and it may even be that British manufacturers might carry on to module assemblies before embarking on the more complicated printed panels. Where printed circuits provide obvious advantages, as in filter units, switch assemblies, and the like, they are used extensively. This is mainly due to the fact that they obviate the considerable number of individual operations needed in the manufacture of such items. Printed circuits are also being used in a few converters and audio pre-amplifiers. There was one printed circuit television receiver to be seen, nevertheless, and this was exhibited by Pam. The set is the model 500, and nearly all its circuit is printed. The only part of the chassis not employing printed circuitry was the line output stage. The small number of connections required here, together with the wide insulation spacing necessitated by high pulse voltages may make the advantages of printed circuitry problematic in applications of this type.

Television

Band III is now with us, and most of the original publicity with which it was introduced has died away. This point was demonstrated by a lack of interest in Band III converters, of which only a small number were exhibited. All television sets shown were, of course, fitted with turret tuners or similar front ends capable of giving reception of Band I and Band III signals.

Whilst the r.f. circuits of television sets are becoming more or less standardised, development is taking place elsewhere. Electrostatic instead of electromagnetic focusing is becoming employed more and more. Mullard are now in production with 14in electrostatic tubes, whilst similar tubes are being manufactured by Brimar and Emitron. The electrostatic arrangement has the advantage of obviating the rather cumbersome magnetic focusing arrangements which have been employed to date. All that is required with the electrostatic tube is to apply the requisite voltage (easily obtainable from the receiver power circuits) to the focusing electrode of the tube.

Aluminised tubes are being employed more and more. From the point of view of presentation one manufacturer (Murphy) has, for some time, been mounting the tube such that the whole of the front is seen by the viewer. The picture is then framed by an apparent black border provided by the edge of the glass.

New manufacturing techniques, apart from printed circuitry, are also noticeable. In the new Ferguson 306 and 308 receivers a vertical chassis is employed, this being mounted at right angles to the neck of the tube. As a result, all components are fitted on a single uni-planar chassis, with obvious reduction in cost. This method of assembly also increases accessibility of components for servicing.

Audio

How hi is *your* fi? This question becomes increasingly more difficult to answer as manufacturers continue to improve their audio products. A number of demonstration rooms were given over to high fidelity demonstrations. Whether the conditions were as good as those given at the Audio Fair is difficult to determine.

Of *new* developments, the most noteworthy is the Ionophone tweeter which is now being made by Plessey. This has no moving parts at all, the sound being generated by an ionised volume of air coupled into a horn. Electrostatic tweeters (Goodmans and W.B.) were also being demonstrated.

What is called 3D sound was evident from several manufacturers. The main idea is to use three reproducing speakers mounted in a corner, one directed on the listener and the others on to the corner walls. The result is that a large apparent sound source is obtained, partly direct and partly reflected from the walls. This method of reproduction should not be confused with stereophonic reproduction (exhibited by H.M.V.).

V.H.F. helps to make the public interested in better quality, even if only because it enables interference-free reception to be obtained. Most receivers (apart from low-priced sets and portables) which covered medium and long-waves also carried a v.h.f. band.

Home-constructor Interests

Specialised home-constructor interests do not usually take up a lot of space at the show, for obvious reasons. Nevertheless, those firms which have always taken a keen interest in home-constructor requirements continued to maintain their contact. Mullard, in particular, were to the fore in this particular field, devoting an entire demonstration room to the home-constructor. The demonstration room was staffed by engineers ready to answer constructors' queries, and a large number of Mullard home-constructor amplifiers and transistor devices were on view. A transistor measurement panel, for checking transistor performance, was also shown.

G.E.C. demonstrated their "912-Plus" amplifier, this being the latest high fidelity amplifier developed by this company for the home-constructor. The "912-Plus" has an output of 12 watts.

Thirty years ago Cossor introduced radio receivers in kit form for home-construction. Much water has flown under the electronic bridge since that time, and it is interesting to note that Cossor Instruments Ltd. is now

(*continued on page 193*)

BOOK REVIEWS

CORRECTING TELEVISION PICTURE FAULTS. By John Cura and Leonard Stanley. 69 + x pages, 150 illustrations. Published for *Wireless World* by Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1. Price 3s. 6d., postage 3d.

This latest edition of a well-known handbook is revised and enlarged. The considerable number of actual screen photographs illustrate typical fault conditions in a way that is extremely clear, and helpful for diagnosing almost any cause of picture deformity likely to be encountered.

The text describing these effects is brief but factual. Phrased mainly in non-technical language for the guidance of the majority of viewers, the booklet is clearly intended to appeal chiefly to the layman, but additional notes in italics are provided for the technically-minded viewer and service engineer.

The eighteen sections of the book cover such conditions as picture positioning, interference, magnetic distortion, use and interpretation of Test Cards, and faults due to control settings, scanning coils, timebase circuits, and miscellaneous causes. Control faults are further divided into nine sections dealing with brightness, contrast, focusing, line and frame hold and linearity, etc. A good index, and a glossary of terms used for receiver controls are included. Without a doubt—good value for money.

PUBLIC ADDRESS AND SOUND DISTRIBUTION HANDBOOK. Edited by Alex. J. Walker. 160 pages, 145 diagrams and illustrations. Published by George Newnes Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 21s.

There is something more in public address than rigging up a microphone, amplifier and speaker to make oneself heard above other noises. The fact that a whole book can be devoted to the subject and then only skim the cream off it gives some indication of what the sound distribution engineer needs to consider in planning, installing and maintaining electronic sound amplification equipment.

This book consists of five chapters. The first one discusses general principles of sound amplification, commencing with some basic elements and leading on to considerations of typical amplifier circuits. Some information is given on speaker matching, negative feedback, cathode followers, volume expansion and compression, etc.

The second chapter is devoted to equipment associated with sound systems, such as microphones, pick-ups, mixers, pre-amplifiers, power supplies and so on. In the third chapter there is some useful information on pre-installation surveying and the installation of equipment. This covers power output requirements, positioning of equipment, wiring and cabling, use of Post Office lines, testing, operating, etc. The licences and insurance aspect is well described.

The particular requirements of special installations occupy the fourth chapter, and here are described the diversities between systems for lecture halls, skating rinks, hospitals, swimming baths, sports stadiums and cinemas, to mention a few. The last chapter has information on routine maintenance, wiring tests, the tracing and correction of faults, and particularly mentions faults that commonly occur in amplifiers.

Three appendices and an index round off what should be a useful book from which to learn, and one that sound engineers could find extremely helpful as a reference. It is not known whether the scarcity of information on mobile amplifier systems is an omission by design or accident, but the writer of this note certainly did not bewail the fact that little is said of what to him is nothing more than a distracting and annoying atrocity.

PLASTICS ENGINEERING. By F. T. Barwell, PH.D., D.I.C., WH.SCH., B.SC. (ENG.), M.I.MECH.E., A.M.I.E.E. 44 pages. 12 illustrations. Published by Cleaver-Hume Press Ltd., 31 Wright's Lane, Kensington, London, W.8. Price 3s. 6d.

This cloth-covered booklet is a monograph which forms Chapter XIX of Modern Workshop Technology. In a relatively small number of pages Dr. Barwell has contrived to give a clear but interestingly written survey of the several polymeric materials used in industry today, not the least of which are the electrical and electronic crafts. The text is mainly devoted to the structure, manufacture and testing of plastics, and their uses for particular purposes. There are several very informative Tables concerning the properties of different materials.

RADIO RESEARCH 1955. Report of the Director of Radio Research, Department of Scientific and Industrial Research. 56 pages. Obtainable from Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2. Price 3s. 6d., postage 3d.

Those who like reading official documents will find considerable interest in this Report of the work carried out by the team of scientists at Slough and at certain Universities. In his statement to the Privy Council, Sir Noel Ashbridge, Chairman of the Board, says enough in his short summary to whet one's appetite for what follows in the body of the Report. The field of investigation is indeed wide, for the scope of research is not confined to radiocommunications as a means of conveying intelligence from one point to another. Much has been done to improve upon navigational aids and direction finding, and investigation into materials for radio purposes forms only one branch of study. Semi-conductors and ferrites, it seems, continue to provide ample food for thought.

MECHANICAL DESIGN FOR ELECTRONIC ENGINEERS. By R. H. Garner, B.SC. (ENG.), A.M.I.E.E., A.M.I.MECH.E., A.F.R.AE.S. A.M.I.P.E., A.M.BRIT. R.E. 223 pages, 140 illustrations. Published by George Newnes Ltd., Town House, Southampton Street, Strand, London, W.C.2. Price 25. 0d.

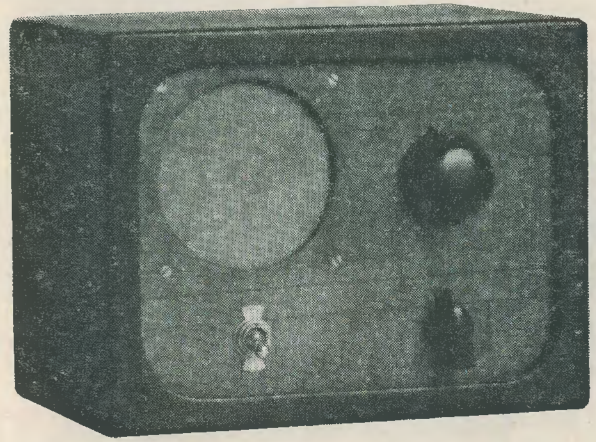
It is impossible to describe fully all that is written in this book on a subject to which the layman may not give much thought; it is nevertheless of importance to industry in both design and manufacture. There have been great strides made in recent years on several aspects of electronic equipment design, and the collection of information in this book reveals many of them, and their import.

The seventeen chapters describe standard racks and apparatus cabinets, chassis and sub-panel construction, accessibility, ventilation and cooling, sheet-metal working, finishing processes, printed circuits, printed and potted components, soldering, brazing, labelling of panels and cables, coil winding, etc. These and other headings are divided into sections too numerous to mention, and although some of the sub-headings receive only brief attention there is no denying the considerable amount of data presented in this book.

The illustrations and diagrams are well in keeping with the clear production of the book. The fact that nearly a hundred firms and organisations have contributed data of some sort or another to the author gives the reader the impression that no pains have been spared to present factual, up-to-date and authoritative information. This amount of research no doubt influences the price of the book, but even so it would not be expensive to those who have need of such a reference.

W. E. THOMPSON

The COMPACT UNIVERSAL TWO



by **F. G. RAYER**

THE CONSTRUCTOR WHO WISHES TO BUILD an inexpensive and straightforward receiver, for 110/250V a.c./d.c. supplies, should find this circuit ideal. Though size has been kept down, no special midget components are required, and valves and other components may readily be obtained, new or surplus. If the precautions mentioned are taken, and the receiver fitted in a wooden cabinet, it will be quite safe. Metal cabinets should not be used because the a.c./d.c. circuit requires that the chassis be connected to one mains lead.

Two pentodes in a 2-valve circuit, with reaction, provide quite a high degree of sensitivity. With a short "throw out" aerial consisting of a few feet of insulated wire, the local stations can be powerfully received. With a better aerial, more distant stations come within range. No earth is required.

The circuit is shown in Fig. 1, and none of the component values are very critical. The two 2MΩ resistors, and 75kΩ (75,000 ohm) and 0.25MΩ resistors may be $\frac{1}{3}$ or $\frac{1}{2}$ watt components. The 440Ω bias resistor should be a 1 watt component, and the 5kΩ resistor a $\frac{1}{2}$ or 1 watt type. The mains dropper resistor is 0.3 amp wire-wound with two adjustable clips, with a total value of 800Ω.

The reaction condenser is of 100pF to 300pF capacity. An air-spaced tuning condenser is recommended; but is by no means essential as the solid dielectric type will be satisfactory. The 0.01 μF coupling condenser should be of the mica type, and the 50pF aerial condenser should be mica or rated at 750V, since it also serves to keep mains voltages out of the aerial. For smoothing, an 8 plus 8μF block can be used, or two separate 8μF condensers, or an 8 plus 16μF condenser. The 50μF bias condenser is of the 50 volts working type.

For operation on up to 250V, a 60mA 250V metal rectifier, such as the Brimar DRM1B or DRM2B, is required. In the event of the receiver only being used on d.c. mains, this rectifier can be omitted, if care is taken to see that the receiver is always plugged in with the correct polarity (negative to chassis). When the rectifier is employed, the set may, of course, be used also with d.c. mains, without modification, and the rectifier protects the smoothing condensers against damage such as would arise if the receiver were plugged in with wrong polarity (positive to chassis). When using a.c. mains, it is worth while connecting the mains plug in such a way that the "negative" mains lead goes to chassis (via switch). The chassis is then not normally at a high voltage above earth. A double-pole mains switch is used, so that the receiver is totally disconnected in the "off" position.

A small 60mA smoothing choke is used, and a 200–550 metres coil, with reaction. Any standard medium wave or dual-wave coil, with reaction, should be suitable.

The rectifier is supported on metal strips, no insulation being required as the centre mounting rod is normally isolated from the rectifier elements. It *must* be wired in the correct polarity, positive going to smoothing choke.

When the dropper is wired, care should be taken to connect up correctly. The bottom clip goes to the output valve heater; the inner clip goes to the rectifier; the top clip is wired to the switch. Bolted connections are necessary as soldering would be unsatisfactory here.

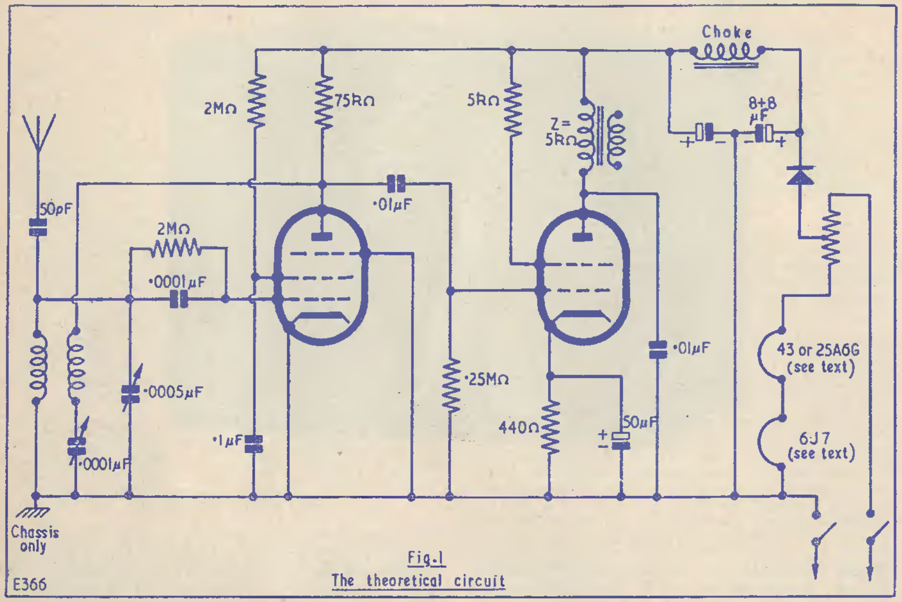


Fig.1 The theoretical circuit

The grid cap lead of the detector valve should be as short as possible, or hum may be caused. The length of the connection from 2MΩ resistor and 100pF condenser to the tuning condenser is not critical, however, as hum frequencies will be bypassed by the coil winding. If the tuning condenser is not bolted to the chassis, a lead must be taken from the moving plates tag to chassis. The condenser was further supported, at the top, by means of a bracket.

Other connections will become apparent from Fig. 3, and points marked MC are bolted to the chassis. Two leads pass up through a hole to the reaction winding. If no reaction is obtained, connections to this winding should be reversed. Coil connections are completed by taking the earth tag to chassis, and grid tag to the fixed plates of the tuning condenser. The 50pF aerial con-

Constructional Details

The chassis is approximately 5in by 7¼in and the layout of components is shown in Fig. 2. Such a simple chassis may easily be bent up from a piece of aluminium, and it was given a "step" formation, as shown, in order that the speaker could be accommodated without increasing the cabinet height. If this is not done, a higher cabinet would be required. The completed chassis has a small flange at the front of each runner, so that it can be bolted to the panel, as shown in Fig. 3. When the receiver is inserted in its cabinet, these bolt heads are covered.

The speaker (a 3½in model) is bolted to the panel after the circular cut-out has been covered with a suitable cloth material. Insulated bushes were added to these bolts so that the speaker, which rests on the chassis, is not in contact with the bolts themselves. This guards against the possibility of shocks which might, in some cases, be experienced if the countersunk bolt heads on the panel were touched while the receiver was plugged in with the line (or "positive") mains lead going to the chassis.

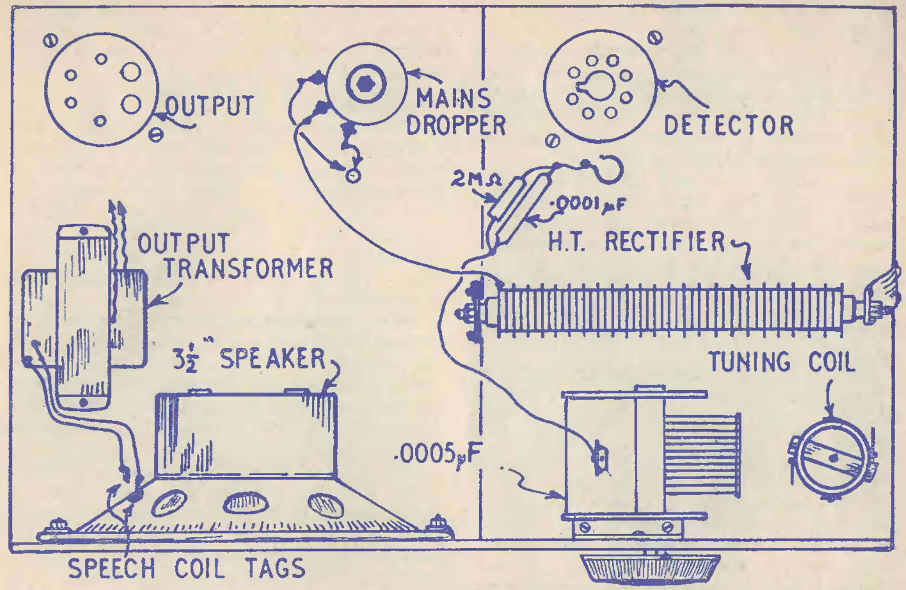


FIG.2: LAYOUT ABOVE CHASSIS

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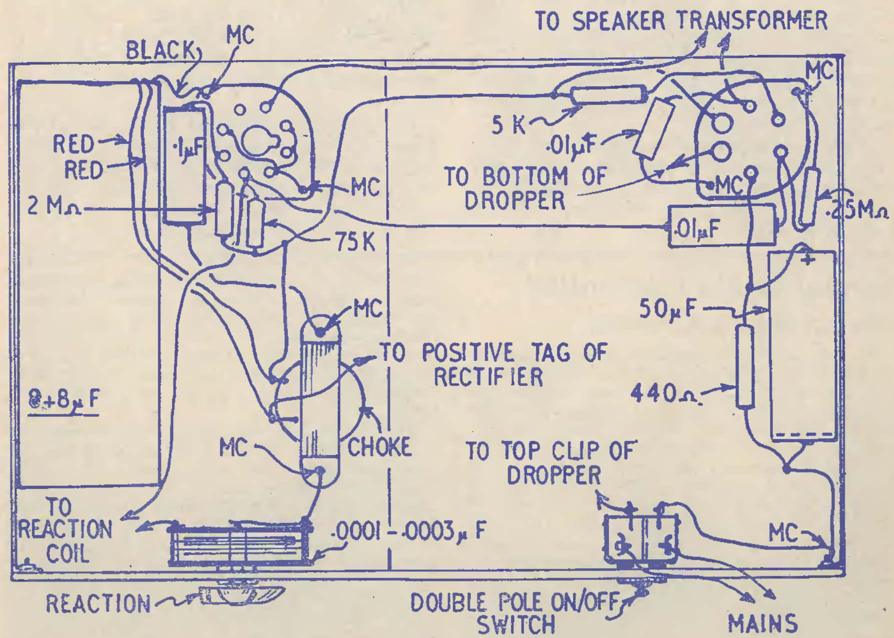


FIG.3: SUB-CHASSIS WIRING

E368

denser is soldered directly in series with the aerial lead-in, at the coil.

All wiring should be reasonably short and direct, and heater leads and other leads carrying a.c. should be kept away from other connections in the set. For mains connections, a length of twin-flex, terminating in a suitable plug or adapter, is required.

The securing bush and dolly of the on/off switch should not be in contact with the chassis. With both tuning and reaction condensers, the control knobs should completely cover the spindle and fixing bush, and the grub-screw holes may be filled with some insulating compound. There will then be no chance whatever that live parts can be touched.

When wiring is complete, the centre clip of the dropper should be placed in a central position, and about five-sixths of the element left in circuit for the heaters. If a reliable a.c. voltmeter is to hand, adjust the top or bottom clip until a reading of 25V is obtained across the 43 or 25A6G heater. If no meter is available, adjust the clip until the set reaches normal operating temperature, from cold, in about 45 seconds, i.e., full volume should be obtained 45 seconds after switching on.

The centre clip of the dropper should then be adjusted until the 43 screen and anode voltages do not exceed 135V and 160V respectively. (The voltages read at these points will be much higher at the moment of switching on, but will fall to a steady value as the valve heats up.) If no meter is available, the rectifier clip may be left at about the middle of the dropper.

With 110V supplies, the rectifier should be wired directly to the positive mains lead. The dropper will also have to be adjusted as explained, to reduce the resistance in series with the heaters.

If a pilot or dial lamp is required, this can consist of a 6.3V, 0.3A bulb, with 40Ω resistor in parallel, wired between 43 valve heater and dropper.

The Cabinet

This is important in contributing to the safety of the finished set, but may easily be made from ¼in plywood. For a cabinet to accommodate the chassis mentioned, the bottom is 7½in by 5½in. Each side is 5½in by 6in, and the top is 5½in by 8in. A front measuring 8in by 6¾in has a cut-out 5in by 6¾in. The parts may be fitted together with thin panel pins.

When completed and adjusted, the receiver is inserted from the back, the panel coming up against the cut-out mentioned. A few small screws driven through the panel from the back will hold it in position; care should be taken that these screws do not protrude from the front.

The rear of the cabinet is covered with 3-ply, and rows of ¼in dia. holes must be drilled in this to permit circulation of the air. Two vertical rows of such holes should be positioned near the dropper and output valve, which become hot after a period of use.

Using Alternative Valves

Provided sufficient space is allowed, and suitable holders used, equivalent valves can be employed, if to hand. For the detector, a 6J7G or 6J7GT may be used. A 6C6 can also be employed, with UX 6-pin holder. If a 6K7 is to hand, this can be used with success, but is slightly less suitable than the 6J7.

For output purposes a 25A6, with octal holder, can be used, and is an equivalent of the 43. Other output valves would require a bias resistor of other than 440 ohms, but the value could be ascertained from a valve list, if it is desired to use such valves.

Annual Radio Controlled Model Boats Contest

At the annual contests for radio controlled model boats, organised by the International Radio Controlled Models Society, held at the Valley Pool, Bournville, Birmingham, on Bank Holiday Monday, 6th August, 1956, the outstanding feat was achieved of sailing on the water at the same time and under completely separate and individual control, a total of nine model boats, comprising seven power-driven boats of various types and two A-Class yachts. This was not a planned attempt with specially prepared models, but was a spontaneous effort using the normal model boats then available on account of the contest. It was staged in the middle of the afternoon, between ordinary contest events, with no more than two hours warning of the intention to make the attempt. The nine boats were maintained in free and active movement about the pool for a period of fifteen minutes, with no attempt to regulate the traffic by imposing obligatory paths or routes. During the attempt there was no untoward event other than one minor collision between two boats, which did not damage either craft. For a short time there was an additional power-driven boat in operation, making a total of ten on the pool at the same time.

This remarkable feat, which demonstrates the great progress in reliability and design which has been achieved in the radio control of models, was made possible by the use of crystal controlled transmitters on 27 Mc/s frequency operating with crystal controlled receivers using superheterodyne circuits developed by Tyneside members of the Society. By this means four of the power-driven boats (for a short time five) and the two yachts were controlled. One more power boat was controlled on the 465 Mc/s frequency. The remaining two power-driven boats belonged to two visiting competitors from France, whose craft were controlled on the frequency of 72 Mc/s specially permitted for the occasion.

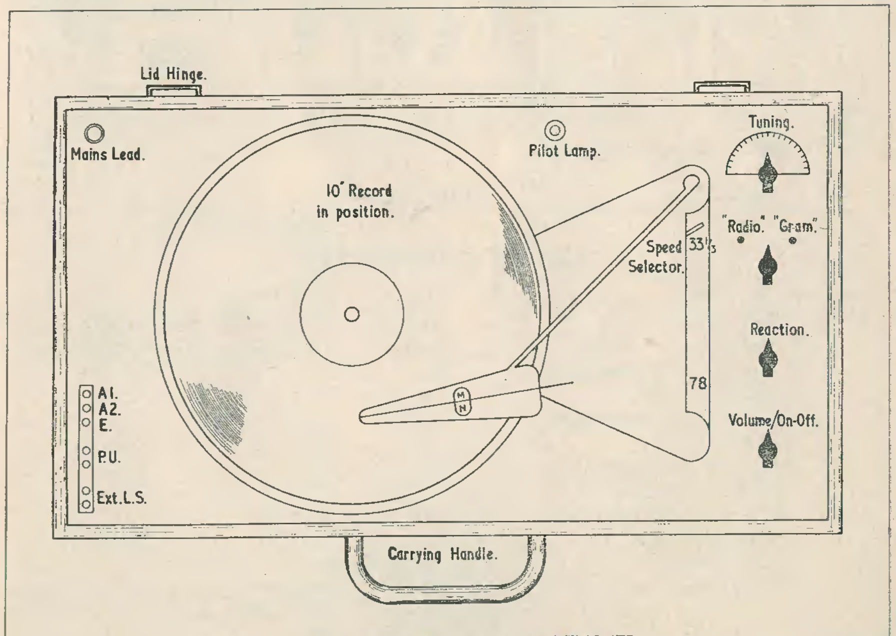
A SUITCASE RADIOGRAM

by **M. CORBETT**

General Description

OWING TO THE INCREASING POPULARITY OF the new micro-groove records, many miniature record players have appeared on the market. Some merely consist of a motor deck and small built-in amplifier, whilst others take the form of a complete portable radiogram. Such models are attractive but also very expensive, and the results can never be the same as a console. used a miniature 2-speed motor unit along with a crystal pick-up of the sapphire type. Those who already have access to a standard size motor may always employ a larger suitcase and enjoy the advantage of a bigger loudspeaker. The lid may be closed while playing to prevent "needle talk," which can be annoying when the volume is set low.

A brief glance at the circuit diagram will reveal that the whole unit is built around a



VIEW FROM ABOVE WITH LID REMOVED.
Not to scale

There is a demand, therefore, for a simple and inexpensive unit which, although completely portable and self-contained, is equipped to be speedily coupled up to a bigger amplifier or loudspeaker should one be available.

The apparatus about to be described was built into a suitcase 18in by 11in by 6in, and 4-valve straight receiver utilising a reacting detector. The reaction is controlled by a potentiometer in the detector screen, and the pre-set reaction condenser should be set so that oscillation occurs when the control is about two-thirds advanced. This is to ensure that the detector is getting adequate screen

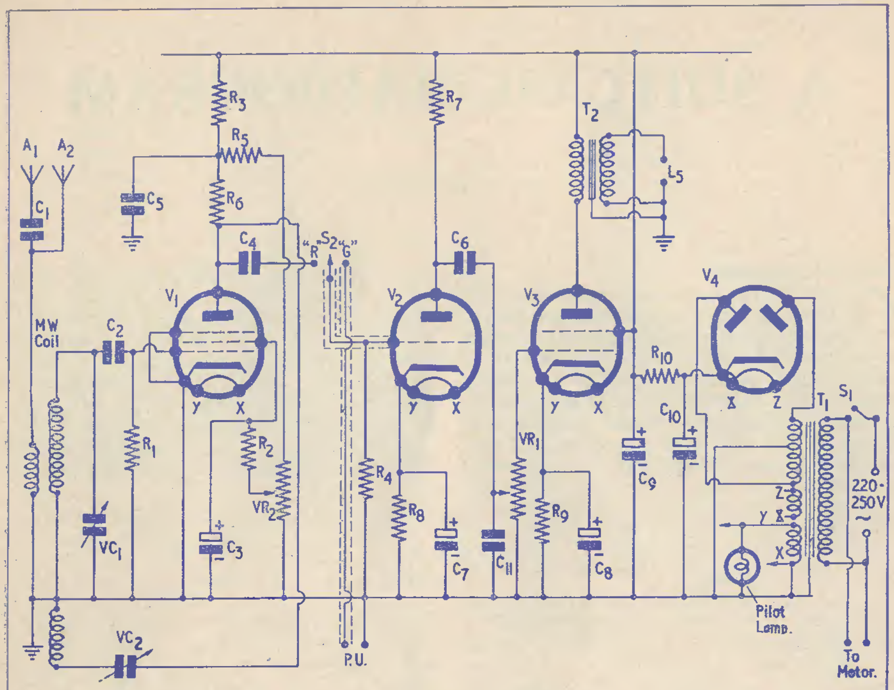


FIG. 1.

LIST OF COMPONENTS

Condensers

C_1	100pF mica
C_2	100pF mica
C_3	2μF 350V wkg electrolytic
C_4	0.01μF 350V wkg
C_5	2μF 350V wkg electrolytic
C_6	0.1μF 350V wkg
C_7	25μF 25V wkg electrolytic
C_8	50μF 50V wkg electrolytic
C_9, C_{10}	16 + 8μF 450V wkg elect.
C_{11}	250pF mica
VC_1	500pF tuning
VC_2	250pF pre-set

Resistors

R_1	1MΩ ¼W
R_2	10kΩ ¼W
R_3	10kΩ ½W
R_4	1MΩ ¼W
R_5	15kΩ ½W
R_6	47kΩ ½W
R_7	200kΩ ¼W
R_8	3kΩ ¼W
R_9	230Ω 1W
R_{10}	1kΩ 3W
VR_1	500kΩ potentiometer with switch
VR_2	100kΩ potentiometer less switch

Valves

V_1	EF39
V_2	6J5
V_3	6V6
V_4	5Z4

Miscellaneous

T_1	Primary: 200–250V, secondaries 250–0–250V 60mA; 5V, 2A; 6.3V, 2A.
T_2	To suit speaker

Pilot lamp, 6.3V, 0.3A

8-way socket strip

Miniature 2-speed or 3-speed motor with crystal pick-up.

Suitcase to accommodate above motor unit.

S_2 Single pole change-over switch

Coils to suit constructor's requirements.

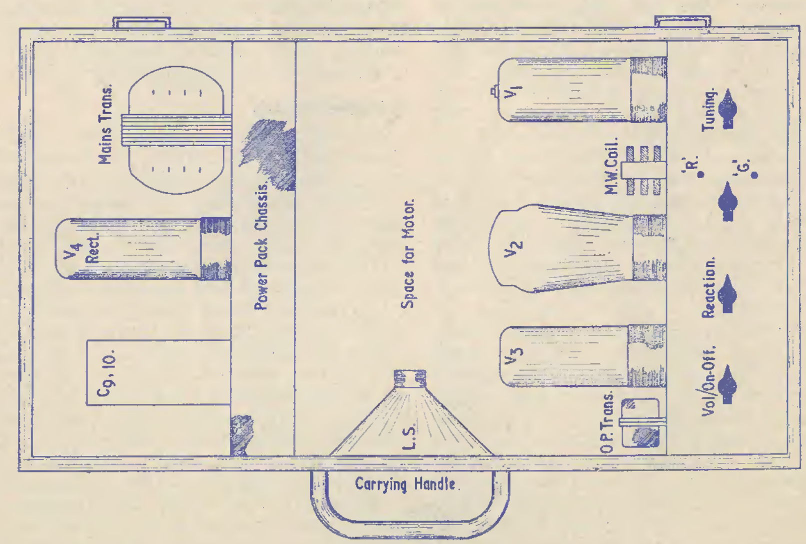
voltage when the critical point is reached, thereby obtaining maximum gain from this stage. Medium wave only was incorporated in the original model, but the addition or substitution of a long wave coil should not present any serious problem, the choice of coils being left to the constructor.

A 6J5 is employed as a.f. amplifier, followed by a 6V6 for output. The pick-up is fed to the grid of the 6J5 via the radiogram switch. This isolates the pick-up on "radio," whilst on "gram" it mutes the radio by disconnecting the coupling condenser. If a little more gain is required, the 6J5 could be replaced by a 6J7, but a certain amount of decoupling in the anode circuit might become necessary, as has already been done in the case of the detector. The pick-up and output leads are taken to sockets on the motor deck to facilitate connection of any external equipment. The power pack is a standard job, resistance smoothed, and it utilises a 250–0–250V mains transformer. A.C./D.C. technique was not considered, as dangerous conditions might arise if other equipment was connected.

eliptical one is, of course, the best proposition. The size and position of the motor will have to be taken into consideration here. Both chassis are fitted to a wooden rail around the top of the case by means of small brackets; and once the motor deck is in position, they are secure in all directions.

As there are not many components, an under-chassis view is not given, and construction is quite straightforward. The pick-up leads should be screened, and care taken to ensure that the metalising of the detector is earthed via pin 1. The motor is connected after the main on-off switch to avoid accidentally leaving it running when the rest of the unit has been switched off. The radiogram was found to give adequate volume even with the lower output of the long-playing records, and when used with an 8in extension speaker a surprising standard of quality resulted. The radio section gave good volume on the "locals," and with a bit of patience quite a few Continentals were received during the evenings.

To those who have spares in the junk box,



TOP VIEW WITH MOTOR DECK REMOVED.
Not to scale

Constructional Details

As can be seen from the sketches, the power pack is on a separate chassis to allow room for the motor and speaker. As suitcases vary somewhat in depth, the actual size of the speaker cannot be stated, although an the whole unit can cost less than £6, and most of the components are available on the surplus market. The circuit lends itself to considerable experiment, and a de-luxe version using an all-wave superhet has been considered.

Radio Miscellany

IMMEDIATELY FOLLOWING THE COMPLETION of this column last month, a further interesting letter on the subject of wind-driven generators arrived from W7UMF of Hoquiam, Washington. Oddly enough, he was one of the few who particularly mentioned that his interest was purely for the "fun of it," having plenty of cheap power on tap.

He planned an especially nice arrangement using the rear-end housing of a model "T" Ford with the generator driven by a "V" belt to the brake drum. The tower was of 4in by 2in bolted and mortised lumber in tripod form. It also had a pilot vane to turn the head out of the windstream during sudden gusts. He, too, suggests wire and pulley arrangements to pull the propellor to neutral (or switching out the generator) during gale periods. The timber tripod part has a touch of humour about it. William, in his interesting letter, mentions that Hoquiam (the name of his town, which has a population of over 10,000) is an Indian word meaning "hungry for wood." It is mainly dependent on the timber trade and is situated some 12 miles from the Pacific Ocean. Kerosene lighting there is a thing of the long distant past, and hence the local interest in wind generators is, like his own, purely academic.

Before leaving this topic, a word of thanks is due to all those who have been good enough to write, either for details for future construction or to pool their experiences. Our good friend Dr. Arthur Gee (G2UK) is busy investigating the possibilities of a cheap and practical design which can be built from easily available parts, and we look forward to a basic design which will be something of a symposium of the successful ideas from our wide, and very friendly, circle of readers.

The Long View

A number of British T.V. receivers have been shipped over to America where it is hoped to receive something of our B.B.C. transmissions. The attempt is being made by the National Broadcasting Company, who are installing the receivers at their Riverhead Station, Long Island, hoping to relay any images received (duly filmed) in the "Wide, Wide World" programme. By the time this appears in print the hoped-for "peak period" will have passed, and perhaps something of the results will have appeared in the daily Press. In any case we shall know something of the conditions, if they prove to be abnormal, by the interference affecting our own domestic receivers!

Attempts to pick up B.B.C signals in America were unsuccessfully made in 1953, at the time of the Coronation, but some years earlier, during a period of high sun-spot activity, successful reception of B.B.C. signals was reported. At that time, of course, no attempt was made to re-broadcast them. What a spot for I.T.A. to achieve this in reverse! A huge audience sitting agog waiting to see one of America's star programmes—and a couple of adverts slipped in!

Listener Watch

Several readers, especially Mr. Alex P. Buchanan of Carrick Park, Ayr, have written about next year's launching of artificial satellites—particularly of the electronic equipment and of organised amateur reception of the radio signals they will send back to earth. While suggestions have from time to time been put forward that the services of amateur observers may be of value, as far as I can make out no practical steps have yet been taken to enrol their help. As the work is under the direction of the U.S. Naval Research Laboratory it is doubtful that the initiative in seeking such help will come from the official side. Nor are the Russians likely to ask for co-operation. Indeed, they are revealing no details of their project at all.

However, for visual observation, the Smithsonian Institution in Washington have arranged for (and are still organising) a world-wide chain of knowledgeable amateur observers to man posts to track the sphere, so as to make sure (if it gets lost) that we shall know something of what happened to it. As I mentioned, when the project was first announced, it should be visible in the reflected light of the sun to watchers armed with quite ordinary binoculars, and under favourable conditions even with the naked eye.

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

As I see it, it is rather doubtful whether amateur radio observation would be of much value with our present unreliable maps. Errors of several miles occur in the charted positions of many of the smaller islands and even in the distances of continents from each other. Accurate measurement, for radio purposes, is far beyond the scope of amateur equipment. Even the loss of signals, should the satellite wander off into outer space, could hardly be accurately plotted or timed without elaborate equipment. There is, however, one aspect scheduled for official investigation, in which a corps of widely spaced amateur listeners might be able to help. That is the problem of propagation for V.H.F. working and the effects of the ionosphere in reflecting and refracting radio signals, with the view of making wide-coverage T.V. an early possibility.

First Shot–

I am not normally a pessimist, but I have wondered just how many satellites will have to be launched before one can be made to circle the planned orbit. The lay mind seems to take it for granted that it is already as good as done, quite overlooking the amount of experimental work history teaches us is required for such ventures. And this is a stupendous step involving many unknown factors. Remember the early German V2 rockets?—only one in the first twenty or so worked and even *after* the war, development was brought only to a 60 per cent successful launching stage. It is doubtful whether we can yet claim to be through the growing-pains stage, and we glibly talk of a three-stage tandem rocket reaching the right altitude and finally kicking the satellite off to an 18,000 m.p.h. start. If its velocity is too slow it will sink back into an increasingly heavier atmosphere and burn up, perhaps even before completing one circuit. If it travels too fast it will fly off into space. The world's leading rocket engineers are confident that one day we shall get a satellite in the right orbit, but they won't quote how many firings they think may be needed before it is achieved.

Nor is there any agreement among scientists on how long it will stay up. Some think a few hours (it will circle the Earth from west to east every 90 minutes). Some venture to suggest perhaps for months. Either guess might be right. The satellite will approach within 200 miles of the Earth and wing out to 1,400 miles at each revolution, moving about 1,500 miles west at each circuit, and our present knowledge of atmospheric density at these heights is so slender that either conjecture might well prove right.

Remember, that even as a first effort, the engineers are building twelve satellites (not just one) and hope to get *one* into the planned orbit, if only for a short spell. When that has been achieved perhaps we shall be in a better position to evaluate just how a corps of skilled amateur radio enthusiasts might usefully be of service.

Wall Decoration

The R.S.G.B.'s recent addition to their book range "Certificates and Awards" would, to judge by its title, be primarily of interest only to the transmitting fraternity. It is, however, very much more than simply a catalogue of awards and their required qualifications, containing as it does much useful information for the keen short-wave listener. It is not generally realised just how many scores of certificates, etc., are available. I certainly would not have guessed there were so many—but you have to be an extra keen type to qualify for most of them. My own periods of operation, although pleasantly successful, are far too irregular to qualify me for more than one or two of the less formidable ones.

A feature that will prove valuable for listeners is the "Countries" tables, with columns to log calls on five different wavebands. Looking down them proves pride-shattering as one realises just how many there are that one has not heard, let alone worked, for years. After all, you have to hear 'em to work 'em, as the saying goes, and to hear them you have to have an aerial. By aerial, I mean Aerial. Broadcast listeners are apt to think of aerials as merely bits of wire, very much of a nuisance and something to be poked out of sight, but however good your receiver is low power DX signals cannot be logged that way. An efficient aerial, *properly matched*, reveals stations formerly unheard, but it is very difficult to get those bred on normal listening to believe it.

"Certificates and Awards," by the way, is available to all, not simply R.S.G.B. members. It costs half a crown. *(cont on p.190)*

Technical Forum

C.R.O. Amplifiers

Last month we discussed methods of tracing and eliminating some of the faults which occur in cathode ray oscilloscopes. Space, however, prevented our dealing with some of the more obscure defects which can occur in the "X" and "Y" amplifiers, and it is proposed to consider these more fully this month. Due to the ageing of certain components the response of the amplifiers may gradually deteriorate, or perhaps an oscilloscope has been made and due to some layout or design fault a poor reponse is obtained. Whichever may be the case, some very misleading results can be obtained. Remember that the oscilloscope is basically a measuring instrument, and one giving incorrect results is of little value; unless, of course, the operator is aware of its shortcomings, in which case a correcting factor may be applied. If the instrument is to be used seriously, it is thus important that the amplifiers do not distort the waveform under examination; or if some distortion is present, the operator should be aware of it so that due allowance may be made.

There are two basic types of oscilloscope amplifier, the direct coupled or d.c. arrangement and the a.c. type. In the former, the various valve stages are directly coupled together without the usual blocking capacitor; this has the advantage that the low frequency response is retained right down to zero frequency or d.c. This type of amplifier is of particular use in examining square waves of very low frequency. The simpler and more common amplifier is the a.c. or resistance/capacity coupled type. Whichever type is used we are generally concerned with two particular characteristics which it possesses, its frequency response and its transient response. There is a popular fallacy to the effect that a good h.f. response will ensure a good transient response; this is not necessarily correct, and it is advisable to check both characteristics separately. Should lack of test gear prevent this, it is best to examine the transient response if the oscilloscope is required for general test purposes.

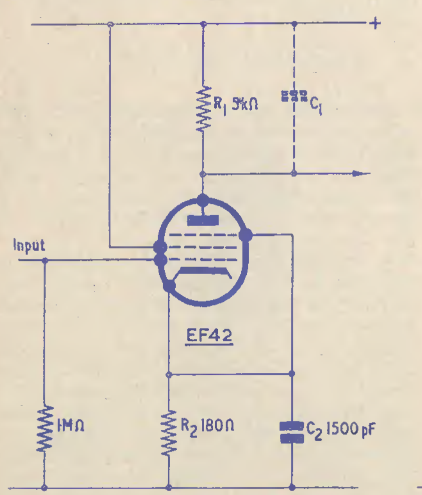


FIG. 1A.

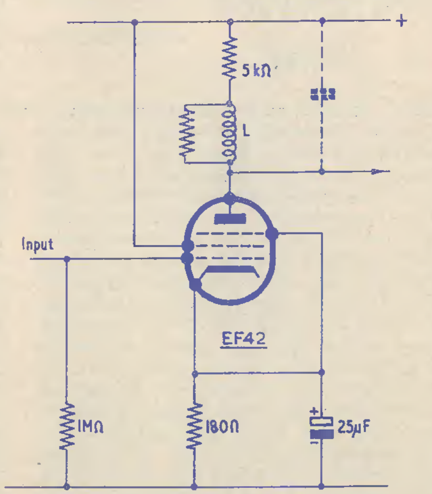


FIG. 1B.

Frequency Response

In testing the frequency characteristic of an amplifier we are primarily concerned with its ability to provide a reasonably constant level of amplification from about 10 c/s to around 2 Mc/s. In an R–C coupled amplifier the h.f. response is mainly limited by the effect of shunt capacitance on the anode load resistors. This capacity reduces the effective load on the valve as the frequency rises, and thus the gain is reduced. There are two simple methods of combating this effect. One is to add an inductance in the anode circuit, so that the increasing inductive reactance with frequency offsets the effect of the shunt capacitance. The other method is to use negative feedback which is arranged to reduce as the frequency increases. A simple and very efficient method of achieving this is by "cathode compensation," where the cathode bias resistor is partially shunted by a small capacitor. This system is used in the single-stage amplifier shown in Fig. 1a, whilst anode compensation is employed in Fig. 1b.

The value of the cathode compensating capacitor may be obtained from the formula:

$$C_2 = \frac{R_1 C_1}{R_2}$$

where R values are given in ohms and C values in pF. C_1 is the total effective shunt capacitance across the load resistor R_1. C_2 will normally have a value of between 1,000pF and 1,800pF. The effect of employing different values for the compensating capacity is shown in the frequency response curves of Fig. 2. A similar effect is obtained by adjusting an anode compensating inductor. An inductance of about 175μH (medium wave tuning coil) is usually satisfactory, and the degree of compensation is conveniently adjusted by using various values of shunt resistance across the coil.

Just a word about the method of plotting response curves. The only instrument required for a simple check is a signal generator covering the medium and long wavebands. This generator should preferably be fitted with an output level indicator, otherwise a simple valve-voltmeter will be needed; this need not be calibrated. Feed the output of the generator into the oscilloscope amplifier, set the amplifier gain near maximum and the signal level such that a trace which about half fills the screen is obtained. Make this adjustment at 150 kc/s and then adjust the frequency in steps of 100 kc/s, resetting the output of the signal generator to the same level each time, and observe the change in the height of the trace on the screen. To plot the results in decibels, convert the trace height measurements as follows:

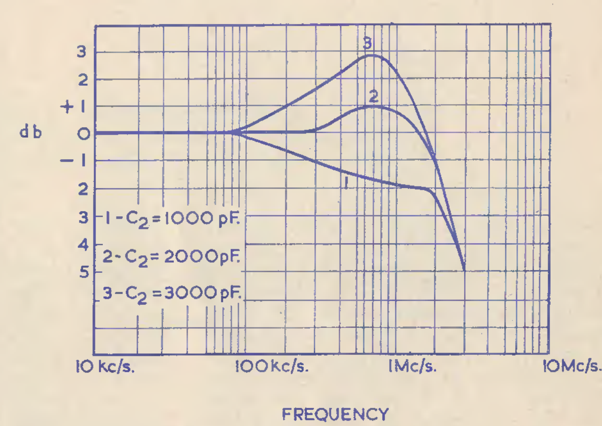


FIG. 2.

$$\text{Decibels} = 20 \log \frac{\text{(Height at new frequency}}{\text{Height at 150 kc/s)}}$$

The height is conveniently measured in centimetres, and the results are plotted on log/linear graph paper.

Transient Response

This is the most important of the two characteristics of an amplifier as a good transient indicates a good frequency response; the converse is not, however, necessarily correct. To assess the response a source of square waves is required. This waveform may be obtained from a simple multivibrator, or perhaps more conveniently from a t.v. receiver. If the latter is used, suitable waveforms at a frequency of 10,125 c/s may be obtained from the line pulse output of the sync separator stage, or at the grid of the line output valve. The waveform should first be examined by feeding it directly to the Y plates, and any deviation from square formation carefully noted. Then upon applying the pulses through the amplifier a similar formation will be obtained, if all is well. Care is required not to overload the oscilloscope amplifier as this will inevitably lead to severe distortion; a resistive attenuator may be required for this purpose.

The different output waveforms which may be observed indicating various defects are depicted in Fig. 3, and their probable cures are given below.

Tilting. This is most likely to show up at the lower frequencies and indicates poor l.f. response or excessive phase shift. Check all coupling capacitors.

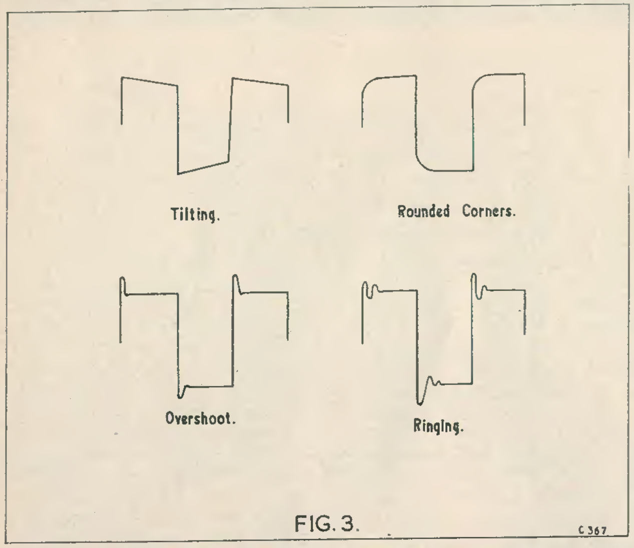


FIG. 3.

Rounded Corners. Caused by poor h.f. response. Check compensating components.

Overshoot. Result of a tendency to too much h.f. response. Reduce compensating capacities or shunt compensating inductors with lower value resistors. First check coupling capacitors.

Ringing. Accentuated h.f. response. Proceed as for overshoot above. Ringing will undoubtedly occur if by over compensation the response curve is as shown in (3) Fig. 2. A gassy valve will also produce an effect which is very similar to ringing.

Radio Miscellany

(*continued from page 187*)

"888"

I had intended to write at some length this month on the recently introduced Eddystone "888" amateur bands Communications Receiver. This set is designed to cover the six major amateur bands, with full bandspread over the whole scale for each band—a specification close to my own heart. I spent many hours designing and building such a receiver some years ago. As the receiver was to incorporate all the refinements usually found in the best communications type set, it was something of a jig-saw puzzle to get it all on a reasonably sized chassis. After a lot of patient work and I got it working to my satisfaction, I grew ashamed of its massive awkwardness and untidy appearance.

The only way to build a satisfying receiver of that description is to build a prototype and then set about the problem of reducing it to reasonable proportions. Then probably one would need to have another go before a really efficient and presentable receiver is achieved. I don't know how many times the "888' was redesigned before it finally went into production, but the designer is to be congratulated on the neat and compact lay-out.

One of the chief difficulties in a receiver of this sort is to overcome oscillator drift to ensure stability after the warming-up period. Drift, which in a normal receiver is completely unnoticeable, when it takes place in a set where the full travel of a 180° scale is spread to cover a few hundred kc/s may mean completely losing a signal. In the "888" such variations are ironed out by using negative temperature co-efficient condensers, an externally controlled trimmer across the oscillator tuned circuit, plus a separate oscillator valve supplied with a stabilised h.t. supply. I hope to report further on this interesting receiver when I have had an opportunity of a more prolonged test.

Two-way Traffic

It is curious how slowly wrong ideas die. Years ago there was a belief that crystal sets gave a "purer" tone than valve sets. I suppose it was the association of ideas. A crystal set must obviously be crystal clear! There are still many people who believe that the two aerial sockets at the back of their t.v. receivers are one for the picture and the other for the sound. To one such believer who I met this week I remarked it was amazing that the signals knew which hole to go in! At first he agreed that it was quite as remarkable as t.v. itself, but after a little reflection he said he thought it was probable that something inside the set "draws" the respective signals into the appropriate holes. Which only goes to show that you can think of an explanation for anything if you ponder on it long enough.

A NEGATIVE FEEDBACK TONE CONTROL

by **R. G. WALLACE**

A simple network for pentode or tetrode output stages, giving infinitely variable treble or bass accentuation by means of one control.

WHILE THE TYPE OF TONE CONTROL fitted to most receivers, consisting of a capacitor and variable resistor in series across one of the audio frequency circuits, is quite satisfactory where treble cut or apparent bass boost is required, the writer has often wished it were possible to obtain a certain amount of treble boost by rotating the knob in the opposite direction.

Under certain reception conditions speech can often be more readily understood if the treble is accentuated, and a little more amplification at the higher musical frequencies is sometimes an advantage in order to compensate for sideband cutting in very selective receivers, particularly on long waves.

A simple circuit was therefore devised which, whilst giving the desired effect, also improves the overall frequency response, and hence the quality of reproduction.

As can be seen from Fig. 2, very few components are required, and no radical circuit changes are necessary. In old receivers the improvement in quality is well worth the little effort involved.

Before attempting to build the network or making tests in any receiver, the coupling capacitor to the grid of the output valve must be increased to about 0.25μF, and the existing tone control must be removed, or it will be impossible to judge the effect of the new circuitry.

However, any small capacitor which may be found wired across the output transformer primary, or between the anode of the output valve and chassis, should be left in position. This helps to prevent the load presented by the transformer primary from becoming excessive at the higher frequencies. If there is no condenser in this position, one should be fitted, and a value of 0.001μF is suitable.

In order to find out how much negative feedback should be used in a particular receiver, tests may be made by connecting resistors ranging from about 1MΩ to 250kΩ between the anode of the last a.f. amplifier (in a superhet this will probably be a double-diode-triode) and the output valve anode.

Find the lowest value possible, consistent with adequate volume still being obtainable when the set is tuned to a weak station, and then replace the resistor by a potentiometer having the same value. This enables the best position for the tapping to be found very easily and, if there is room in the receiver, the potentiometer may be left in permanently.

On the other hand, if a test meter is available, it is a simple matter to measure the resistance between the slider and each of the two outer terminals of the potentiometer, and to substitute two resistors in its place, taking the tapping from the junction.

If the potentiometer is to be left in position, it should be of the pre-set variety and be of adequate wattage rating.

To find the position for the tapping, connect a 0.01μF capacitor and a short length of wire to the slider of the potentiometer, and hold the other end of the lead against the receiver chassis. Adjust the potentiometer until the reproduction sounds extremely high pitched. Then transfer the lead from chassis to the anode of the output valve. The reproduction should now become low in pitch.

If it is not sufficiently low, move the slider a little nearer the end of the track which is connected to the a.f. amplifier anode (V_1). Then re-check for treble boost with the lead taken to chassis once again.

When a satisfying compromise between the two has been found, fit a 500kΩ control in the vacant spot left by the old tone control, which was removed, and wire up across the output transformer primary. The lead from the 0.01μF capacitor is then taken to the slider of this control as in Fig. 2.

Before finally soldering the connection,

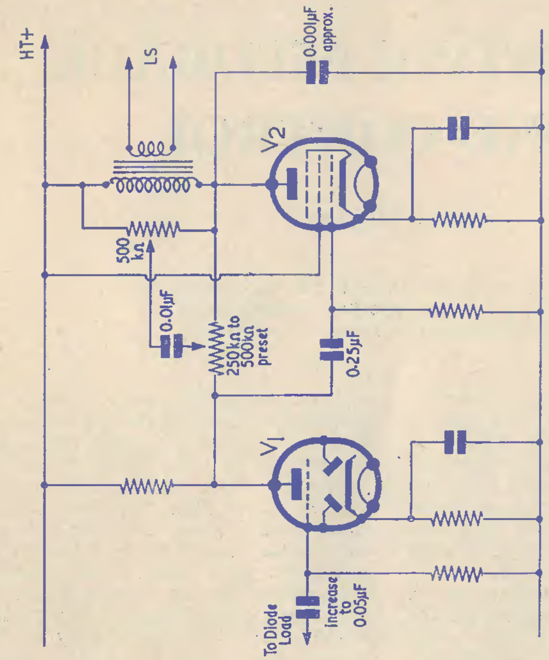


FIGURE 2. A.F Section fitted with the N.F.B tone control and with the various alterations mentioned in the text

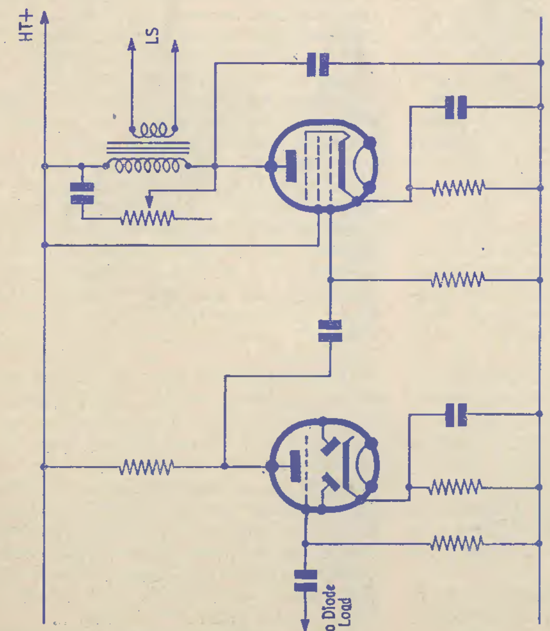


FIGURE 1. Typical A.F Section of Superhet receiver showing tone control and by-pass capacitor

touch the lead on and off against the terminal a few times whilst rotating the control backwards and forwards. When a position is found where the pitch of the reproduction does not vary when the connection is made, put a mark on the spindle, or on the knob if this is on a flat and cannot turn in relation to the spindle. This will serve to indicate the neutral position when the receiver is replaced in its cabinet.

If the control appears to operate in a "back to front" manner, reversal of the connections to the transformer will soon put this right. It is, of course, a matter of personal preference, but the writer prefers "bass to the right and treble to the left."

In order to make full use of the more uniform frequency response of the output stage, it is worth while increasing the value of the coupling capacitor between the diode lead and V_1 grid to 0.02-0.05µF. Larger values may lead to instability or to grid blocking owing to the high values of grid leak usually employed.

List of Basic Components

- 250-500kΩ potentiometer
- 500kΩ potentiometer
- 0.01µF tubular paper condenser
- 0.25µF tubular paper condenser

A Constructor Visits the 1956 NATIONAL RADIO SHOW

(continued from page 177)

reverting to home-constructor kits once more. In this case the kits are for test equipment, and it is anticipated that the amateur or serviceman can save himself quite a useful amount of money by making his own test equipment from these kits.

The Cossor test gear kit range consists of two items at the time being. The range is to be extended later to cover more equipment, although, so the writer was given to understand at the Cossor stand, this may depend upon how well the first two kits sell. One of these is for a single-beam oscilloscope (model 1045K) whose Y amplifier is flat within 3 db up to 3 Mc/s, and which gives a useful response up to 10 Mc/s. The top timebase frequency is 250 kc/s, and maximum sensitivity is 50mV per cm, with a rise time of 0.12 microseconds and less than 10% overshoot. The second kit is for the valve voltmeter type 1044K. This has seven ranges, these extending from 1.5 to 1,500 volts f.s.d. for d.c. and r.m.s. a.c. Ohmmeter facilities are also available. For those interested, further details may be had from Cossor Instruments.

Gadgetry

A radio show is not a show without gadgets, and there were plenty to be seen this year. Probably the most impressive display was put on by the G.P.O., one exhibit consisting of a speech synthesiser. This device was capable of being operated by the public and had a limited vocabulary of quite easily recognisable words.

Amongst other gadgets shown was a futuristic rocket-firing control console in the R.A.F. Display. What was apparently a television screen displayed the track of a rocket. The writer, who never likes to take these things for granted, had a close look at the back of the console, to find that the picture came from an ordinary projector running with an endless loop of film. Due, probably, to the small amount of space available, the beam from the projector was deflected by no less than three plane mirrors before reaching the final transparent screen which represented the "picture tube" face. What tickled the writer was the fact that this screen had been ruled at the back with a number of parallel horizontal lines in order to make the projected film look like a television display. There is food for thought here!

Next Month . . .

The G.E.C. "JUNIOR" 4-Valves 5-Watts

ULTRA-LINEAR AMPLIFIER

TRANSISTOR SUPERHET

Radio Control of MODEL AIRCRAFT

PART 1

by **"QUENCH COIL"**

THE RADIO CONTROL OF MODEL AIRCRAFT demands rather a specialist approach. Whilst much of what has been written regarding the radio control of model boats and similar models is applicable to model aircraft, this aspect of the subject needs the full attention and skill of the model builder. The first consideration, of course, is that of the size and weight of the equipment, which must be got down to the minimum possible, whereas, particularly in the case of model boats, weight is of little importance. The midstream, which may mean a swim for its owner. With a model aircraft out of control, very severe damage can take place through a bad landing. A crash with power on or a steep uncontrolled dive can, in fact, result in the total destruction of the model and much of the radio gear, too. Failure in the steering mechanism may well result in the model's flight terminating in the top of an unclimbable tree some miles away! It will be appreciated, therefore, that nothing short of 100% reliability can be tolerated.

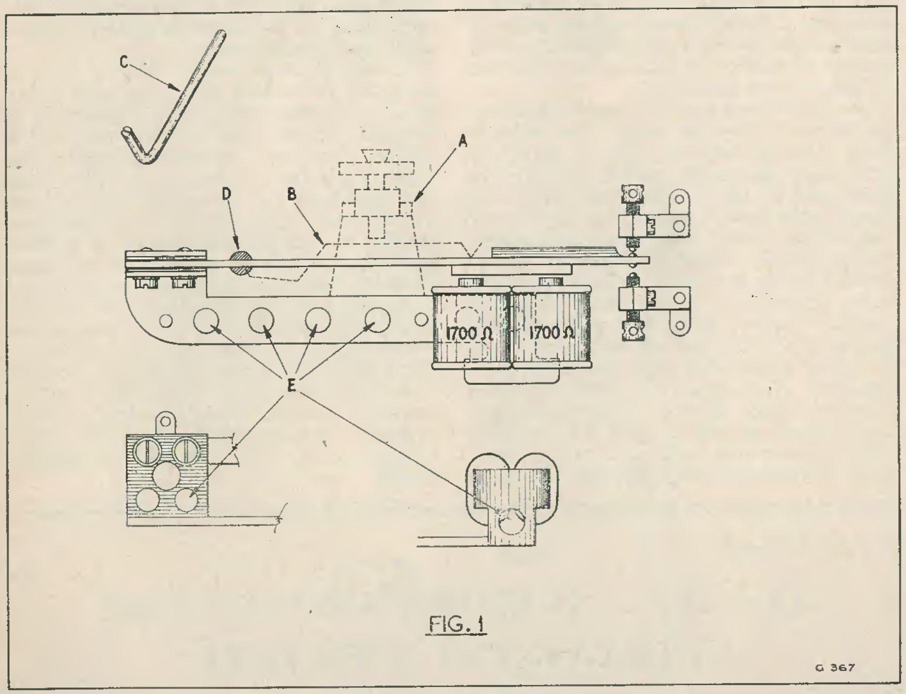


FIG. 1

next most important factor is that of reliability. The worst that can happen to a boat is a crash which does not usually result in much damage; or the model may be stranded in

Mention of radio-controlled model aircraft to the uninitiated usually conjures up visions of a twin- or four-engined ten foot wing-span model with radio links to rudder, elevators,

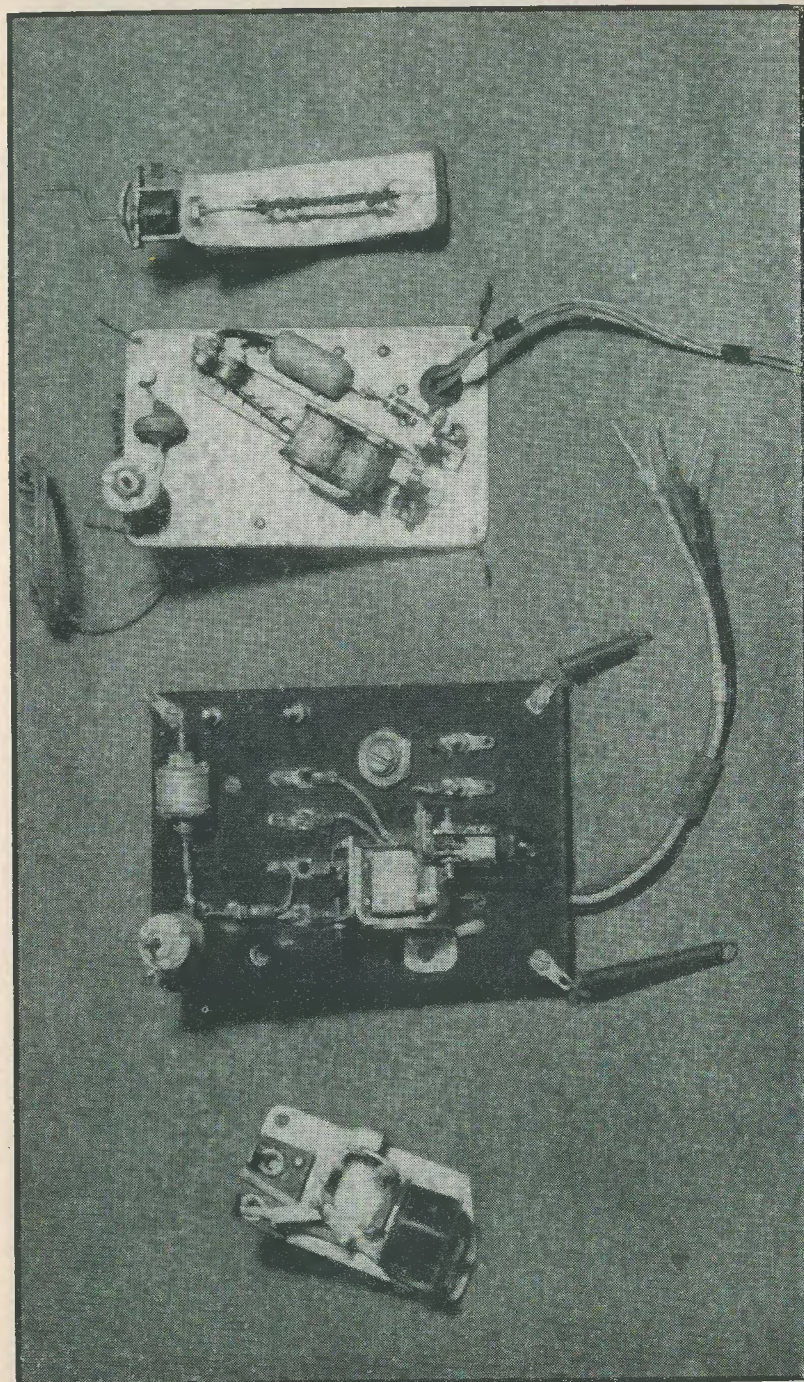
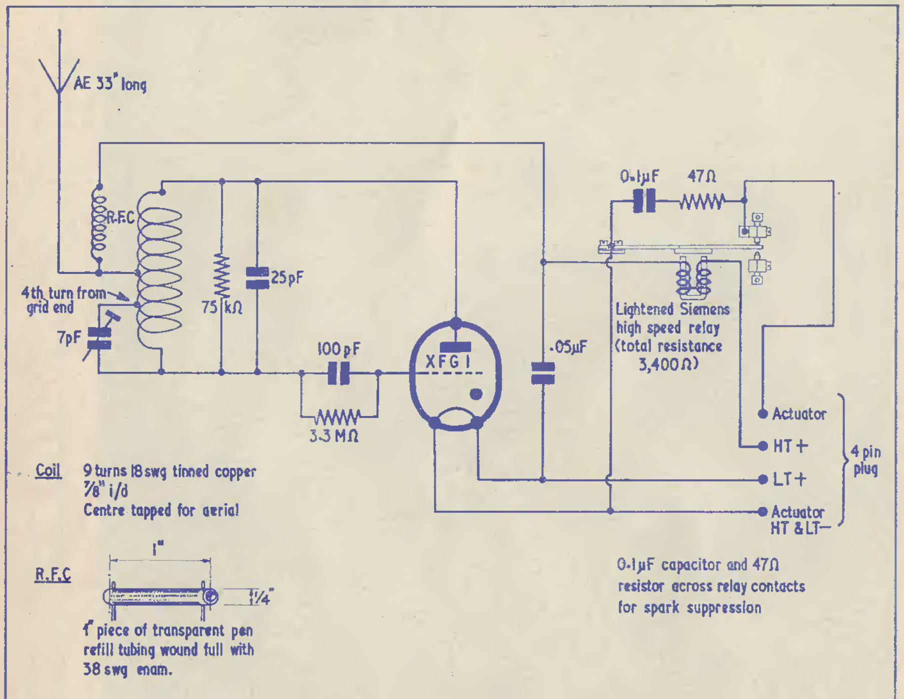


Fig. 2. Left to right: 3-pawl escapement; gas-filled triode valve receiver for boat; gas-filled triode valve receiver for plane; 2-speed engine actuator.

ailerons, engines, flaps and so on. In actual fact—with the exception, perhaps, of the professionals and very advanced amateurs—rudder control only is sufficient for most R/C fans, with eventual engine and elevator control as a challenge to their ingenuity. If the reader prefers 500 hours of bench work, testing, adjusting, checking, altering, re-checking, repairing, etc., to five minutes of actual flying, then by all means let him tackle the multi-control, multi-engined project. On the other hand, there is the simple four foot span, single-engined model using a one valve

can be kept down by making components in the workshop. The writer's transmitter, receiver and actuator were all home made, and this kept the price of the complete outfit down to about nine pounds, not counting parts from the junk box.

Some sort of open space suitable for flying usually presents itself if the surrounding country is carefully reviewed. Again, if a local model flying club exists it is obviously desirable that one should join, not only for the flying facilities offered, but also because of the help available from the flying angle.



RECEIVER CIRCUIT AS USED IN AIRCRAFT —— SEE PHOTOS

FIG. 4

receiver and the simplest of the simpler types of rudder-only control, which will give far more satisfaction in that it can be made to operate reliably and give consistent trouble-free flying. In any case, the simpler type of model is a "good step" for the more ambitious of us.

When deciding on the type of aircraft to build, three main factors need consideration, viz., depth of pocket, flying facilities available and the ability of the constructor. Expenses

It is common to find radio enthusiasts joining forces with model aircraft builders to produce a joint effort, each being responsible for his own speciality, but the writer would venture to suggest that anyone with the intelligence required to wrestle with radio problems would find the construction of a suitable first attempt radio model quite straightforward, especially if a kit was bought such as the "Skyskooter" 48in wingspan model or the "Mercury Matadore," a 50in wingspan job.

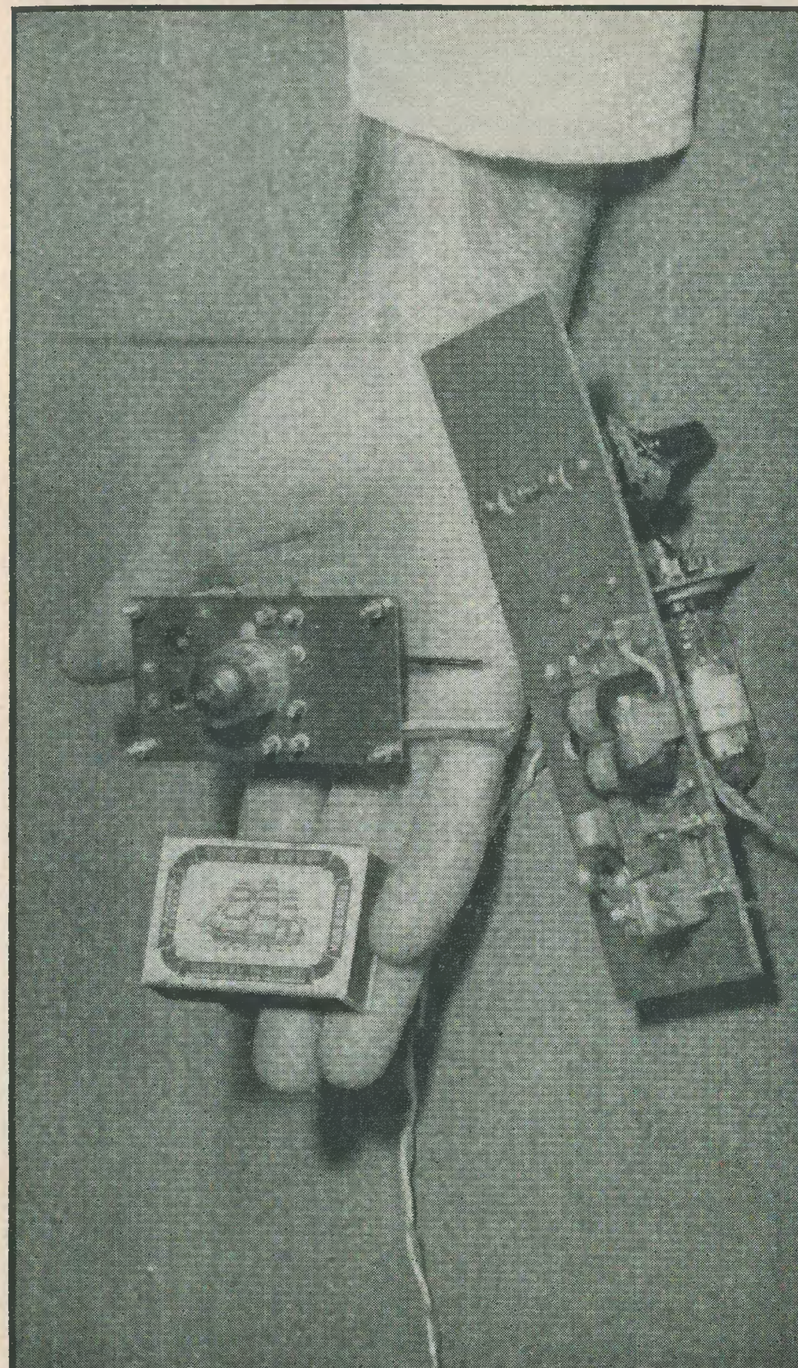


Fig. 3. Two small receivers shown against an ordinary matchbox for size. That at the top uses a 1S4 hard valve, with a polarised relay fitted underneath the panel. The lower receiver employs a 3A4 valve operating a Siemens relay. The top receiver is the most suitable for use in model aircraft

In both these cases all the materials required, together with plans and step-by-step instructions, are given. Both these planes are designed for radio control, and have excellent flying characteristics, so that the newcomer can concentrate on the radio side and leave the plane to fly itself.

The "Skyskooter" in particular is a very stable and pretty aircraft in flight. It can be powered by a 1 c.c. diesel engine and will carry about 12oz. of radio gear, the all-up weight of the model being 30oz. The fuel tank will hold enough for about a 3-min. engine run, which is plenty of time for one's initiation into radio-controlled model flying. To keep within the 12oz payload for the radio with this size of plane requires the lightest type of equipment. The receiver recommended is one of the types previously described using the XFG1 type of valve. A miniature relay or a standard type suitably lightened should be used. A two- or three-pawl escapement driven by a rubber motor is all that is required for the steering mechanism. Batteries are made up from pen cells and deaf-aid 22½ volt h.t. cells. Heavier gear could be used and the plane may be able to take it up; but with increased wing loading and, therefore, increased flying speed, the landing stresses would be greater—and as these seem to tell on the airframe more than the flying stresses, the working life of the plane is likely to be shortened. The tools required for making the airframe will usually be found in most model maker's workshops. The installation of the R/C gear cannot really be separated from the building of the airframe, and both should be done together.

Lightening the Relay

One of the heaviest components in the receiver is the relay and this, therefore, must be lightened in weight as much as possible. The surplus relays, Siemens type and similar, are usually mounted on a paxolin base. This can be removed and the various parts remounted direct on to the receiver panel. Use the original base as a template for drilling the receiver panel, and then re-mount the relay parts exactly as they were taken off. This re-mounting must be done accurately as any mal-alignment will result in poor operation of the relay.

The relay weight can be reduced even further by drilling holes in some of the metal parts where some of the metal can obviously be removed without unduly weakening the structure. Some parts, too, can be entirely removed. Fig. 1 shows a diagrammatic sketch of a typical relay in which suggestions for these lightening processes are indicated. The tension screw and bracket "A" can be completely removed together with spring "B." Adjustment of tension can then be made with the special tool "C" used on the blade at "D." When the relay has been finally mounted on the receiver panel it should be checked and adjusted for correct setting as described earlier.

A receiver using a relay reconstructed as suggested is shown in Fig. 2 (gas-filled triode valve receiver for plane). Some idea of the small size to which these receivers can be constructed may be gathered from Fig. 3. The circuit of the receivers shown in Fig. 2 is given in Fig. 4.

(*To be continued*)

Philips High Fidelity Loudspeakers

Two high fidelity loudspeakers (8-in type 9710 and 12-in type 9762)—the first in a new range—have been introduced by Philips Electrical Ltd. These are each available in two versions—single cone (/00) and dual cone (M). The prices are:

9710/00	£6	2	6	(tax paid)
9710/M	6	12	6	(tax paid)
9762/00	10	0	0	
9762/M	10	10	0	

These loudspeakers have been designed to meet the needs of those who require true high fidelity units which provide a wide frequency range, excellent transient response and adequate power handling capabilities under normal domestic conditions.

A number of special design points are incorporated. The air gap is long, so that even at the greatest amplitudes the coil is completely enclosed in a homogeneous magnetic field. The cones are extended rearwards to the apex which fits into a conical recess, giving excellent air damping. A copper ring is inserted in the air gap and this keeps the voice coil impedance constant over the entire frequency range. The resonance frequency of these loudspeakers is very low, resulting in an extremely straight low note response curve. "Ticonal" steel is used for the magnets. This material makes possible high flux densities from modest sized magnets.

The dual cone M versions of these loudspeakers are claimed to cover the entire audible range. A smaller cone of stiffer material is attached to the main cone; this increases the high frequency response. It is claimed that greatly improved diffusion of sound is achieved by this design. The small cone acts as a diffuser for frequencies below 10 kc/s generated by the large cone; likewise the large cone reflects frequencies above 10 kc/s produced by the small cone.

Technical Specification

	9710 (8in)	9762 (12in)
Power handling capacity	10 watts	20 watts
Voice coil impedance	7 ohms	7 ohms
Cone resonance	50 cycles	45 cycles
Efficiency	4.5% at 400 cycles	14% at 400 cycles
Flux density	8,000 gauss	11,000 gauss
Total magnetic flux	97,000 Maxwells	134,000 Maxwells
Magnetic weight	428 gram.	1075 gram.

DESIGN CHARTS FOR CONSTRUCTORS

No. 10. SINGLE-LAYER INDUCTANCE WINDING DATA $0.07\mu H$ to $3\mu H$

by HUGH GUY

THE INDUCTANCE OF A COIL OF WIRE IS usually stated to be proportional to the square of the number of turns comprising the coil. Thus one would expect that to double the number of turns on a given coil would multiply the inductance by four. This would only be true if the volume occupied by the coil were to remain unchanged. Since this is impossible for a fixed wire gauge, then any practical formula relating the turns on a coil to its inductance must also include the effects of its changing size as the number of turns increases.

One formula does this with certain restrictions, and gives the low frequency inductance L in microhenrys as:

$$L = \frac{r^2N^2}{9r + 10l}$$

where r is the mean radius of the coil, l is the length, and N is the number of turns. (See Fig. 1.)

One restriction is that the coil length l must not be less than 80% of the mean radius r.

Despite appearances, this formula is by no means a simple one to deal with, for the following reasons:—

1. The mean radius r is the sum of the radius of the former R, and the wire diameter d, and therefore varies with wire gauge.
2. The length l is itself the product of the wire diameter d and the number of turns N, and consequently is again dependent on wire gauge.
3. As it stands, the formula will tell us the inductance of the coil if we know its size and its number of turns, but it will not tell us the number of turns required for a specified value of inductance, a form in which it would be more useful.

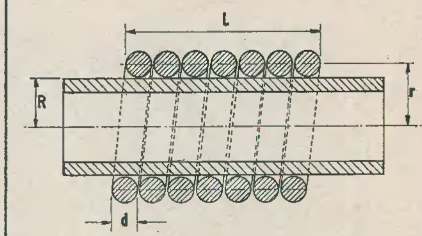
If rearranged to provide this solution, the formula is rather unwieldy:

$$N = \frac{10L}{(R + d/2)^2}\left[d + \sqrt{1.09d^2 + 0.36dR + 0.36R^2}\right]$$

Presentation in Chart Form

All the arithmetic can be removed by presenting the inductance in chart form, and the process can be further simplified by restricting the application of the chart to a standard range of coil formers, and selecting a limited number of wire gauges. Having chosen a former the maximum and minimum winding lengths are automatically fixed, and a data line can be used to cover the range of possible inductance values and appropriate number of turns for a given wire gauge.

Four wire gauges have been selected: namely 16 s.w.g., 20 s.w.g., 26 s.w.g., and 36 s.w.g., all in enamelled copper wire. Each wire gauge gives rise to its own chart, each of which, for five different sized formers, relates low frequency inductance values and corresponding turns of wire, enabling either to be determined in terms of the other.



SINGLE LAYER COIL DIMENSIONS

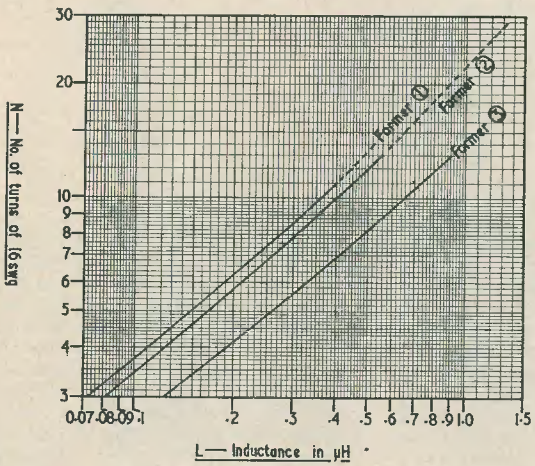
FIG. 1

o 369

Coil Formers

Most modern coil formers are of the iron dust-cored type, adjustment of the latter providing a means of varying the inductance of the coil. Of these types the most widely encountered ones are in a group defined by three different diameters. These diameters are 0.276in, 0.300in, and 0.415in. It is upon formers of these diameters that these design charts are based.

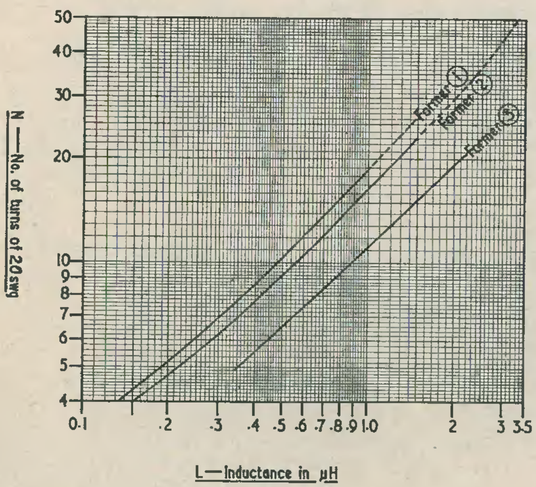
DESIGN CHART 10a



Former	Dia. Ins.	Length
①	0.276	0.75 1.0
②	0.3	0.91 1.96
③	0.415	0.875

COIL DATA for 16swg enamelled copper wire.
SINGLE LAYER CLOSE WOUND

DESIGN CHART 10b



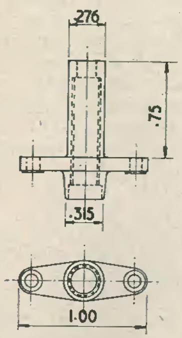
Former	Dia. ins.	Length
①	0.276	0.75 1.0
②	0.3	0.91 1.96
③	0.415	0.875

COIL DATA for 20swg enamelled copper wire.
SINGLE LAYER CLOSE WOUND

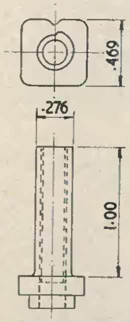
G 370

TYPICAL COIL FORMERS SUITABLE FOR USE WITH DESIGN CHARTS

FORMER ①

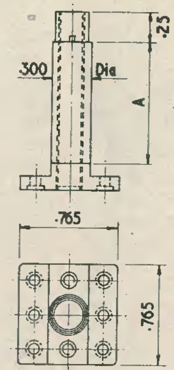


TEE BASE
Chart Code — Former ①
Aladdin Types-5961, 5959



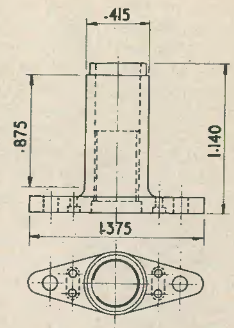
CAM BASE
Chart Code — Former ①
Aladdin Types-5947, 5948

FORMER ②



MOULDED BAKELITE
Chart Code — Former ②
Aladdin Type — 5938
A 0.910ins.
Chart Code — Former ②
Aladdin Type — 5937
A 1.96ins.

FORMER ③



MOULDED BAKELITE
Chart Code — Former ③
Aladdin Types — 5892, 5925

SCREW DUST CORES FOR FORMERS

Dia. m/m	Pitch m/m	Length ins.	Aladdin Type	Associated Former Type
6	0.75	0.500	5921	5947 5959
6	1.0	0.315	5972	5937
6	1.0	0.375	5942	5938
6	1.0	0.500	5839	5961
6	1.0	0.625	5884	5948
8	0.75	0.675	5920	5925
8	1.25	0.500	5918	5892
8	1.25	0.675	5804	

DRAWINGS REPRODUCED BY KIND PERMISSION OF 'ALADDIN RADIO INDUSTRIES' GREENFORD.

G 371

Now each of these types is available in several different lengths and styles depending on the whims of the manufacturer, but the reader will recognise several from the outline drawings of Fig. 2 which shows a typical range produced by Aladdin Radio Industries of Greenford. In the figure, the types are listed under three headings defined by their respective diameters.

Other manufacturers supply formers of differing lengths, but for convenience the charts have been designed around those indicated in the figure.

The maximum number of turns that it is possible to wind on a particular former is governed by its length. Since two types of each of former 1 and former 2 exist, then the winding lengths will differ for each.

For example, a line will be found on each chart labelled Former 1. Two different formers under this heading are available, one of winding length 0.75in, the other 1in. Obviously more turns can be wound on the latter; and thus, on the chart, the solid line covers turns that can be wound on either former while the dotted continuation of this line will cater only for the turns that can be accommodated on the longer (i.e. 1in) former. This system also applies to the two types available under the heading Former 2. The legend on each chart summarises this information.

Using the Charts

Having selected a coil former, using the charts is extremely simple.

Suppose that it is proposed to wind an inductance of $2\mu H$ on a former of type 2. Then the two charts published this month, numbers 10a and 10b covering 16 s.w.g. and 20 s.w.g. respectively, show that 20 s.w.g. wire must be used. Thus on chart 10b it can be seen that 30 turns is the required number since the inductance value of $2\mu H$ intersects 30 on the turns scale at the data line marked former 2. Furthermore, since the data line is dotted at this intersection, the larger type of former 2 should be used.

Practical Points

These charts cover the low frequency inductance values of single layer coils. That is to say that the coil of $2\mu H$ just considered, for example, could only be guaranteed to have this value at low frequencies. Invariably, of course, such a coil would be required for a much higher frequency than that for which this specification holds. Consequently for very small values of inductance, such as are covered by these two design charts, it is possible to get an apparent error of as much as 2 : 1 in the values of these coils when they operate at high frequencies.

This is due largely to the effect that the leads to the coils themselves have on the inductance, and as a rule one may expect to find the inductance larger in practice over this range than indicated by the charts.

For all practical purposes, therefore, it is a good policy when having to make a coil of this type to halve its required value and wind one to the data provided by the charts to this new value. The exact value can then be obtained by inserting the iron core.

In all cases, the design data is given for formers with the core removed. Consequently to ensure that the final coil is of an inductance whose value is produced with the core about half-way in, it is a good plan to design coils of somewhat less inductance than the required value.

Styles of core vary, of course, as does their electrical performance, but as a rule most cores provide up to a 2 : 1 variation in inductance up to medium frequencies. At high frequencies, however, say from 30 Mc/s upwards, certain cores are responsible for eddy current losses with consequent worsening of the Q or magnification factor of the circuit in which the coil is connected.

A list of iron cores suitable for use with the formers mentioned is given also in Fig. 2.

Next month the two charts covering 26 and 36 s.w.g. enamelled copper wire will be given to provide design data for coils of up to $60\mu H$ inductance.

New Mullard High Power Triode for Industrial R.F. Generators

The TY7–6000 is a new Mullard triode specially developed for use in industrial r.f. generators such as are used for r.f. heating. It will deliver an output of 6kW at frequencies up to 50 Mc/s and has been conservatively rated to ensure adequate margins of safety when used in industrial heating applications, where the valve may be subjected to mains and load variations, which can result in intermittent overloads.

The new triode is available in two versions, the TY7–6000A which is designed for forced air cooling, and the TY7–6000W which is a water-cooled version. The maximum permissible anode dissipation is 6,000 watts in either case, and anode voltages up to 7kV may be used. The valves have directly heated thoriated tungsten filaments, and external anodes.

A STANDARD AUDIO FREQUENCY GENERATOR

by **D. R. BOWMAN**

THE EXPERIMENTER WILL OFTEN HAVE found the need for a standard audio-frequency wave; the calibration of the lower-frequency bands of an oscilloscope is one obvious application, while a suitable tone for modulating a signal generator is another. The testing of audio-frequency amplifiers can hardly be carried out without apparatus of advanced design, but it is often useful to have a ready means of checking the amplifier for obvious harmonic distortion—especially when the ear is the only measuring instrument available.

Tone generators usually employ the principle of the phase-shift oscillator, especially when a wide range of audio-frequencies is needed. With care in design, and assuming that only a very small output is necessary, these can be made to give nearly sinusoidal wave-forms. The frequency range, however, is often difficult to calibrate accurately.

The piece of equipment here described was developed with the idea of having at once available an accurate frequency standard without the need for a stabilised power supply. In addition it seemed worth while to have it generate a pure sine-wave, since distortion can not only be estimated aurally when such a wave is passed through an amplifier, but if an oscilloscope is available, quite accurate measurements can be made of the percentage harmonic distortion.

Accordingly, the phase-shift oscillator was not used, and instead a tuning-fork-controlled audio-frequency generator was decided upon. Though this can operate at only one frequency, it has the advantages of accurate operation at the specified frequency and also, since the fork itself is only very lightly damped and therefore has an effective Q of many hundreds of thousands, the wave-form generated is accurately sinusoidal.

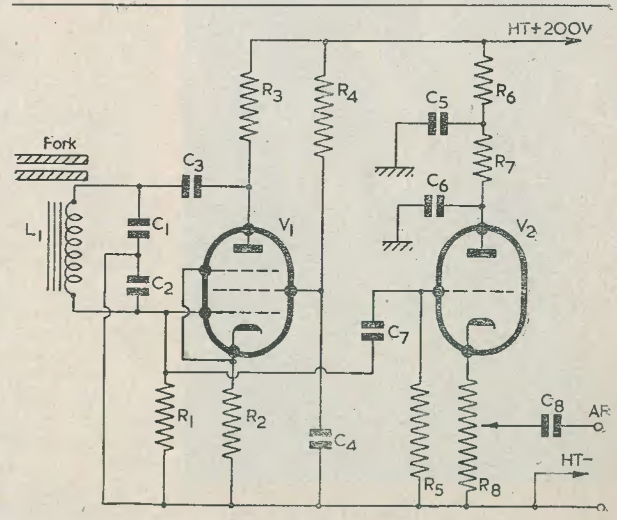


Fig.1 Circuit diagram.

Fig. 1 shows the theoretical circuit. It will be seen to consist of a Colpitts oscillator with a buffer amplifier giving cathode-follower output. The choice of the Colpitts circuit depended on the fact that, since at both anode and grid the impedance is low for frequencies other than the fundamental, a very nearly sinusoidal output is obtained even without tuning-fork control. Some negative feedback is introduced by way of R_2, and the result is that the sine-wave generated by the fork remains entirely undistorted by the working of the oscillator. To ensure a really low impedance at harmonic frequencies C_1 and C_2 have been given relatively very large values. As a result, the impedance at the frequency of the second harmonic is, at grid or anode, less than 500 ohms compared with about a megohm at the resonant frequency, and negligible second harmonic voltage is thus present.

The choice of frequency was for 440 c/s. This was not only because a tuning fork for that frequency is commercially available, but also because it is—for the musically inclined—an important reference frequency, namely A above middle C.

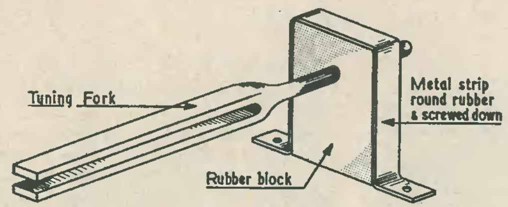


FIG. 2. SUGGESTED METHOD OF MOUNTING THE FORK

Constructional Notes

L, the inductive element of the resonant circuit, needs to be about 0.6 to 0.7 Henrys. In the writer's instrument, the pole coil of a very ancient moving iron loudspeaker was fitted with three strips of stalloy to get the required inductance—strips from an old transformer lamination were used. One element from a high-resistance telephone earpiece would also do quite well. It is quite important to get the circuit L_1–C_1–C_2 resonant at approximately 400 c/s, otherwise the tuning fork will not "lock in." On the other hand, too close a match is neither necessary nor even desirable. If the match frequency is too close, the fork may be over-driven, resulting in its striking the laminations, and its sinusoidal wave generating properties destroyed.

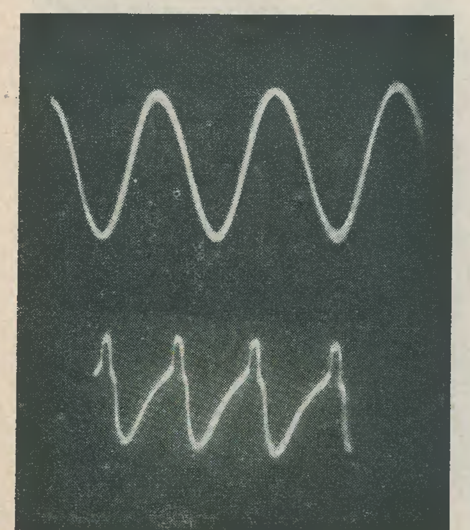


Fig. 3

It will be obvious that the link between the oscillatory circuit and the fork is magnetic. Consequently a tuning fork of magnetic material must be employed. A fork of the required frequency can be obtained from any good music shop, and the constructor should take with him a small pocket magnet to test its properties before buying.

The fork should be mounted so that the prongs approach about $^1/_{10}$in from the laminated core of L_1. Some small adjustment should be allowed for. To avoid too much sound radiation from the fork, it may be mounted on a rubber block. Fig. 2 shows the writer's method of mounting, which is with the fork horizontal. A piece of india-rubber eraser, bought from the local stationers, and anchored with a strip metal clip, was found to diminish the sound radiation appreciably. Too violent a vibration of the fork can be avoided by increasing the gap between the inductor L_1 and the prongs.

Layout is by no means critical, and any arrangement to suit individual needs can be adopted. If the circuit is built on a metal chassis, as is preferable, of course, it may be screwed to a wooden base to get increased mechanical stability.

All resistors can be ½ watt with the exception of R_3, which should be of 1 watt or higher rating, and R_8 which is a 1 watt 10kΩ potentiometer. Capacitors may be of the tubular variety except C_3, C_1 and C_2; all of these should be of the waxed paper dielectric type or better, and should be tested for their ability to "hold a charge" before wiring.

The output is of low impedance—about 100 to 400 ohms, depending on the type of valve used in the output stage. There is thus very little likelihood of the waveform becoming distorted by feeding it into unsuitable C–R networks from the output terminals. Maximum output impedance occurs when the slider of R_8 is near its mid-position of rotation. The maximum output is about 5 or 6 volts; this is hardly enough to modulate a signal generator to a depth of 100% by grid or suppressor grid modulation, but will give a useful degree of modulation nevertheless, with high accuracy of waveform. The total output will, of course, fully drive a modulator valve for anode modulation.

Since in any case the maintenance of oscillations in a self-excited oscillator requires harmonics to be present, the circuit is liable to be a "difficult starter" in view of its remarkable purity of waveform. If any trouble is experienced in getting the oscillations to start, the easiest way—and one which is almost invariably effective—is to switch off the heater. As the cathode cools, the valve impedance rises, and if h.t. is left switched on a point will be noted at which oscillations begin. At this point the heater should be switched on again, when oscillations will be maintained. Alternatively, if the resonant frequency of L_1–C_2–C_1 is very close to that of the tuning fork, plucking the prongs of the fork may cause oscillations to begin and to be maintained.

Fig. 3 shows photographs of the waveform produced by this circuit, and also for comparison the waveform produced by a Hartley circuit using the *same* components differently arranged. This shows up the Hartley in an unfavourable light—a better wave could be produced by modifying the circuit values—but the advantage of the Colpitts circuit is obvious.

Component List

L_1 see text

Resistors
R_1 220kΩ
R_2 200Ω
R_3 33kΩ
R_4 100kΩ
R_5 1MΩ
R_6 10kΩ
R_7 10kΩ
R_8 10kΩ pot.

Capacitors
C_1 0.5μF
C_2 0.5μF
C_3 0.25μF
C_4 2μF
C_5 0.5μF
C_6 0.5μF
C_7 0.1μF
C_8 0.1μF

Valves
V_1 SP61 (CV1065)
V_2 6J5 (or CV1065 connected as triode)

CLUB NEWS

Details for insertion in this section should reach us not later than 7th of the month of publication. Insertions are subject to space being available.

CRAY VALLEY

The October meeting of the Cray Valley Radio Club will be held at the Station Hotel, Sidcup, on Tuesday, 23rd October, 1956, at 8 p.m. and will comprise an exhibition of members' home-constructed equipment. The event is also in the nature of a competition, and awards will be made for the best exhibits.

A full programme of monthly meetings has been arranged for the winter season and all having any interest in any aspect of amateur radio are welcome to attend meetings of the club. Applications for membership are particularly invited. Hon. Sec., S. W. Coursey, G3JJC, 49 Dulverton Road, London, S.E.9.

THE BRITISH AMATEUR TELEVISION CLUB

This year's Convention of the above club will be held at the Bonnington Hotel, Southampton Row, London, W.C.1, from 10 a.m. till 7 p.m. on Saturday, 27th October. In addition to demonstrations of equipment owned by some of the members, there will be a film show and other interesting displays.

Prices of admission (which do not include the cost of lunch) are as follows: Members 3s. 6d., Non-members 5s. Tickets will be on sale at the door, or may be obtained in advance from D. S. Reid, 4 Bishop Road, Chelmsford, Essex.

CRYSTAL PALACE AND DISTRICT RADIO CLUB

On Saturday, 20th October, G4ZU will deliver a talk on his well-known Four Band Mini-Beam aerial array. The meeting will commence at 7.30 p.m. at Windermere House, Westow Street, London, S.E.19. Hon. Sec., A. J. Worrall, 169 Kent House Road, Beckenham, Kent.

PLYMOUTH RADIO CLUB

The club meets fortnightly, on alternate Tuesdays at 7.30 p.m., this month : 2nd, 16th and 30th, at the Virginia House Settlement, Barbican, Plymouth. Hon. Sec., C. Teale, G3JYB.

THE "CLARIBEL" AMPLIFIER

In the article bearing the above title, in our last issue, the voltage of the PCL83 heater and the secondary of the heater transformer was erroneously given as 6.3 V. This should, of course, have read 12.6 V. A suitable transformer is the Radiospares C.R.T. transformer, which is rated at 12.6 V tapped at 10.5 V.

An R.F. RESONANCE INDICATOR

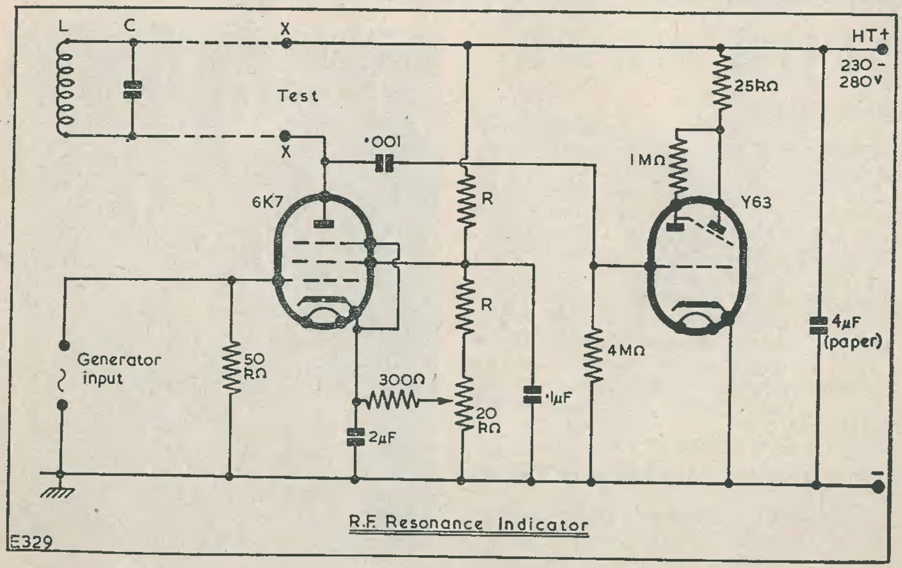
by E. DARMANIN, *A.M.I.P.R.E.*

An R.F. amplifier valve gives maximum amplification when the anode load offers an infinitely high impedance. This condition only occurs when the anode load is a parallel-tuned circuit, which is exactly tuned to the incoming signal at the grid. Therefore, it follows that if an r.f. amplifier is loaded by a parallel-tuned circuit, and a signal generator is fed between grid and earth, maximum amplification is obtained *only* when the generator is feeding that signal to which the tuned circuit (anode load) resonates.

A valve-voltmeter between anode and earth will indicate resonance. However, we can dispense with the valve-voltmeter and employ with advantage a magic-eye indicator. By using a high value grid resistor there will be no damping effect on the impedance of the circuit under test. Also, a magic-eye is much more obtainable and cheaper than a valve-voltmeter. All that matters here is resonance, and not voltage measurement.

The uses of this indicator are versatile. When a tuned circuit resonates at a certain frequency and either the capacitance or the inductance is known, the other can be found from

$$f=\frac{1}{2\pi\sqrt{LC}}$$



R.F. Resonance Indicator

For example, with a standard condenser coils can be matched or compared. With a variable condenser, either calibrated or not, the tuning range of coils can be found. I.F. transformers which are not marked can be tested in the same way. Also, i.f. transformers can be tuned to a standard frequency while not in circuit in a receiver. With the use of a calibrated variable condenser, and an r.f. coil, unknown condenser values can be found by first shunting the parallel-tuned circuit with the condenser of unknown capacity and tuning the generator for resonance. Note the setting of the variable condenser. Without altering the signal generator, remove the condenser of unknown capacity and retune the variable condenser until resonance is again indicated. The difference between the two settings of the variable condenser will be equal to that of the unknown capacity. Therefore, this indicator can serve as a capacitance and inductance meter. The user of this indicator will soon find out for himself in how many more ways he can employ it, using only resonance and the formula

$$f=\frac{1}{2\pi\sqrt{LC}}$$

The circuit, as can be seen, is quite straightforward and there is little to be said about it, except to keep the wiring as short as possible, especially the leads to the grids and test terminals, and also to screen the amplifier valve. A 6K7 and Y63 were used in the prototype, but any variable-mu r.f. pentode and cathode ray indicator will serve the purpose. Naturally, the value of the resistors "R" will have to be calculated to meet the voltage requirements of the valve used. The cathode resistor is returned to the slider of a variable resistance which forms part of a potential divider, so that variable bias to the amplifier can be provided. This will allow sharp tuning indication and prevents overloading of the indicator.

To check the resonance of a parallel-tuned circuit, insert same between test terminals X–X, feed in a signal from the generator and tune the generator until maximum indication is given by the closing of the magic-eye. To tune i.f. transformers, insert one of the parallel-tuned circuits between X–X, feed the necessary frequency from signal generator, then adjust trimmer or core for maximum resonance; the other half can be treated likewise. Connections to X–X should be made when the indicator is switched off, as these points are at h.t. potential.

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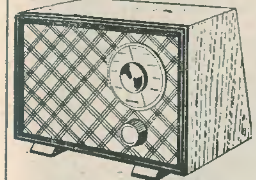

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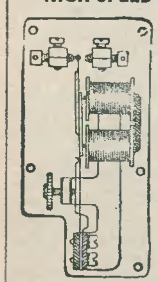

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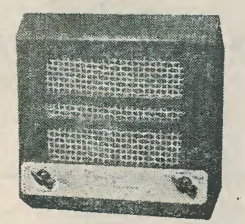

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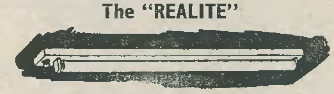

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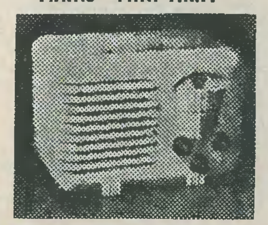

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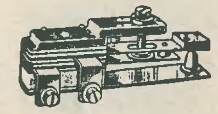

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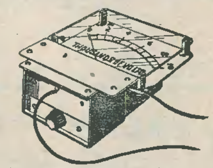

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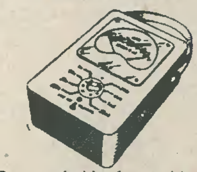

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(*continued on page 215*)

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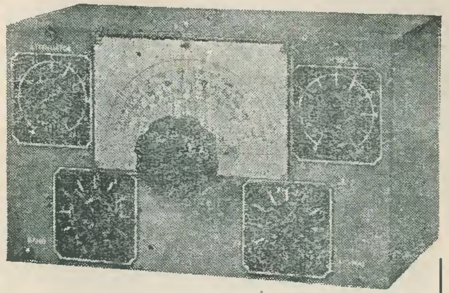

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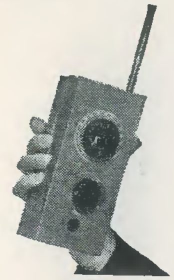

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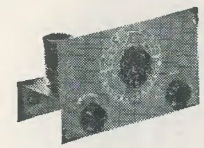

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