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Volume 7
Number 5
DECEMBER
1953

The RADIO CONSTRUCTOR

for the Radio and Television Enthusiast

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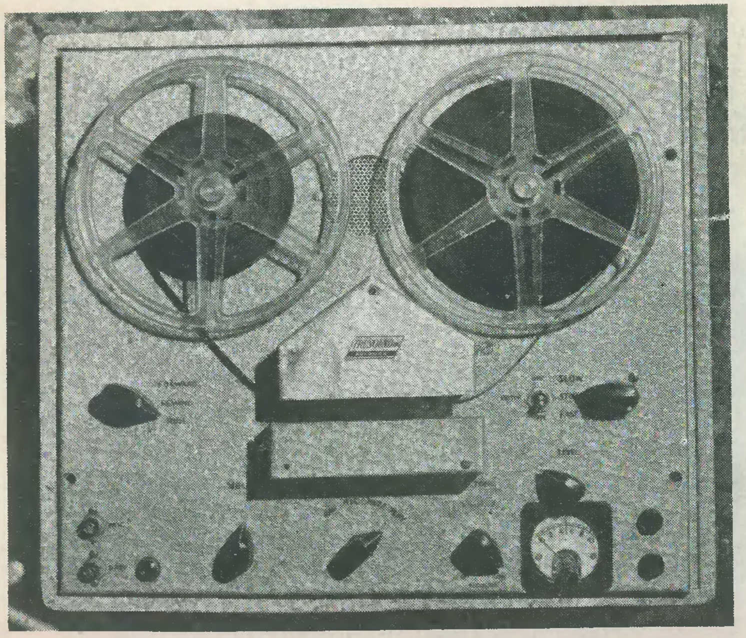

ALSO IN THIS ISSUE

1/6

A KIDDIES' CRYSTAL SET

CONSTRUCTING & USING AN AUDIO OSCILLATOR · HI-FI & RECORDING AMPLIFIER, Pt.2. · BEGINNER'S RADIO CONTROL RECEIVER · CAPACITANCE-OPERATED MUSICAL INSTRUMENT · R1155 OUTPUT STAGE & POWER PACK · Improved Fidelity at Low Cost · Rotary Transformers & Vibrators etc. etc.

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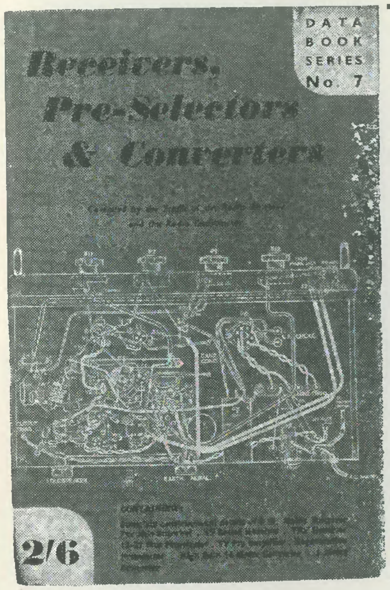

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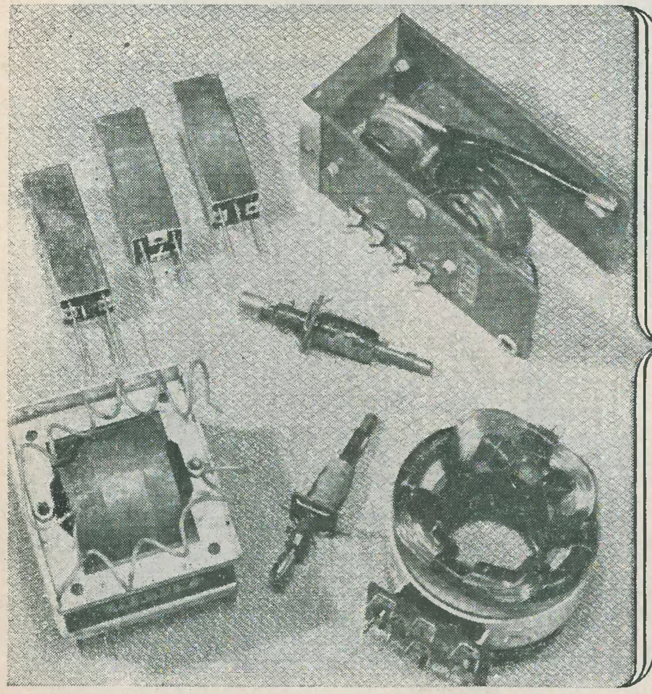

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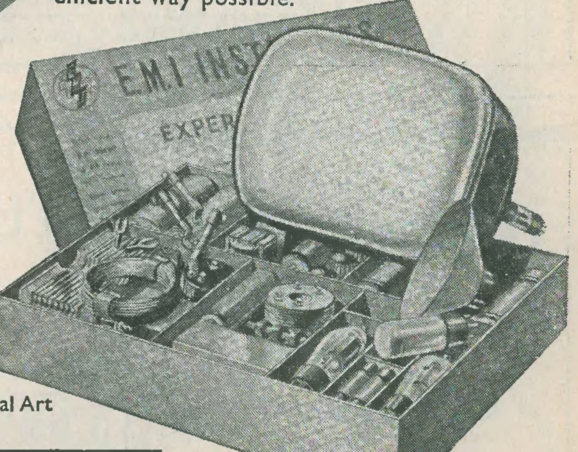

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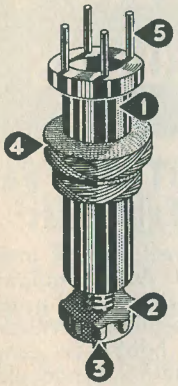

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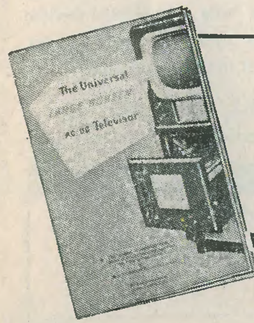

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The RADIO *Constructor*

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NOTICES

THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should 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 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.

ALL CORRESPONDENCE should be addressed to *Radio Constructor*, 57 Maida Vale, Paddington, London, W.9. Telephone CUN. 6518.

Suggested Circuits for the Experimenter

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. 37 : A Capacitance-operated Musical Instrument

THE PRINCIPLE OF USING the varying capacitance existing between the hand and a vertical metal rod to operate an electronic musical instrument is by no means new. A considerable amount of research into the possibilities of such an arrangement was made by serious musicians before the war; and it was claimed that, owing to the complete freedom of the hand when playing the instrument, a considerable degree of expression could be obtained.

In its original form, the instrument consisted of two RF oscillators, these being tuned approximately to the same frequency and so arranged that their combined output was fed to a common detector. A vertical metal rod was connected to one of the oscillators in such a manner that, as the player's hand approached the rod, the varying capacitance existing between the rod and the hand altered the frequency of oscillation. Thus, as the outputs of the two oscillators were beating together in the detector, it was possible to obtain an AF tone which varied with the proximity of the player's hand to the rod.

This arrangement was fitted with a pedal-operated volume control which carried out the approximate function of a swell control. At this state of its development, the instrument suffered from the disadvantage that it was difficult to operate the swell pedal sufficiently quickly to prevent "slurring" as the player proceeded from one note to the next. At the same time, however, it was still possible to obtain several interesting effects, including a vibrato which could be given by moving the fingers. (It should be pointed out that this was a vibrato in *pitch* and not in sound amplitude).

The slurring effect was later overcome by the addition of a switch which was held in the performer's left hand. This switch controlled one of the oscillators (or subsequent amplifier), and enabled the instrument to be switched out while the player selected his notes. The switch afforded a considerable improvement and the instrument became capable of far more versatile applications than was hitherto possible.

Due, possibly, to the lack of development in the electronic art in pre-war days, or more probably, to the advent of the war itself, the capacitance-operated instrument does not appear to have evolved further. It had, nevertheless, already made several public appearances in various forms, the most noteworthy in this country being, perhaps, in the music-hall sphere where it was demonstrated both as a novelty and as a serious instrument.

A New Departure

It will be seen from the above that the capacitance-operated instrument is capable of offering a considerable amount of expression to the musician. It has further advantages. These consist of an almost unlimited range of pitch, since it may produce any tone lying between the upper and lower limits of audibility; a considerable range of swell control (in common with almost all other electronic instruments); and the advantage that it requires no manual or finger-board. This last point not only reduces the cost of the instrument; it also allows the novice to acquire its technique in a very short space of time.

It has, however, the disadvantage that the note produced is a sine-wave; and it therefore lacks tone-colour.

In this month's Suggested Circuit the writer has, amongst other things, made an attempt to considerably enrichen the tone of the instrument. This has been done by multiplying the fundamental frequencies in such a manner that second, third and fourth overtones (or harmonics) may be added to the original note in any proportion whatsoever. Indeed, it is even possible, with quite simple controls, to obtain the overtones by themselves and completely cut out the original fundamental tone!

The process of obtaining the overtones is made possible by multiplying the radio frequencies of the two oscillators, and subsequently detecting the multiplied frequencies at separate detectors. Thus, assuming that the RF oscillators were working originally at, say, 5,000 and 5,001 kc/s repectively, their beat note would consist of a 1 kc/s note. If the radio frequencies were doubled they would become 10,000 and 10,002 kc/s, these new frequencies producing a beat note at 2 kc/s. Similarly, trebling the frequencies would offer 15,000 and 15,003 kc/s respectively, giving a beat note of 3 kc/s; and so on.

The Circuit

Let us now consider the circuit accompanying this article.

The two oscillators providing the radio frequencies are V1a and V2a. These feed into cathode followers V1b and V2b; the two outputs appearing finally across the combined cathode resistor, R20. It is necessary to isolate the two oscillators from each other by cathode followers (or similar buffer stages) as their frequencies would otherwise tend to "pull" towards each other. The two circuits are, for the same reason, screened from each other.

The oscillators work at 6 Mc/s. From the writer's experience, this frequency is quite convenient (although it is not, of course, critical), as it allows the complete audio range to be obtained with some 75 to 100pF for the capacitive element of the tuned circuit to which the pick-up rod is connected. The capacitor C6 is a panel control which may be used for finally trimming the tuned circuit whenever this is required.

A key, S1, is connected in the anode circuit of V1, and is used for switching this oscillator in and out. S1 may be either hand- or foot-operated. It would be preferable, however, to have it hand-operated and, furthermore, mounted on the panel together with the other controls. These could then be adjusted by the left hand whilst the right hand was used for playing. If desired, the pick-up rod could be mounted several feet from the rest of the instrument, it being connected to its appropriate circuit through low-capacitance coaxial cable, the outer sheath of which would be earthed to the instrument chassis.

Both V1 and V2 are double triodes. Two 6SN7's would cope quite well here.

The combined RF output appearing across R20 is applied to V3, which acts as a leaky-grid detector. Both RF and the fundamental AF beat note appear at the anode of this valve, and the second RF harmonic is picked out by L5-C12. The AF note, filtered by R9, C15 and C16, is then passed, via C17, to R31.

The second harmonic RF built up across L5-C12 is passed to a further tuned circuit, L6-C13, by means of the mutual inductance existing between the two coils. This coupling is obtained by mounting the coils side by side in the same manner as is done in an IF transformer. Both tuned circuits are peaked to 12 Mc/s, and this frequency is passed to V4, which also performs the double function of leaky-grid detector and multiplier. By a similar process to that occurring in the anode circuit of V3, the 2nd harmonic AF tone is passed, via C25, to R30; whilst the 4th RF harmonic, at 24 Mc/s, is passed to V5.

V5 acts as a leaky-grid detector, the detected 4th harmonic AF tone being passed to R28.

At the same time, the combined RF oscillator output appearing across R20 is fed to V6. This valve is over-biased by R22, and the 3rd RF harmonic is picked out by L9-C34 and L10-C35. The RF is then fed to the leaky-grid detector V7; and the 3rd harmonic AF note produced at its anode passed finally to R29.

The pentodes V3 to V6 should be straight (not vari-mu) RF types, such as the 6J7. V7 may be a 6J5, or similar valve.

Variable Couplers

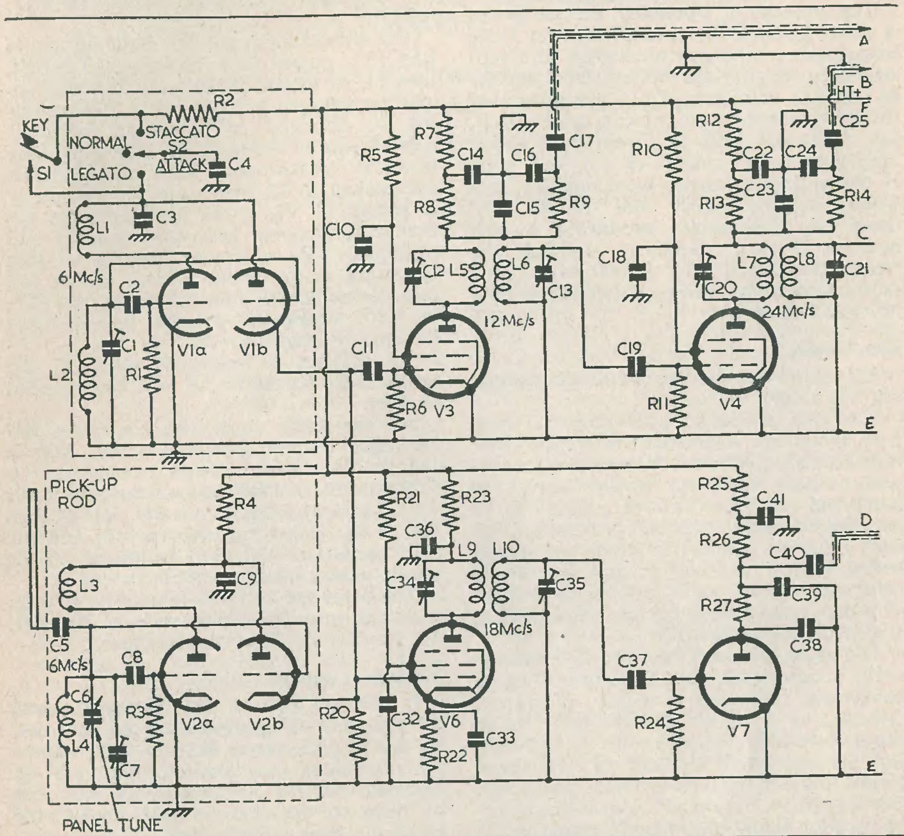
It will now be seen that the fundamental AF tone and its harmonics are fed, in order, to the potentiometers R31 to R28. These potentiometers are pre-set, and are so adjusted that the AF amplitudes presented by them to the resistors R32 to R35 are all at the same volume level.

These latter resistors are the Variable Couplers and are panel mounted. Their purpose is to select whatever proportion of overtones is desired for passing on to the subsequent stages of the instrument. Their nomenclature, "1st Octave," "2nd Octave," and "3rd Octave," refer to the 2nd, 3rd and 4th harmonics. Resistors R36 to R39 are included in the circuit to prevent individual settings of the Variable Couplers from interfering with each other.

The combined output from the Couplers is next fed to the pentagrid V8, and thence, via the Swell Control, to the subsequent amplifier. V8 may be a 6L7 or similar valve; and the Swell Control may be either foot or knee-operated according to individual requirements.

Vibrato

A vibrato control is introduced by the circuit around V9. This valve functions as a phase-shift oscillator, the values of C46, 47 and 48, and R46, 47 and 48 being such that it oscillates at approximately 3 cycles per second. This frequency is tapped off R48 and is applied, via direct connection, to the second control grid of V8. The depth of vibrato may be varied from nil to maximum by adjusting R48. V9 may be a 6J5 or any equivalent valve.



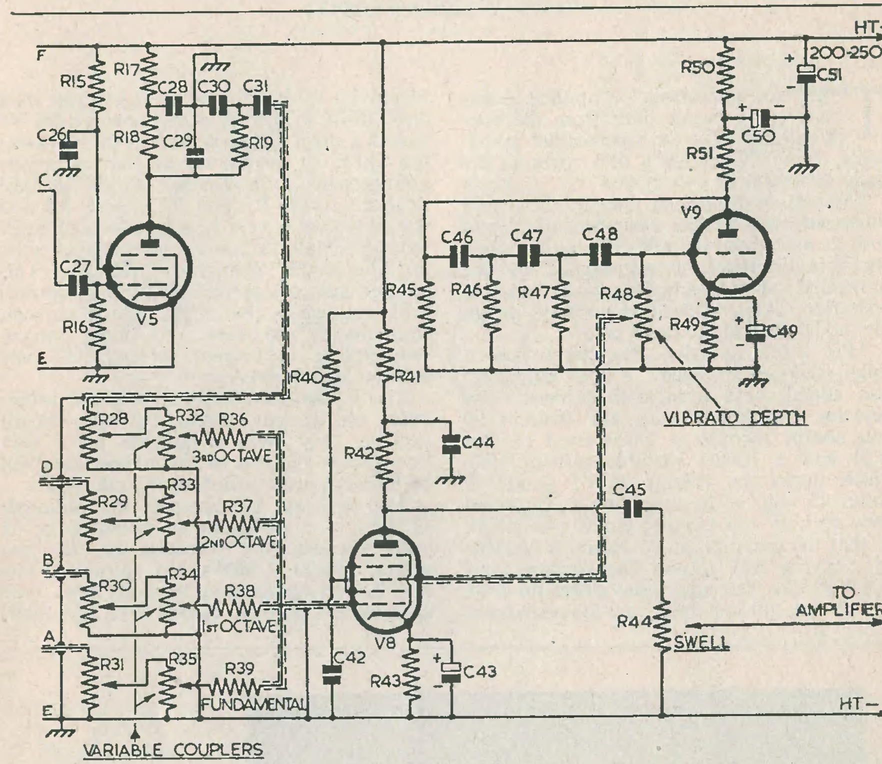
RESISTORS

R1	20kΩ	R15	150kΩ	R27	20kΩ
R2	50kΩ	R16	250kΩ	R28 to 35	250kΩ
R3	20kΩ	R17	50kΩ	R36 to 39	500kΩ
R4	50kΩ	R18	100kΩ	R40	200kΩ
R5	150kΩ	R19	20kΩ	R41	50kΩ
R6	250kΩ	R20	2.5 kΩ	R42	150kΩ
R7	50kΩ	R20	2.5kΩ	R43	2kΩ
R8	100kΩ	R21	250kΩ	R44	500kΩ
R9	20kΩ	R22	20kΩ	R45	100kΩ
R10	150kΩ	R23	50kΩ	R46, 47	300kΩ
R11	250kΩ	R24	250kΩ	R48	250kΩ
R12	50kΩ	R25	50kΩ	R49	1kΩ
R13	10kΩ	R26	100kΩ	R50	25kΩ
R14	20kΩ			R51	100kΩ

"Attack"

A further refinement is offered by the "Attack" Switch S2. When this is in the central, "Normal" position, the keying of the instrument is flat and without peaks. On switching to the "Legato" position, the 0.5μF capacitor, C4, is connected to the anodes of V1a and V1b. C4 tends to discharge through the valves when the key is raised, with the result that, when it is pressed again, the anode voltage of V1a and V1b takes a short time to rise to its full voltage. The keying at this position is, correspondingly, relatively slow and smooth.

The reverse happens when S2 is switched to "Staccato." In this case the voltage across C4 tends to rise to the full HT voltage when the key is raised. Therefore, when the key is depressed, V1a and V1b work at a momentarily higher voltage as C4 discharges again. This results in keying which is staccato in character.



CAPACITORS

C1	Trimmer	C18	.1μF	C36	.1μF
C2	200pF	C19	150pF	C37	150pF
C3	.01μF	C20, 21	Trimmer	C38, 39	200pF
C4	.5μF	C22	.1μF	C40	.01μF
C5	.001μF	C23, 24	200pF	C41, 42	.1μF
C6	25pF	C25	.01μF	C43	25μF
C7	Trimmer	C26	.1μF	C44	.1μF
C8	200pF	C27	150pF	C45	.01μF
C9, 10	.1μF	C28	.1μF	C46, 47, 48	.1μF
C11	150pF	C29, 30	200pF	C46, 47, 48	.1μF
C12, 13	Trimmer	C31	.01μF	C49	50μF
C14	.1μF	C32, 33	.1μF	C50	32μF
C15, 16	200pF	C34, 35	Trimmer	C51	16μF
C17	.01μF				

A Beginner's

RADIO CONTROL RECEIVER

By H. WATSON G3HTI

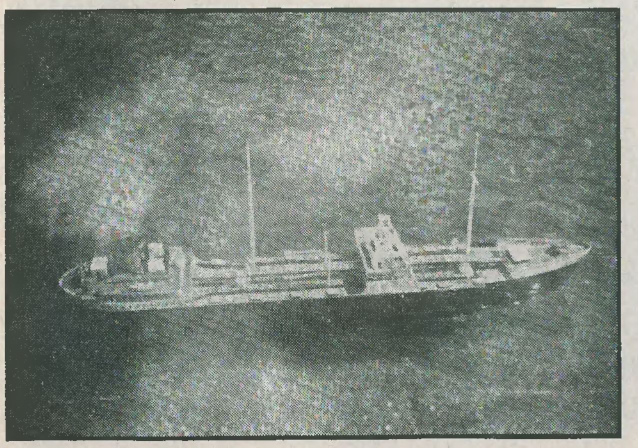
THE TERM 'BEGINNERS,' as applied to this receiver, is meant both from the constructional and the operational standpoint, being the author's first effort in the radio control field.

The aim of the design was simplicity and cheapness, rather than miniaturisation, and with its associated batteries it is quite bulky, but this drawback is outweighed by the simplicity of construction and ease of operation. After all, one can always design the model around the radio gear!

After a few abortive attempts to use a single-stage super-regen., a DC amplifier* was added, with immediate success. The detector is supplied with HT from a 90 volt source through a 25kΩ fixed resistor (R3) and a 100kΩ variable resistor (R2) which drops the voltage at V1 anode to about 45 volts. The amplifier is connected between a 45 volt tap and the 90 volt point, so that the potential at V1 anode is variable (by varying R2) around the filament potential of V2. The relay used closes on 3mA and drops out on 2mA, so for maximum sensitivity R2 is adjusted until just less than 2mA flows in V2. A signal received by V1 causes a drop in anode current in the detector, with a corresponding rise in anode voltage, due to a decrease in the voltage dropped across R3 and R2. Since R3 and R2 constitute a very high anode load resistance, a small change in current gives quite an appreciable change in voltage. This voltage change is applied direct to V2 control grid, causing a rise in V2 anode current, thus closing the relay. At short ranges, this change in current through V2 may amount to 8 or 9mA.

The valves used, both 3A4's, are rather heavy on filament current, but were chosen because they were obtainable at a very low price. The rest of the components will be found in most well-stocked junk boxes.

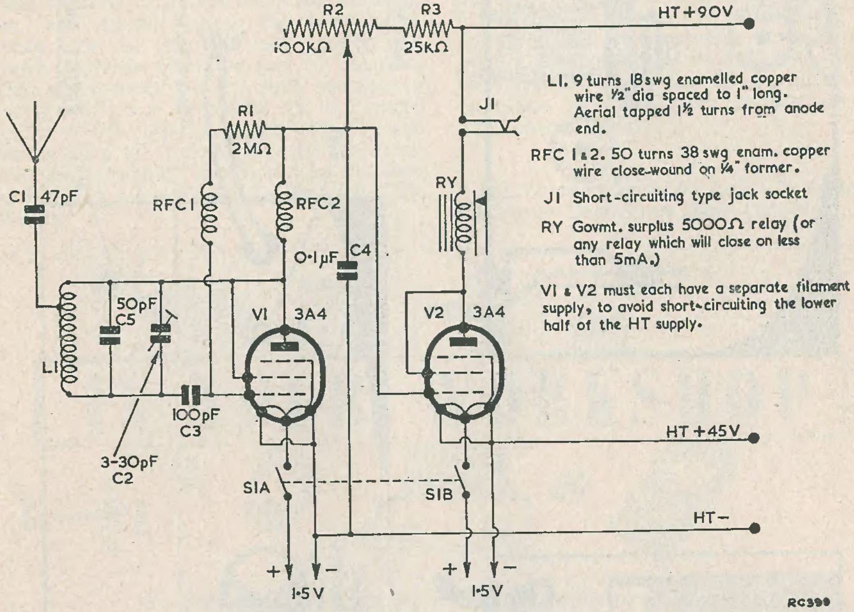
Two separate LT batteries are required, as there is a difference in potential of 45 volts between the filaments of the two valves. Vidor L5040's are suitable. The HT is derived from a 90 volt layer type portable HT battery, Vidor L5512 or similar.



Action photograph of the model tanker in which is fitted the receiver described in this article. The model is electrically propelled, the realistic "smoke" being artificially produced

To obtain a 45 volt tap for the filament of V2, the outer cover must be carefully opened up and the contents slid out. It will be found that the battery consists of four 22½ volt sections, and a lead-out is soldered to the 45 volt point and the battery replaced in its cover, which can be re-glued, or held together with a rubber band.

If a receiver covering 27 Mc/s is not available, then the setting up process is reversed. R2 is adjusted to the value where the relay just drops out, and with the transmitter radiating on 27 Mc/s C2 is rotated until the relay closes. By backing off R2 a little at a time, it is possible to find the exact resonance point when the relay just flicks in and out on tuning through. When this point is found, R2 should be re-adjusted for maximum sensitivity, to the point where the relay just drops out. Faulty setting will result either in greatly reduced sensitivity and range, or in the relay closing on the first signal received, and remaining closed until R2 is reset!



Circuit of the radio control receiver

Setting Up

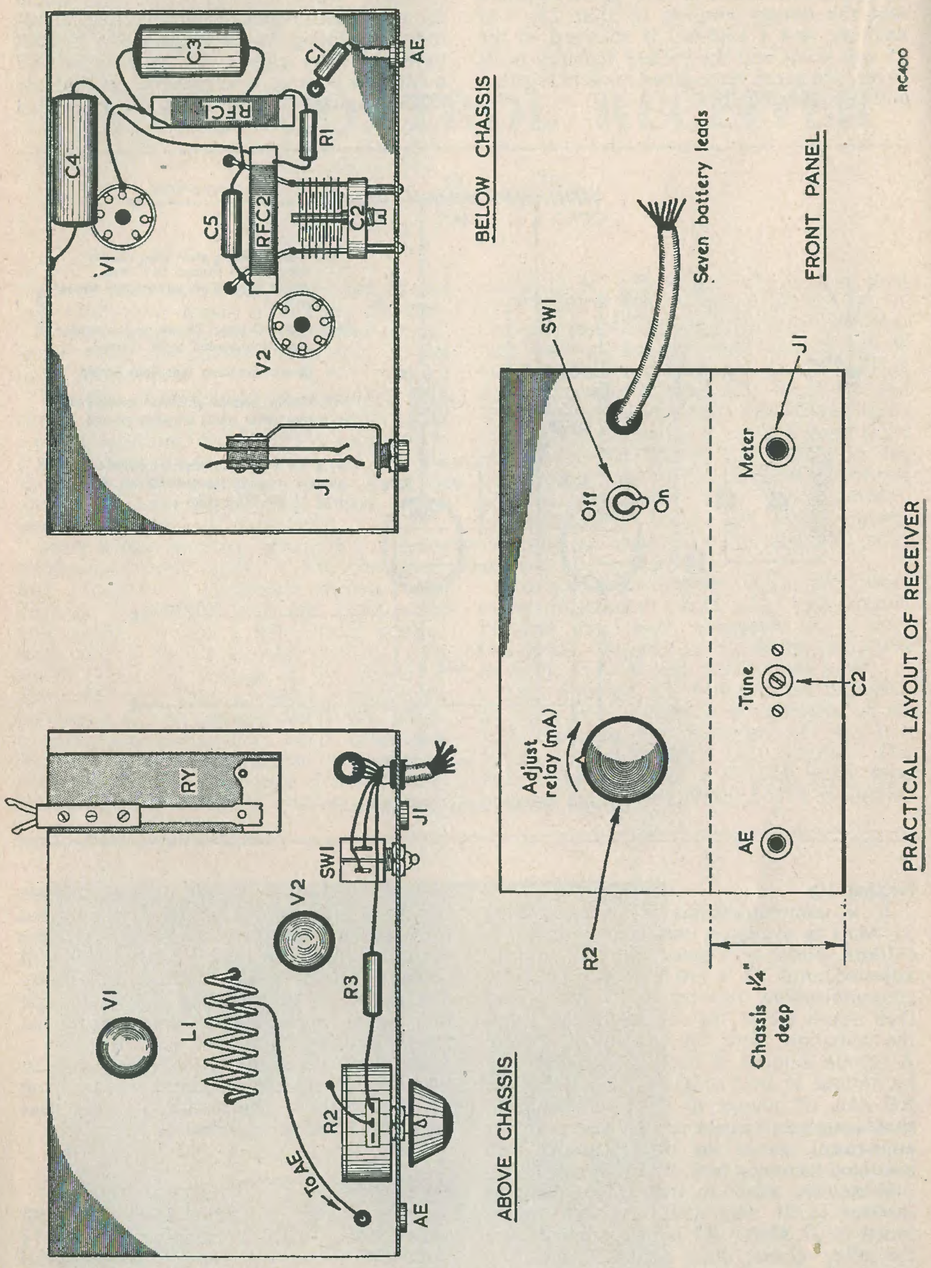
If a communications receiver covering 27 Mc/s is available, this is very easy. A 0-10mA meter is plugged into J1, and R2 adjusted until V2 is just cut off. Tune the communications receiver to 27 Mc/s, and then adjust C2 on the control receiver until the radiation from the detector is heard. A certain amount of hand capacitance may be noticed as both sides of C2 are 'hot' to RF and, of course, to DC. An insulated shaft coupler, or in the case of a screwdriver adjustment, as in the original model, an insulated trimming tool, should be used.

When the signal in the communications receiver is at maximum, the detector is tuned to 27 Mc/s. R2 is now rotated until the relay closes, then reversed until the relay just drops out. A 27 Mc/s carrier should now operate the relay.

The 47pF capacitor in the aerial tends to reduce body capacitance effects when setting up, and with it, the length of aerial has negligible effect on the receiver tuning.

Performance

Using a pair of 3D6's in a push-pull self-excited oscillator running about 1½ watts DC input, with an 8*ft.* whip aerial and a 2*ft* 6*ins* aerial on the receiver, a range of about a quarter of a mile was obtained.



PRACTICAL LAYOUT OF RECEIVER

Maximum permitted input for model control being 5 watts, with this amount of transmitter power this range should be doubled or trebled.

Construction

The receiver is built on an aluminium chassis 5″×3½″×1¼″ deep, and is totally enclosed in a small aluminium case (home made) measuring 5″×3¼″ high, ×3½″ from back to front. All switches, leads, controls, etc., are brought out to the front panel, except for the relay contact connections, which protrude from the rear of the case. This arrangement proved quite satisfactory except that the proximity of the aerial socket to the variable resistor control made setting up a bit 'touchy', due to hand capacitance. Probably this would be obviated by bringing the aerial out to the rear of the chassis.

Batteries require about the same amount of space as the receiver, which is used to control a model boat 3*ft* 4*ins* long, by 6*ins* beam, by 4*ins* from deck to keel, there being ample room for all control gear, propulsion motor and batteries.

A second effort would probably produce a much more compact receiver, but attempts to use smaller LT batteries and a lower HT supply were not very successful, as battery life became too short to be of any use.

Probably by using 3V4's, or 3S4's, the saving in LT consumption would enable smaller LT batteries to be used, and indeed the increased initial cost of the valves will be offset by the smaller expenditure on replacement batteries.

* See *Remote Control by Radio*, F. C. Judd, *The Radio Constructor*, Sept.-Oct.-Nov., '52.

IN YOUR WORKSHOP

In which J. R. D. discusses Problems and Points of Interest connected with the workshop side of our hobby and based on Letters from Readers and his own experience.

MY REMARKS THE OTHER DAY about the running of a TV receiver from 24-volt battery supplies has prompted several country-dwelling readers to write to me. My correspondents claim that insufficient space is given in constructional journals to those who live in the country without mains, and they state that they would very much like to see more articles devoted to this subject. One reader, N. V. Dinsdale, Stokes St. Milburgh, Ludlow, stated: "The shock of seeing a reference to 24-volt equipment was so great that this letter had to be written in grateful acknowledgment."

Charging Supplies

Mr. Dinsdale also sent a few useful hints that should be worth while passing on.

He obtains his charging supply from a high-current 30-volt tank heater of a type which was prominent in the surplus market several years ago. These generators deliver 50 Amps, run at high speed, and "drink petrol like water." Mr. Dinsdale has reduced the speed of his model by replacing the spring in the centrifugally-operated built-in speed control by one which is weaker. "Trial and error finally yielded an output of 10-20 Amps according to demand, still at 30 volts as the generator is compound-wound."

This reader states also that a neighbour, who uses a 24-volt DC to 230-volt AC converter, gets the same picture wobble on his TV set that I described in my earlier article. In this case, the wobble has been cured by passing the input current to the converter through a variable resistor. Careful manipulation of the resistor yields a position at which the wobble disappears. At this point the output of the converter is, of course, at 50 cycles.

For sound radio Mr. Dinsdale uses an ex-R.A.F. Power Unit type 173. This is a vibrator job and offers an output of 120 for 24-volts input. If, however, the internal neon stabiliser is removed the output jumps to 200 volts at a current sufficient for a four-plus-one.

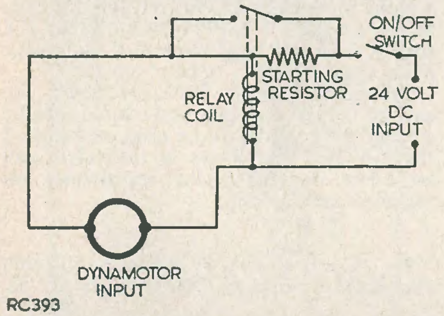


Fig. 1. A simple starter circuit, suitable for operating a small dynamotor from a volume-control switch

Mr. Dinsdale, who is obviously a live-wire in his district, also adds a postscript.

"An amusing exercise in ingenuity was the construction, for the village Coronation 'do', of a 12-volt radiogram. The basis of this was one of those oak HMV table model gramophones, with an excellent motor, spring driven, bought at an auction for £1. Doors on the front opened into the sound chamber. Into this chamber was built a 10-watt amplifier, 2 6C5's and 2 6V6's in push-pull. A new piece of oak above carried the Connoisseur pick-up. Switching on at the front panel (behind the doors) gave choice of radio (for the Queen's speech at 9 p.m.) provided by a conventional 12K8, 12K7, 12Q7; or amplifier only. A built-in vibrator pack supplied the HT.

"It was a great success; it began its life by playing the National Anthem on my study floor, and stood up to a most exacting day of music and announcements outside and dance music until 2 a.m."

Dynamotors

As another reader has pointed out, an alternative to the Power Unit type 173 for HT is one of the "Command" dynamotors which offer 200 volts at 60mA for an input of 24-volts. I have used several of these myself for country installations, and they are almost completely trouble-free. The models I employed ran for several years without any attention at all. After that time they needed a change of brushes only.

The starting current of these dynamotors is a little high, although it should be possible to run them from the usual switch fitted to a volume control. However, to play safe, I added starter circuits to the ones I fitted.

A suitable circuit for a dynamotor starter is shown in Fig. 1. When the switch is closed, current to the dynamotor input passes initially through the starting resistor, this limiting it to a safe value. As the dynamotor gains speed its back EMF builds up, and the voltage appearing across its input terminals rises. When it is sufficiently high, the relay operates, whereupon its contacts short-circuit the starting resistor and allow the dynamotor to run at full input voltage. The whole arrangement is completely foolproof.

The value of the resistor is best found experimentally, but it will probably lie between 5 and 10 ohms. The relay should operate at about 15 volts.

The only snag with these dynamotors is that they create a certain amount of interference on medium and long waves, unless they are screened. Alternatively, the interference can be cured by the simple expedient of positioning them several yards away from the set!

I would be very interested to hear from readers who have tried both vibrator and dynamotor supplies, and who have been able to decide which is the better.

Purchase Tax

Some time ago I gave the Government a present of twenty-six shillings and tenpence. This present was offered somewhat reluctantly on my part, and was most definitely not in return for any services at all that I had received. The presentation occurred when I bought a set of five miniature valves, and the twenty-six shillings and tenpence represented the tax which was levied on their sale.

I think that the time is now more than ripe for Purchase Tax to be removed from radio valves altogether. After all is said and done, no one buys valves just for the fun of it; and, when one considers that most of the valves purchased by the population of this country are used for replacements in faulty receivers, the imposition becomes very unjust, indeed.

It is well known that one of our basic export industries consists of the manufacture of electronic equipment. And it is also well known that the electronic industry, like any other, needs an adequate home consumption of its output if it is to stabilise its finances and develop its markets abroad. Yet consumption at home is deliberately reduced by taxing the component which is used in every single item of equipment—the valve!

Many potential purchasers in this country refrain from buying radio and television receivers simply because the initial cost is too high for their pockets, and because the cost of subsequent maintenance is sometimes more than they care to pay. The initial cost is higher than it should be because of Purchase Tax; and the cost of servicing is often higher than it should be because Purchase Tax has to be paid on any valves that are replaced.

In the last Budget, Purchase Tax was removed from radio batteries because it was considered unfair to tax an article which had to be continually renewed. Valves, also, have to be continually renewed, and the tax should be taken off them, as well.

Early Morning Music

A friend of mine (who usually needs a sledgehammer to get him up in the morning), asked me recently if it was possible to modify his alarm clock so that it would switch on his radio set.

I examined the internals of his clock and found that they contained a small brass release lever which moved through approximately an eighth of an inch when the alarm went off. It was consequently a fairly easy job to fit a small insulated contact to the chassis of the clock for this lever to bear against. When the lever moved, a circuit would then be made between the additional contact and the clock chassis.

It was obvious that the circuit closed by this arrangement would not be able to stand the flow of much current, and that it would be somewhat "intermittent." Also, of course, it certainly could not be used for switching mains voltages.

The switching circuit finally employed is that shown in Fig. 2. The relay shown in this diagram is, in the writer's case, an ex-W.D. job which operated comfortably from an energising voltage supplied by a nine-volt grid bias battery. As will be explained later, its contacts are used to switch the associated receiver *on*, only; they do not have to break the mains circuit.

To set up the arrangement, the double-throw tumbler switch is set to "Alarum." When the contact inside the alarm clock is made, the relay closes. Its contacts **A** short-circuit the clock contacts, thereby "holding on" the relay even if the clock contacts break again, or become intermittent. The receiver is now switched on. To release the relay, the tumbler switch is thrown to "Normal." This breaks the supply to the relay energising coil and also short-circuits the contacts **B**, thus allowing the receiver to remain switched on. Due to its snap action, the switch contacts make before the relay releases, obviating therefore any sparking which would otherwise occur at the relay contacts. It will be noticed that the energising battery is used only for a short period of time.

Such an arrangement can, of course, be used in any other application which requires the switching-on of equipment at a predetermined time.

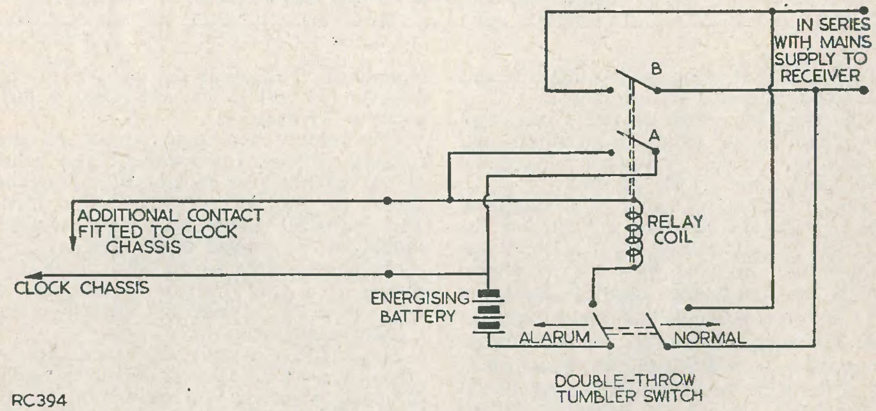


Fig. 2. Alarm clock switching circuit

The R1155

I continually receive queries from readers concerning the R1155. One arriving recently from S. H. McNeil, of London, S.W.9, is typical of many. This reader built a power-pack for the R1155 from a design published in a contemporary, but he has had very poor results. He states also that he gets a lot of mush, and wonders if this due to mis-alignment or instability.

Shortage of space prevents me from devoting too many words to this subject, and I shall only be able to touch briefly on the two points raised by Mr. McNeil.

Fig. 3 shows the circuit of a combined power pack and amplifier suitable for the R1155. The diagram is fairly self-explanatory in itself, although there are one or two points that need more detailed discussion. For instance, a 200-0-200V mains transformer is recommended. This will prove better in practice than a 250-0-250V transformer, since the latter can sometimes cause breakdown of the decoupling capacitors in the receiver. The capacitor C6 is included to prevent mains modulation. It is possible to get a "tingle" from the R1155 chassis via this capacitor, and it is advisable, therefore, to employ a good earth connection. It is most important to ensure that the negative connections from C4 and C5 are taken to HT negative, as shown, and not to chassis. If canned components are used here, the cans must be insulated from their mountings. Note that the cathode of the pentode (as well as its grid leak), is also taken to HT negative.

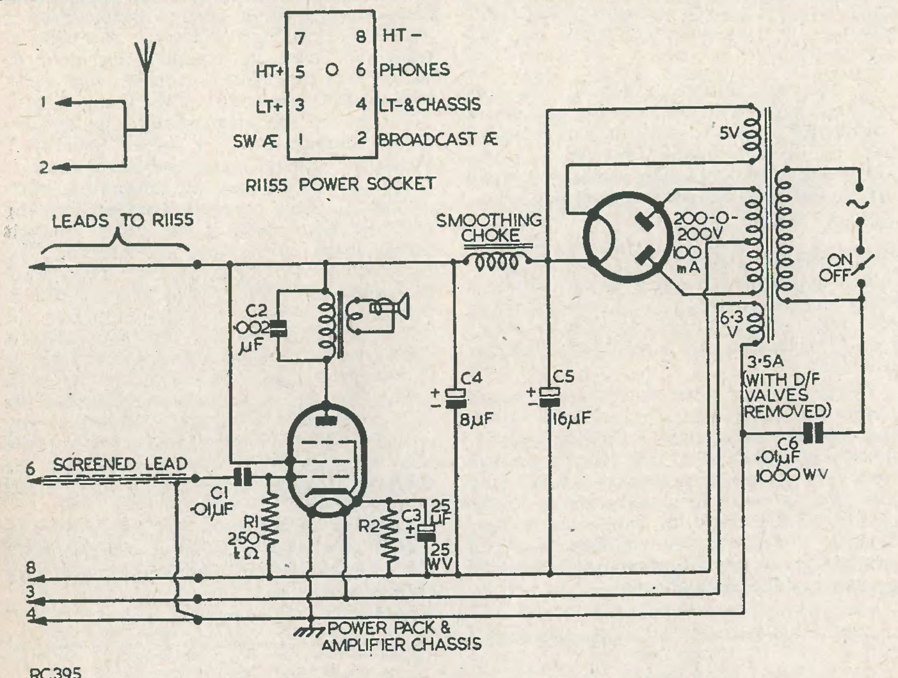
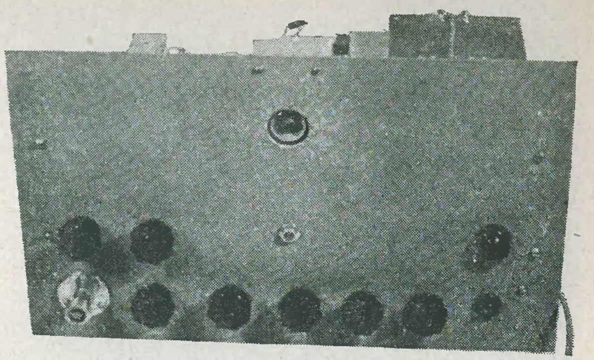


Fig. 3. Output stage and power supply for the R1155

The output valve may consist of any suitable pentode, (or tetrode). The value of the cathode bias resistor, R2, should be chosen to suit the particular valve used. The combined power pack and amplifier should be constructed as an external unit. When power valves are added to the R1155 chassis itself, they dissipate a great deal of heat inside the cabinet and can cause the receiver oscillator to drift.

The R1155, especially when used with an amplifier, gives rise to a considerable amount of mush when the volume is turned up. It is doubtful if mis-alignment or instability (apart from oscillator squegging), would cause the mush to increase.



By
HANS MARHAUER
OZ5HM

A HIGH FIDELITY and RECORDING AMPLIFIER

PART 2

The Output Indicator

The output level indicator employs a 'magic eye' tuning indicator, and works as follows:

The amplifier output voltage, which we want to control,. is taken from a point between **01a** and **01b**. The sensitive section of the indicator valve, V5, will show maximum reading when –5 volts are applied to the grid. The voltage is stepped down by means of the voltage divider formed by R31 and R32. The AC voltage taken from the voltage divider is now rectified by V4, a small germanium diode, as for instance 1N34 or PHILIPS' OA50, which is connected so that it short-circuits all positive half-cycles, thus leaving a negative DC voltage on the grid of V5.

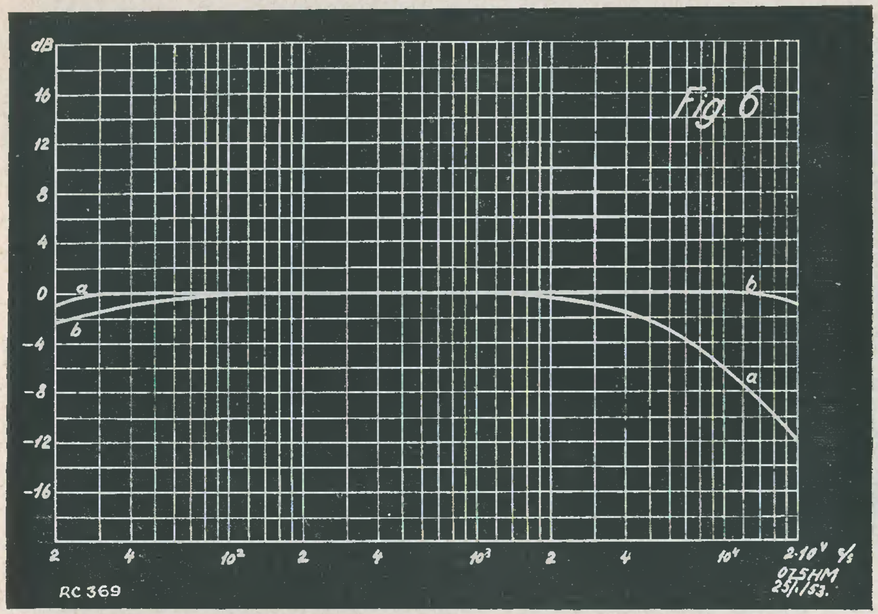
The Dividing Network

As shown in the circuit diagram, the output impedance of the amplifier is 500 ohms. Any secondary impedance of the output transformer may be used to match a single loudspeaker, and if a low-impedance loudspeaker is employed, the secondary winding of T1 may be at the same time act as feedback winding. In this amplifier, however, a 500 ohms output winding and a separate feedback winding has been employed in order to allow the use of an inexpensive dividing network for use in connection with two loudspeakers, one for the treble and the other for the bass.

At an impedance of 500 ohms the value of the capacitors in the dividing network have come down to the order of 0.1μF, whereas at an impedance of 5 ohms the capacitors should be of the order of 100μF—and 100μF capacitors are somewhat expensive. The dividing network designed to match the 500 ohms output can be built at small cost, including two additional transformers after the dividing network which are necessary to match the low-impedance loudspeakers. These transformers are home-built and they are easily made, because each of them need only be linear over part of the frequency range.

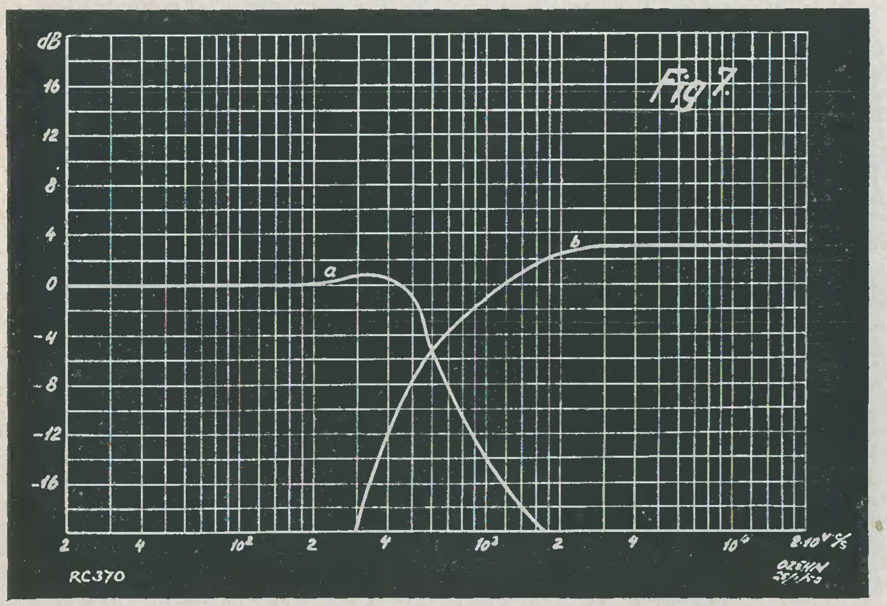
It may be difficult to find an output transformer, T1, having the specification given here (primary: 7,000 ohms; secondary: 500 ohms+5 ohms feedback winding), so here are details on how to convert a normal transformer, having a 5 ohms secondary, to suit the purpose:

Take a good output transformer, having a primary impedance of 7,000 ohms as required, and a 5 ohms secondary. Remove the iron core and wind off the secondary winding while you carefully count the number of turns and measure the diameter of the copper wire. In place of this winding we want to put a new secondary having an impedance of 500 ohms, or 100 times as large as the original. So the new winding must have 10 times as many turns as the original, whereas the diameter of the copper



wire need only be 1/3 of the original wire used. On top of this winding is then wound the feedback winding, which should have as many turns as the original 5 ohms secondary; enam. copper wire 40–42 swg will be satisfactory for this winding.

T4 need only be linear above som· 600 c/s, so the primary inductance is of no importance, while it is important that the capacitance between the turns in each winding and between primary and secondary is kept as low as possible. This is achieved

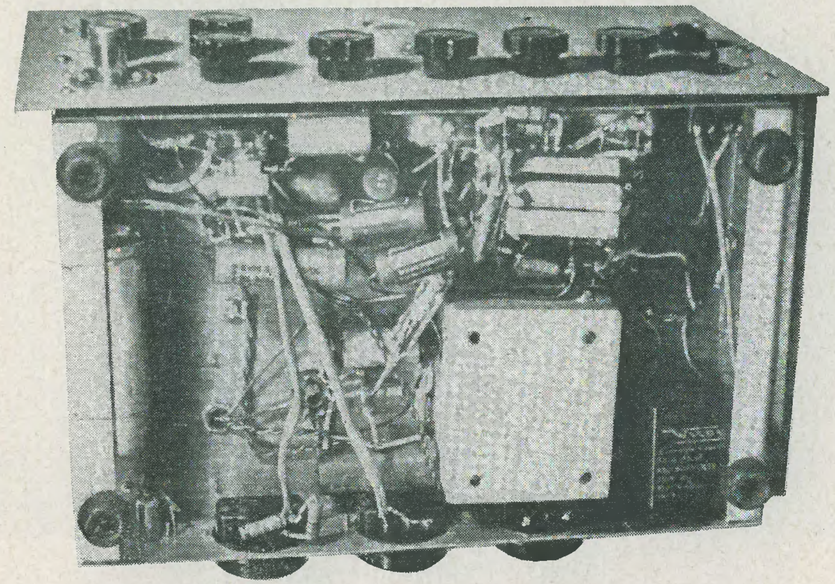


by winding one or two layers of oiled silk between each layer in the windings, and also between the two windings.

As to T5, the capacitances are of no importance, whereas the primary inductance should be high, as this transformer must be linear at all frequencies below some 600 c/s. So for this transformer is used a larger iron core, and each winding has more turns than

Curve (a) in Fig. 6 shows the frequency characteristic of T5 and we notice that it is linear from 20–4,000 c/s, while T4 (curve (b)) is linear from 100–20,000 c/s.

The circuit of the dividing network is shown in Fig. 5. Ch3–C24 is a high-pass filter giving passage to all frequencies above 600 c/s, and Ch4–C25 is a low-pass filter



Under-chassis view of the original amplifier

in the case of T4. No additional insulation is required between the layers of T5.

Winding data for T4:
- Iron core: 3/8 sq. inch.
- Primary: 700 turns, 33 swg enam. copper wire.
- Secondary: 70 turns, 25 swg enam. copper wire.
- No air gap.
- Secondary impedance: 5 ohms (to match small treble loudspeaker).

Winding data for T5:
- Iron core: 1 sq. inch.
- Primary: 1,500 turns, 35 swg enam. copper wire.
- Secondary: 210 turns, 25 swg enam. copper wire.
- No air gap.
- Secondary impedance: 10 ohms (to match large bass loodspeaker).

which lets only frequencies below 600 c/s pass. The capacitances are:

C24: 0.16μF and C25: 0.64μF.

They are obtained by combining different capacitors to give the proper values.

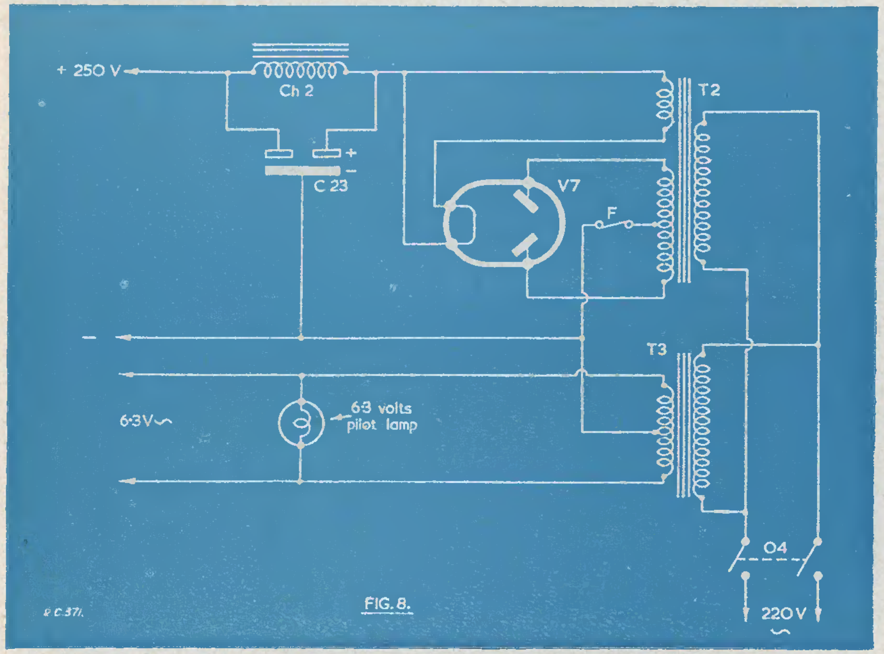
Ch3 should have an inductance of 160mH, which is obtained by 3,000 turns of 36 swg enam. copper wire wound on a former 3/8″ in diameter fitted with iron core.

Ch4 has 1,650 turns of 33 swg enam. copper wire wound on the same type of former, and this gives an inductance of 40mH.

Fig. 7 shows the frequency response of the complete dividing network including T4, T5 and the appropriate loudspeakers. The dividing network is not built into the amplifier chassis, but is built on a piece of plywood about 5″×8″, and is mounted in the loudspeaker assembly immediately behind the two loudspeakers, thus reducing the number of cores in the cable between amplifier and loudspeaker assembly to two.

(b) 24 turns, 22 swg enam. copper wire (to deliver 6.3V at 0.6 Amps.).

Transformer T3:



Circuit of the amplifier power supply

NOTE: In the Parts List given on page 205 of the last issue, V6 should have been bracketed with V3. The details given as for V6 should apply, in fact, to V7

The Power Supply

Eventually we come to the power supply, which for the sake of simplicity is shown separately in Fig. 8. It will be seen that it is quite normal, but that two mains transformers are employed. These two transformers were home-built and the specifications are:

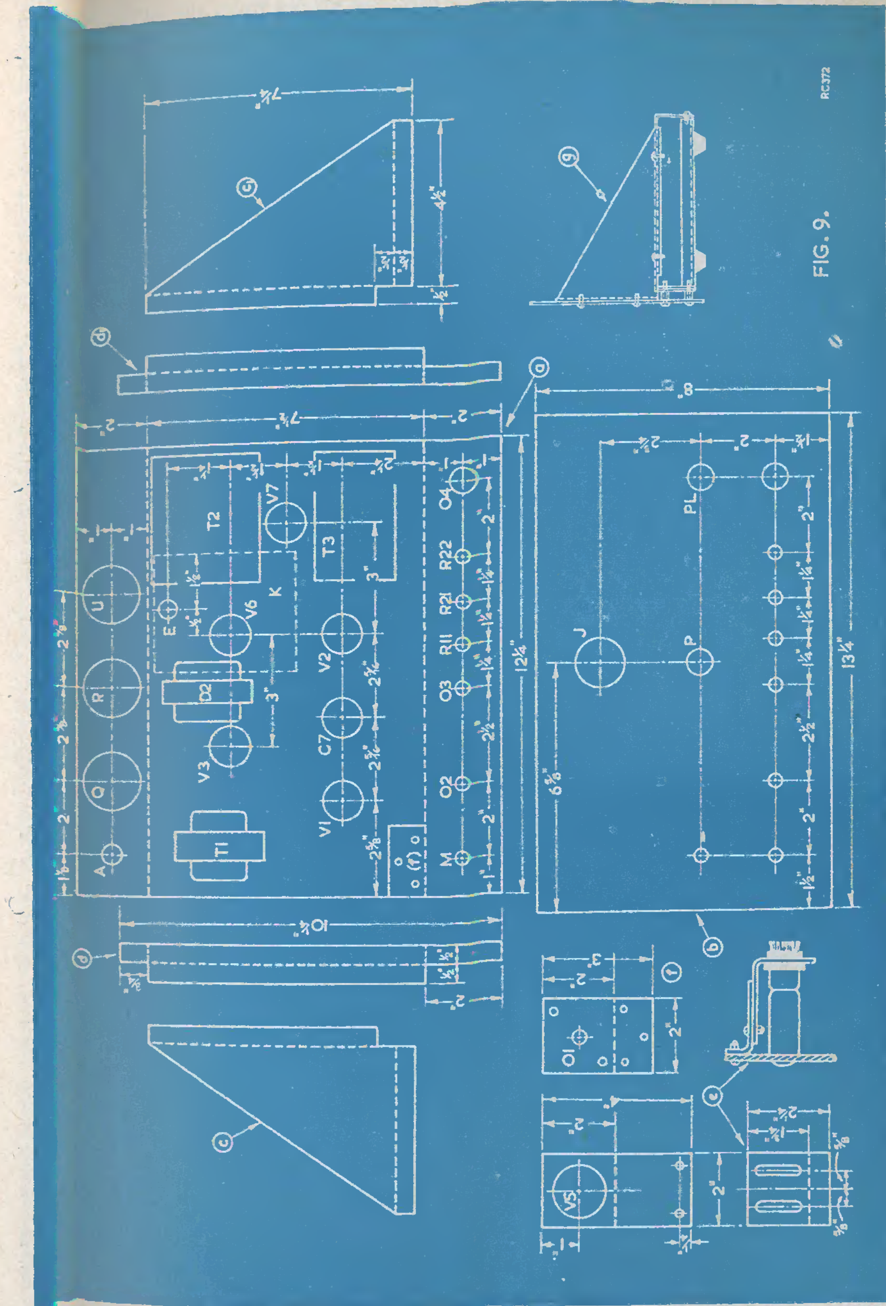
Transformer T2:
Iron core: 2.25 sq. inch.
Window space: 1.1 sq. inch.
Primary: 810 turns, 26 swg enam. copper wire (for 230 volts mains)
Secondaries:
(a) 2×1,115 turns, 35 swg enam. copper wire (to deliver 2×300V at 125mA).

Iron core: 1.5 sq. inch.
Window space: 1.3 sq. inch.
Primary: 1,250 turns, 27 swg enam. copper wire (for 230 volts mains).
Secondary: 38 turns, 17 swg. enam. copper wire (to deliver 6.3V at 3 Amps.).

Constructors can, of course, employ one mains transformer instead of T2 and T3, which should then have the following specification:
Primary: 230 volts.
Secondary: 2×300 volts, 125mA; 6.3V, 0.6 Amps. 6.3V, 3 Amps.

The Chassis

Fig. 9 gives in detail the dimensions of the



Chassis dimensions and assembly details chassis, and it also shows where the main components are situated, so I shall here only give a few explanatory notes to this diagram.

No dimensions have been given for cut-outs for valve bases, plugs, etc., as these vary according to the manufacturer.

a is the chassis itself, on which most of the larger components have been placed. **A** is a hole for the coaxial plug to which the record/playback coil is connected. **Q** indicates the gramophone pick-up plug, **R** the radio-input plug, **U** the 500 ohms output plug, and **E** is the coaxial plug to whcih the erase coil is connected.

On the chassis you will notice a broken line (- - - -) rectangle, marked 'K'. It shows the limits of a small aluminium box placed beneath the chassis, which contains all the components of the HF oscillator. To simplify the construction, **E** has been placed so that it leads directly into the oscillator box, which measures approx. 3″×3½″×2″ and is made from 1/16″ aluminium. The rectangles T2 and T3 show where the mains transformers are placed, and the small rectangle (f) where the flange carrying **01** is mounted. The holes in the front flange are marked according to the symbols used in the circuit diagram of Fig. 1. **M** is the microphone input plug.

b is the front panel, where most holes correspond to those mentioned on the front flange of the chassis. **J** is a 1″ diam. cut-out for the 'magic eye' (V5), **PL** for the pilot lamp in the power supply, and **P** is for a two-pole jack to which a control 'phone may be connected. The headphones should be connected in series with a 0.05μF capacitor between the anode of V3 and earth.

c and **c¹** are the two side flanges of the chassis; their purpose is only to secure mechanical stability. They have equal dimensions, but are bent so that one is the image of the other. What is said about **c** and **c¹** is also applicable to **d** and **d¹** which, in addition, are provided with the 'rubber-legs' on which the chassis rests.

g is a sketch showing the side-view of the completed chassis, and **e** shows the arrangement which permits quick insertion of V5 into its base.

a, **e** and **f** are made from 1/16″ aluminium, while **b**, **c**, **c¹**, **d** and **d¹** are made from 1/8″ aluminium.

Testing

When the amplifier is finished and the wiring—as far as you can see—is correctly done, then comes the great moment when you press the mains switch. But, please, do it before inserting the valves. Many valves are wasted because the HT– lead by a mistake was solderedd to a heater pin of the valve base. So do not insert the valves until you have made sure that there are no more than 6.3 volts on the heater pins. This done, see that the correct anode voltages are applied. 250 volts should be measured where R5, R6 and R7 are soldered together (anode voltage V1) and where R12, R13 and R14 are soldered together (anode voltage V2). The anode voltage of the indicator (V5) is rather critical, and 250 volts—no more and no less—should be measured where R33, R34 and R35 are joined. 250 volts should also be measured directly on the anodes of V3 and V6, the screen grid voltage of which should also be 250 volts or a bit less.

Now, with the loudspeakers connected, set **02** in the gramophone position, **03** to position 1 from left, **01** in the playback position and the tone controls in their central positions. You should then hear a faint hum, growing in volume as the volume control is increased. It is important to remember that a gramophone pick-up must be connected to the gramophone input plug, as otherwise the hum will be very heavy. If the necessary precautions are taken and the hum is still heavy, you should check up the wiring once more, to see if any unscreened grid lead is too close to the heater wiring. Also check C23, which might be faulty.

If you hear a constant, high tone in the loudspeaker it is probably because the amplifier oscillates. If the intensity of the tone can be varied by means of the tone control, it is, no doubt, caused by feedback from the amplifier output to input connections, and you should turn your attention to **01**. If the tone is constant whatever you do, it is most likely due to one of two reasons, or maybe a combination of both:

(a) The connection to the feedback winding of the output transformer may have been connected in such a way that V3 acts as an oscillator. This is cured simply by reversing the connections.

(b) V2 oscillates. This is easily stopped by connecting a 5pF capacitor between anode and grid in each of the two triode sections.

The next—and last—thing to do is to set **01** in the record position. Place a coil of one or two turns connected to a 6V, 0.5 Amps pilot lamp close to L1/L2. If the lamp shines brightly, you may be sure that the oscillator works all right and that the output, too, is sufficient.

All this done, and possible faults traced and corrected, then you have got an all-purpose high fidelity amplifier, which will serve you faithfully for years.

A KIDDIES' CRYSTAL SET

By **F. A. BALDWIN**, A.M.I.P.R.E.

A simple and easy-to-construct Crystal Set, which may be built by the home constructor in a couple of hours, and which will provide endless hours of pleasure and fun for the kiddies at Christmas.

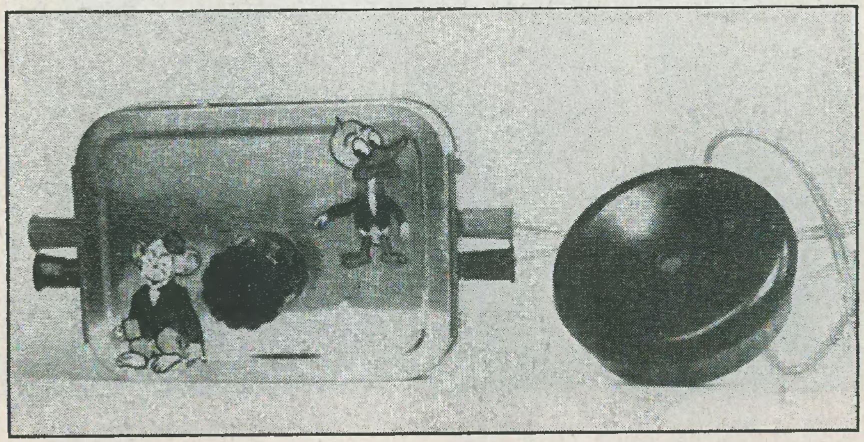
WITH CHRISTMAS ONLY A few weeks away, many of our readers must be wondering what to give the junior member or members of the family as a Christmas present. Others will be casting around for ideas on Yuletide pastimes and how to keep the children amused after the party "spread" has been cleared from the table.

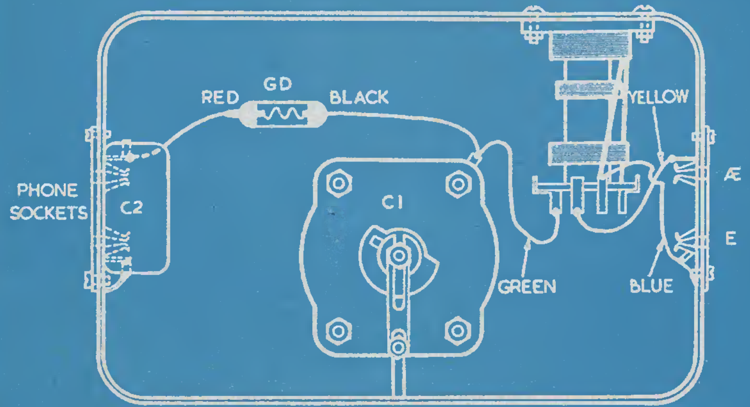
Our suggestion is that ever popular Crystal Set—simple, inexpensive, easy to construct—the whole unit taking something like two hours to build. The completed set will provide endless fun and enjoyment for the youngsters who, if young enough, regard anything in this nature as something akin to "magic."

Placed in the stocking on Christmas Eve (by a Father Christmas looking suspiciously like a radio enthusiast), it will cause much amusement and comment from the juniors.

Circuit

From Fig. 1 it will be seen that there is nothing unusual in the circuit, this being a perfectly simple and straightforward conventional crystal set. The coil used is the R.E.P., which has been regularly advertised within these pages. This coil is ideal for the construction of such a unit; it is compact, efficient, and easily obtainable. Coil connections conforming to the colour code on the solder tags are shown for ease of construction; as given, it fully covers the medium waveband using a 500pF mica dielectric tuning condenser. The Germanium Crystal is the BTH CG1, but any of the following types would serve equally as well—IN34, GD4, GEX55, GEC45 or the Westinghouse type WG7A, B or C. The rectified output from this is fed into a pair of high impedance headphones (4,000 ohms), although the writer only used one such headphone as seen in the photograph. The condenser shown across the phones should be of the mica type, and either the value specified or a 0.001μF may be used. Little more need be said of the circuit except that it may be undertaken by the veriest beginner with every chance of success.





LAYOUT & WIRING DIAGRAM OF THE RECEIVER

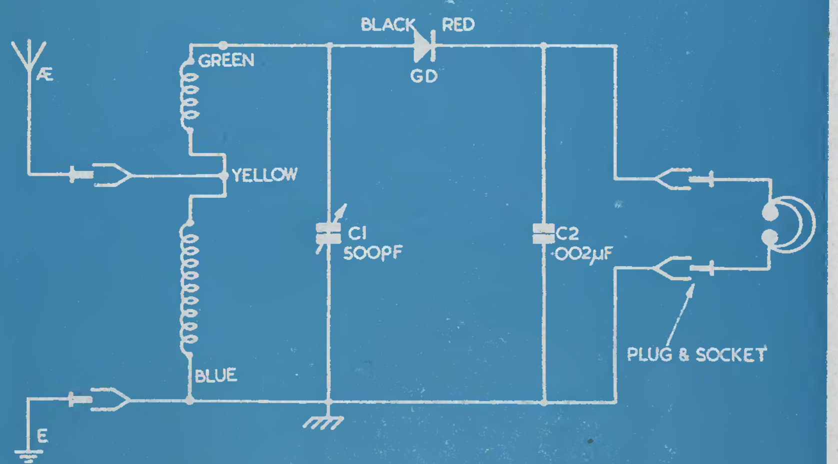


FIG. 1
CIRCUIT OF THE KIDDIES CRYSTAL SET

RC411

Construction

The whole unit is built inside a two-ounce tobacco tin with removable lid, although there is no reason why a hinged lid type should not be used. These tins may be obtained from the local tobacconist, as many of these are used for dummy window displays; a non-smoking reader does not necessarily have to take up the weed habit in order to construct this set!

The illustrations clearly show both the method of construction and position of the various components. The aerial and earth are fed into one end of the case via an aerial/earth paxolin socket strip, and the headphone output through the opposite end of the tin.

On the front of the set (the back of the tin), will be seen two transfers which should delight any child. These are Kaylee paint transfers (see component list) which are easily applied to the surface. The tin itself may be painted prior to the application of these transfers—blue for a boy and pink for a girl! As an added aid to operation, the station positions (dial readings), could be marked. For this, however, it will be necessary to first erect the aerial to be used, as this will have some effect on the tuning.

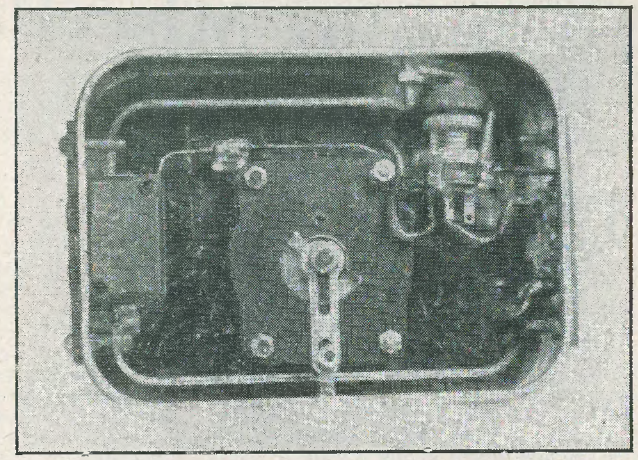
It should be remembered that with a set of this type, the aerial should be as long and as high as possible. No amplification is available, as shown in the circuit diagram, rectification taking place on the received signal only. Therefore, the signal strength depends entirely on the aerial and the locality; for this reason the aerial should be as efficient as possible. A good earth connection will make all the difference to the results, and this should be borne in mind when carrying out tests after completion.

After the initial excitement has died down, the back of the tin could be screwed into a wall or even into the head of the junior's bed, the set then being pressed into position. This would then ensure the youngster a permanent bedside radio—but don't blame me if the wife complains that the youth of today never want to go to sleep!

Component List

1 2*oz* Tobacco Tin
1 500pF Wavemaster mica dielectric variable condenser
1 0.002μF mica, T.C.C.
1 Coil, R.E.P.
1 Packet Kaylee Transfers*
1 Knob
1 Germanium Crystal Diode—see text.
1 Pair Headphones (4,000Ω)
2 2-socket strips

* Kendall & Mousely.



The internals of the set. Compare with the sketch opposite

Modifications

Several of these are possible to the basic circuit shown in Fig. 1, and their adoption will largely depend on both the location of the constructor and the container within which the set is built.

A series aerial condenser of 100pF could be inserted between the aerial input and the coil connection marked "Yellow." This should be of the mica type if a fixed value is to be used or, alternatively, a small variable condenser of the trimmer type could be utilised.

For those who prefer reception of the Long Wave Band or whose location provides better reception of the service on 1500 metres, the Blue connection should be unsoldered and the Black tag taken to chassis. Alternatively, those who require reception of both the Medium and the Long Wave Bands could connect the Blue tag to a switch (one side of which is taken to chassis), and the Black tag to chassis (earth). The switch would then act as a wavechange control, allowing a choice of either band of frequencies.

With the coil specified, the maker supplies a leaflet giving full details of the connections, and also four very interesting circuit diagrams of both battery and mains midget sets.

Radio Miscellany

TO MANY AMATEURS it comes as a surprise when they discover that the new idea they have thought of, or a new application of an old one, has long since already been patented. Equally great is their surprise, too, to find that such commonplace things as TV aerials, etc., cannot be marketed without infringing on patents covering certain aspects that are already held by someone else.

Radio and electronic patents nowadays are legion. Yet surprisingly enough we find that the first patent in the way of a "wireless invention" was not granted until 1896. This was taken out by Guglielmo Marconi who was quicker than others in seeing the commercial possibilities of radio communications. The foundations of radio had long since been laid by the nineteenth century scientists. They had regarded their work as a contribution to scientific knowledge —but, as far as we can judge, they were blissfully unaware of the possibilities their discoveries opened up. Perhaps they did not even look upon their discoveries as having a practical value, let alone think of commercialising them.

It was 33 years before that first patent (in 1863) that Clerk-Maxwell discovered the existence of electro-magnetic waves. Having pointed the way, others added their quota and prepared the way for the young Marconi. By 1888 Hertz was able to produce such waves, and in 1894 Lodge demonstrated their practicability for signalling. The coherer was then already in existence. Branley had invented it in 1890, and this was used, after improvement, by Marconi as his detector.

Barely twelve months after the granting of that first patent, the first wireless company was formed. That, of course, was the Marconi Wireless Telegraph Company. That year proved sensational. A message was transmitted from the Isle of Wight to Bournemouth, a distance of 14 miles! By 1899 the Channel had been spanned and in 1901, the Atlantic.

After studying the patents covering radio and branch sciences, one now begins to wonder if there is still anything left to patent. Yet a surprising number of patents are still taken out annually, often for seemingly trivial things. Far-sighted people take out patents for ideas that are left lying on the shelf—against the time when they will be wanted.

Getting Nearer

There was a significant absence of "close-ups" among the photographs received in the recent competition. Yet a close-up is often essential to the successful photographing of home-made equipment and gadgets. The reluctance of constructors to attempt pictures of this sort seems to suggest that many of them think an elaborate camera with extending bellows is indispensable to such work.

Excellent close-ups can be made with a simple box camera, plus a spectacle lens and a little trouble. True, one needs a separate lens for each distance, but discarded spectacles are to be found in most households, or else they can be picked up quite cheaply at the local opticians.

The easiest approach to fixing the supplementary lens in position is by means of an old pill box with the bottom pushed out. Of course you won't find a pill box the right size, so you make your own with a strip of gummed paper. Then you make a second one to suit the camera lens mount, and fit the two together. The lens mounting must be kept as short as possible, or there is a danger of cutting the corners of the picture.

The maximum and minimum distances resolved in perfect focus with a supplementary lens is found by holding a ground glass screen in the back of the camera with the shutter left open. The ground side of the glass faces the lens, of course. The depth of field will be found to be very small. That is, only those objects with narrow limits will appear in perfect focus. "Stopping down" (i.e. reducing the aperture of the lens) will considerably increase this range, and the smallest aperture should always be used when photographing and a corresponding increase in the length of exposure given.

The card of the lens mountings should be painted a dead black to prevent reflections, and the focusing distance for each lens can be marked on them so that they are ready for use at a moment's notice. Picture records of your home-made gear are nice to look back on, and the ability to provide a good close-up to accompany written descriptions is remuneratively appreciated by all Editors.

"Black" Listeners

The drive against unlicensed listeners and viewers goes on. It is rather amazing that so many of the lay public think the mysterious Detector Vans can smell out hidden TV receivers even after they are switched off. How they imagine it can be done I haven't the faintest idea—nor have they, either. For that matter, they haven't a clue how it's done when the set is switched ON. Sometimes I suspect that the Post Office encourage them in an almost superstitious belief in the Magic of the detector units. Perhaps they are preparing against the day when the licence fee goes up to three, four or even five pounds. Then there will be more pirates than ever.

We don't seem to hear so much about the possibility of future increases now that competitive TV is in the offing. It is, of course, all nonsense to argue about the supposed "value" of what you get for your two pounds. Nothing annoys me more than to be told by some muddle-headed apologist that it would be cheap at a fiver. The point is, what good use the BBC make of their *total* revenue. Your daily newspaper costs tens of thousands to produce, but that is no good reason why you should pay more than three ha'pence for it.

Despite the sensitive DF gear of the detector vans there are still many thousands of TV pirates at the £2 rate. Astonishingly enough, even the most honest of citizens will confidentially tell you that they didn't take their licences out straightaway. How many times have you heard "I wasn't going to pay for a full month when there was only a fortnight of it left. Naturally I waited until the first of the following month."

Other countries—other methods. The French are notorious tax-dodgers, and no opprobrium attaches to fiddling the Government. In fact, it is almost a national pastime. They have many amusing stories to tell concerning piracy. Radio dealers must, by law, reveal on demand the address of all buyers of receivers. An imperative request for the licence fee follows, plus an additional charge for any delay in payment.

I haven't had the good fortune to get to South Africa, but I was told by a ZS amateur, who was over here for the Coronation, that a current licence must be shown before a new set is supplied or an old one repaired. I cannot see how the dealer is supposed to know that it is really your licence which you show him. Or what is to prevent you, in France, from getting a pal who has a licence to buy your set for you. Maybe they'll stop that sort of thing by passing a law requiring dealers to instal lie-detectors under the counter. Then I suppose the buyer's pals will have to gum up the works of the lie-detector with portable jamming gear hidden in a car outside.

Look — No Specs

Regular colour TV programmes from a network of about twenty stations are expected to be in operation in the USA by April next year. It will still be possible to view in monochrome on a normal set, although some loss of definition results. R.C.A. and Columbia have both given satisfactory demonstrations of their systems before the Federal Communications Commission who, at the same time, rejected two other systems.

Both the CBS and RCA methods work to the same specification, which had formerly been agreed by a committee of the radio and TV industry. I hear from an on-the-spot witness of both demonstrations that he preferred the colour rendering of the RCA system. This is a point not easy to decide unless both are demonstrated side by side, using the same subject and lighting conditions. Unfortunately this was not done, and the demonstrations took place on successive days. Suitable receivers will cost roughly four times as much as the normal TV, and there is very little prospect of an early price cut by mass production. Even so it is hardly likely to be more than 15 to 20 per cent.

The Director General of the BBC was over there watching points. We cannot allow the U.S. to get too long a lead, so perhaps we will get something on the same lines soon after. Our senior TV engineers soon hurried across the Atlantic to have a look at it, and also to see something startlingly new—a system of recording ordinary TV on magnetic tape!

Centre Tap *talks about* PATENTS — CLOSE-UPS PIRATES — COLOUR TV

Constructing and Using an

AUDIO OSCILLATOR

By D. W. EASTERLING

Introduction

TO THE RADIO EXPERIMENTER some form of audio signal source is desirable. In many cases this signal can be obtained without any special apparatus; the 50 c/s mains, gramophone records, and radio programmes, to mention just a few. Some experimenters will be able to tap the audio note from an RF signal generator, but eventually the serious worker will require something rather more elaborate, an equivalent of the RF signal generator to cover audio frequencies.

The oscillator to be described generates both sine and square waves over a band of frequencies continuous from 14 c/s to over 21 kc/s, the sine waves pure with negligible harmonic distortion, the square waves o good shape up to about 10 kc/s. The amplitude of both waveforms remains constant over most of the range, falling off slightly at the extreme top end. Frequency stability is good; a drop of 70V HT caused less than one per cent shift.

The Circuit

V1 and V2 form the oscillatory circuit, working on the Valve Phase Shifter principle. At a frequency determined by C1, C2, VR1 and VR2, a total phase shift of 180° will occur, and if fed back should cause the circuit to oscillate. Because the gain of these stages is less than unity, V3 is necessary to maintain oscillation. Automatic amplitude

COMPONENTS LIST

Resistors, all ½ watt unless otherwise stated.	
R1	6.8kΩ
R2, R4, R6, R8, R10	4.7kΩ
R3, R7, R11	5.0MΩ
R5, R9	220Ω
R12	47kΩ
R13, R21, R24	10kΩ
R14	22kΩ
R15	Thermistor type A1522/100, Standard Telephones and Cables
R16, R19, R22	1.0MΩ
R17, R20	500kΩ
R18	100kΩ
R23	1.0kΩ
VR1, VR2	100kΩ ganged, wire-wound, Reliance Mfg. Co., type T.W.
VR4	10kΩ ditto
VR3	25kΩ ditto
Capacitors	
C1a, C2a	0.1µF 350V wkg, Tubular (14 c/s–200 c/s)
C1b, C2b	0.01µF 350V wkg, Tubular (140 c/s–2,000 c/s)
C1c, C2c	0.001µF Mica (1.4 kc/s –20 kc/s)
C3, C4, C5	0.05µF 350V wkg, Tubular
C6	2.0µF 350V Mansbridge
C7, C8, C10	0.1µF 350V wkg, Tubular
C9	100pF Mica
C11	4.0µF 200V wkg, electrolytic
CH1	10 Henry, 60mA, smoothing choke
MR1, MR2	300V RMS, 60mA selenium type metal rectifiers
f1	120mA Fuse and holder
T1	Mains transformer, Prim. 200–250V; Sec. 250-0-250 volts 60mA; 6.3 volts 2A
S1a, S1b	2-pole 3-way Yaxley
S2a, S2b	2-pole 2-way toggle
S3, S4	Each on-off toggle
OP1, OP2	type L6045, Belling and Lee co-ax sockets
V1/2, V3/6, V4/5	6SN7 double triodes
Case, 12×8×4 inches, Reosound Co. Ltd.	
Chassis, wire, valveholders, dial, cord-drive, feet, handle, knobs, mains-lead and plug, nuts, bolts, etc.	

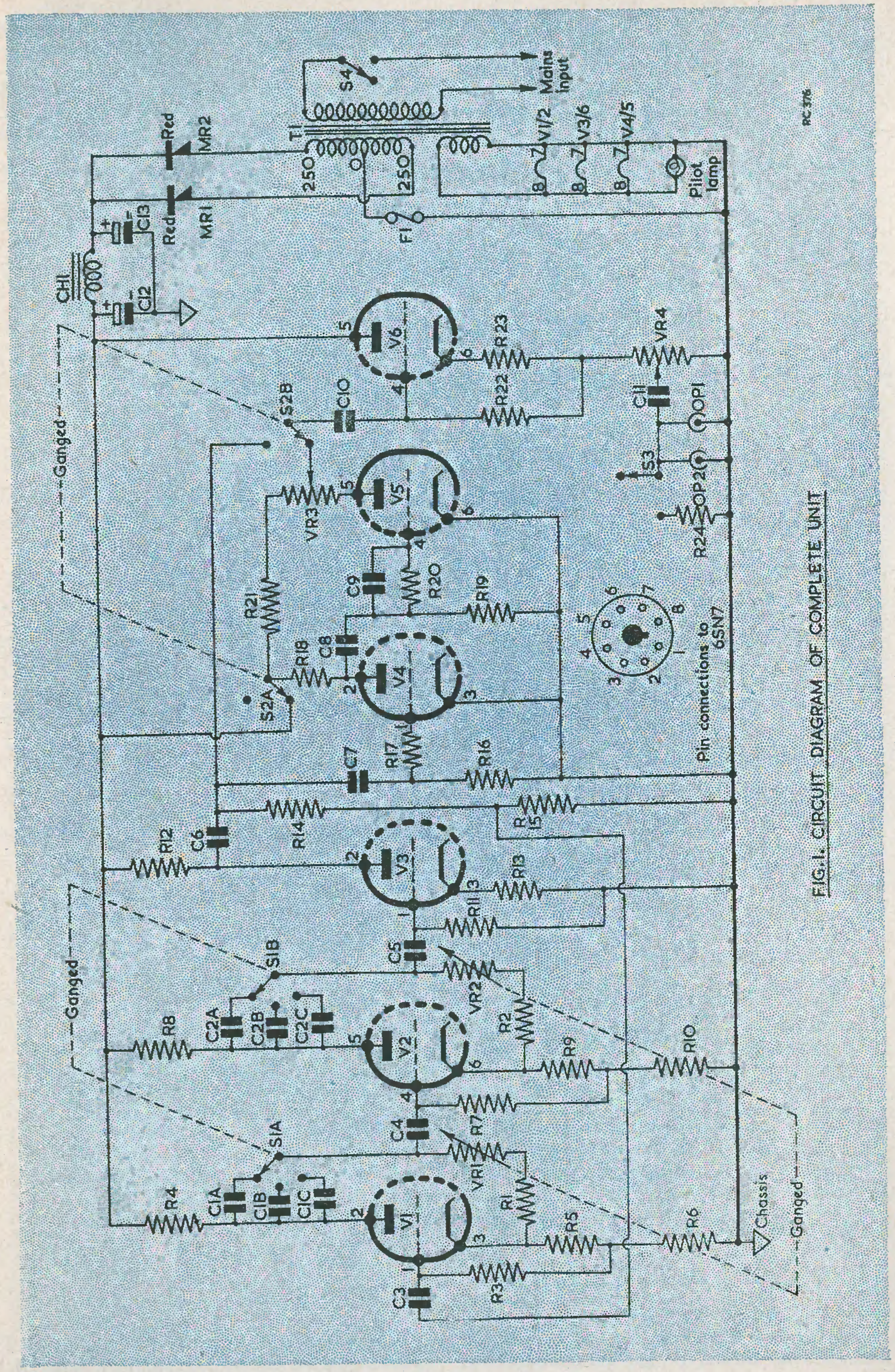


FIG.1. CIRCUIT DIAGRAM OF COMPLETE UNIT

control is provided by R14 and the thermistor R15. For practical purposes a further buffer stage is necessary, the cathode follower being ideal since it provides a low output impedance facilitating connection to external circuits.

circuit when required, and preset control VR3 is adjusted so that sine and squarewaves are of equal amplitude. Output voltage is controlled by VR4, and switch S3 enables an artificial load, R24, to be switched across the output. Two output sockets are

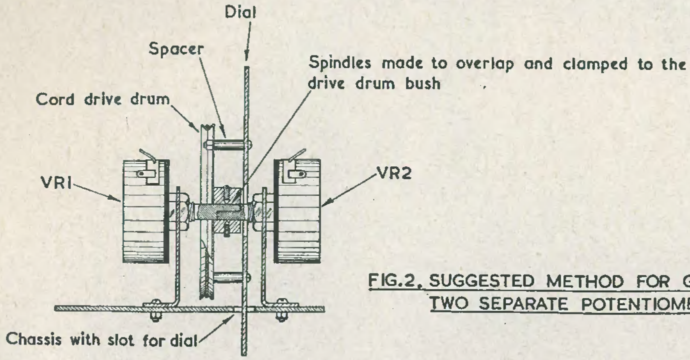


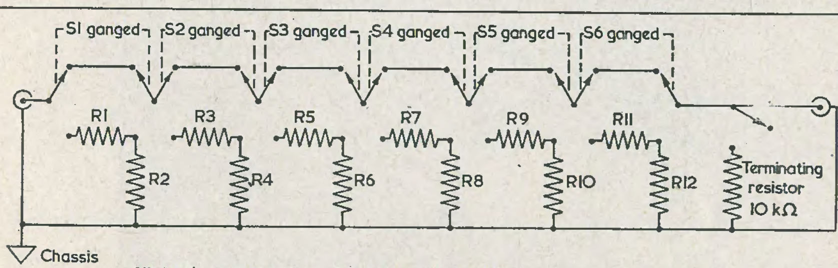
FIG.2. SUGGESTED METHOD FOR GANGING TWO SEPARATE POTENTIOMETERS

To economise space, the above four stages are provided by two 6SN7 double triodes; a third 6SN7 is used for squaring, working as two over-run amplifiers.

A ganged switch, S1a/b, selects the range by altering the value of C1-C2, while VR1

provided facilitating connection of an output meter or monitor CRT.

The power pack is conventional, but if preferred a valve rectifier such as the 5Z4G could be used in place of the metal rectifiers shown; in this case another heater winding



CIRCUIT DIAGRAM OF 0–80 db ATTENUATOR.

Attenuation	−2 db	−6 db	−10 db	−20 db	−40 db
Calculated value of resistors in ohms	R1, R3–2 060 R2, R4–38 593	R5–4 990 R6–10 400	R7–6 820 R8–4 600	R9–9 000 R10–1100	R11–9 900 R12–101
Nearest preferred values in ohms	R1, R3–2 000 R2, R4–39 000	R5–5 000 R6–10 000	R7–6 800 R8–4700	R9–9 100 R10–1000	R11–10 000 R12–100

TABLE OF ATTENUATOR RESISTOR VALUES. All ½ watt.

FIG. 3.

RC 378

and VR2, ganged, vary the frequency within these ranges. Switch S2a/b, a double-pole change-over switch, brings the squarer into

is required.

Wire-wound controls for VR1 and VR2 provide better calibration stability than the

carbon track type. Where this fault is not considered a great disadvantage, some saving can be made by replacing the wire-wound type control VR1 with a 0.5MΩ carbon track type, and shorting out the VR2 position. Ganged controls in the original

handle and rubber feet providing the final touch. Two rows of ¼″ holes spaced one inch apart are drilled in the back panel for ventilation purposes.

Checking and Setting Up

A careful check should be made of the

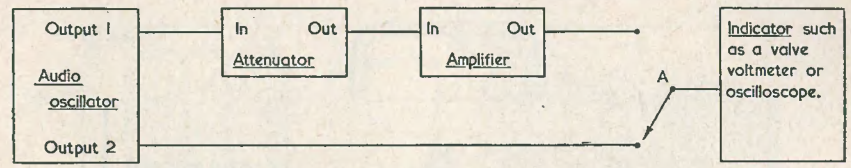


FIG.4. METHOD OF DETERMINING THE GAIN OF AN AMPLIFIER.

case are necessary to provide sufficient sweep, since 100kΩ is the maximum preferred value for wire-wound types.

Another suggestion, shown in Fig. 2, uses two separate controls mounted spindle to spindle, and ganged by the cord drive drum.

Construction

The writer's instrument is built into a case measuring 12×8×4 inches. Looking from left to right, the components on the front panel are:—fuseholder, mains switch, fine tuning control, output control with S3 above, and finally the range switch with S2 above. The ganged potentiometers are cord driven with the dial mounted on the drive drum. Stand-off pillars bring the dial close to the window, which is made of perspex with a cursor line scribed down the centre. Light finished hardboard is used for the dial, although ivorine would look better.

The view behind panel shows V1/2 and V3/6 on the left with the "squarer" valve behind (centre). All switches and controls are situated below chassis, as is C11 and the mains transformer; other power pack components are above chassis on the right. Capacitor C6 is mounted centrally on top of the chassis with its terminals going down through; the preset control VR3 is mounted through the chassis, spindle uppermost.

Constructors may prefer to use a layout more suited to the components at hand. Unlike many oscillators, no special screening or other precautions are necessary, apart from the usual advice to keep connections short, and the power pack wiring away from high impedance circuits.

The exterior of the case is finished in black crackle with ivorine labels, chrome

wiring before switching on. After this feed the instrument into an oscilloscope, and switch to sinewaves and the low frequency range. The waveform should be good from about 20 c/s upwards. Make sure that any distortion is not caused by the oscilloscope amplifier; actually the oscillator output is sufficient to give a good deflection on most oscilloscopes without using the amplifier. Any tendency for the sinewave to square off over certain parts of the band can usually be corrected by increasing the value of R12, but if this resistor is too low bad amplitude control will result. Switching to square waves, adjust VR3 until both sine and square waves are equal. With R24 in circuit, some deterioration of waveform can be expected from 100 c/s down, although an improvement could be made by increasing the capacity of C11.

Calibration

To assist calibration it is convenient to mark the dial in degrees lightly with a pencil; graphs can then be drawn for each range using various frequency checks, and from these the dial plan determined.

Using a pair of linear controls for fine frequency shift, the calibration will be logarithmic with the scale compressed at one end and open at the other. This is no disadvantage, however, since overlap on each range allows the operator to choose a fairly open part.

Very few constructors will have access to a low frequency measuring bridge, but by using the mains as a standard, reasonable accuracy can be obtained. Assuming the constructor possesses an oscilloscope, an easy way of measuring the oscillator frequency is as follows:—

1 Disconnect the sync input to the timebase stage.
2 Switch on both oscilloscope and amplifier, and allow time for warming up.
3 Feed into the Y amplifier a 50 c/s signal; the 6V output from a heater transformer is suitable.
4 Adjust the timebase until two sinewaves are displayed, making allowance for the flyback. The timebase is now running at 25 sweeps per second.
5 Disconnect the 50 c/s mains signal and feed in the oscillator.
6 Adjust the oscillator until one sinewave is displayed. The oscillator is now tuned to 25 c/s.
7 Record the dial reading and then tune the oscillator until two sinewaves are displayed, then three, and so on. Each sinewave represents a multiple of the timebase speed, i.e. 2 waves= 2×25=50 c/s; 3 waves=3×25=75 c/s. In this way it is possible to plot the whole LF range.
8 Re-set the timebase to a higher repetition rate, using a previously calibrated point on the oscillator; say, 100 c/s.
9 Now repeat the process, only this time the check points will be in multiples of 100.

With the graphs completed the dial may be drawn, first in pencil and then with drawing ink. When the ink is thoroughly dry remove the pencil marks with a good rubber, and coat the dial with clear varnish.

The Stepped Attenuator

A discussion of this item would not be out of place, as for many tests it is used in conjunction with the audio oscillator. Some readers may wonder why such a device is necessary, particularly since the unit just described already has a built-in output control. Actually this control can be used for many purposes without any extra equipment, but where it is important to set the output voltage independent of the attenuator (checking high gain amplifiers, for instance), some extra control is required. In any case, the simple component used for output control is not accurate enough for most comparitive tests.

Constructing a Simple Attenuator

For simplicity a number of ladder networks are used, each network brought in or out of circuit by a double-pole changeover switch. With high attenuation, more than one network can be brought into circuit at the same time. For instance, 26db is made up by using the 6db and 20 db networks. This system has the advantage that reasonable accuracy can be obtained using easily obtainable preferred value resistors.

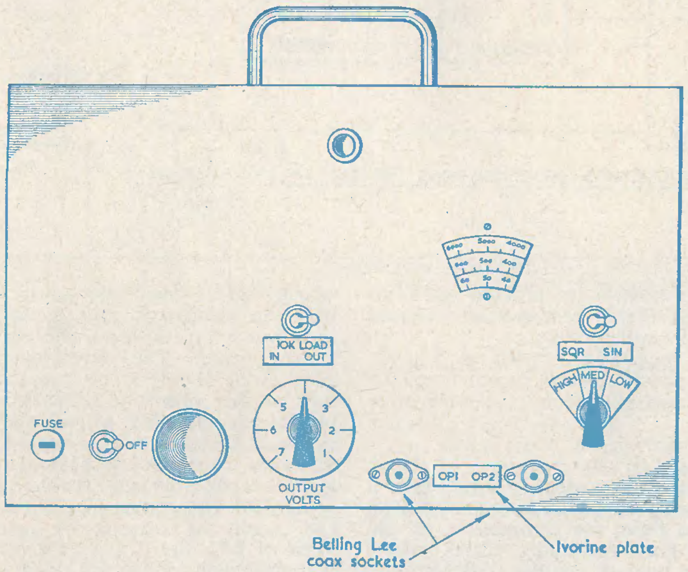


FIG.5 FRONT ELEVATION & PANEL LAYOUT

It is recommended that close tolerance types be used where no measuring equipment is available.

This attenuator will only read correctly when terminated by 10kΩ. In practice, however, it is often fed into a high impedance, in which case an internal terminating resistor is provided which can be shunted by switch S7 across the output.

Using the Audio Oscillator

A signal is often required for injection into equipment under test in order that comparison of input to output waveforms can be made on the oscilloscope. The oscillator described is ideal for this, since both sine and square waves are of good shape, thus making the detection of any distortion reasonably easy.

Once the unit is properly calibrated it may be used to check the frequency of any other oscillator (recording bias oscillators for instance). Lissajou figures are mainly used for this job, although there are other methods. The square wave output fed into the modulator grid of a CRT will produce timing bright-ups, enabling an accurate check of timebase speed to be kept even though an entirely different signal is being applied to the Y plates. Care should be taken here, though, to ensure that good DC isolation exists between CRT and oscillator, since in oscilloscopes the grid is usually at a high negative potential.

Further details on tests made in conjunction with an oscilloscope are available in several excellent books on the subject.

The pure waveform of this oscillator is ideal for driving bridges and other measuring equipment requiring an audio signal.

Reference to Fig. 4 will show how the gain of an amplifier may be determined. After setting the output control so as not to overload the equipment under test, adjust the attenuator until the same deflection of the indicator occurs in either position of Switch A. If the input and output impedances of the amplifier are the same, the gain in db is read direct from the attenuator. Where the impedances vary, gain in db=

$$\text{Attenuator reading} + 10 \log_{10} \times \frac{\text{Input impedance}}{\text{Output impedance}}$$

In conclusion, it is hoped that the preceding notes give some idea of the audio oscillator's possibilities.

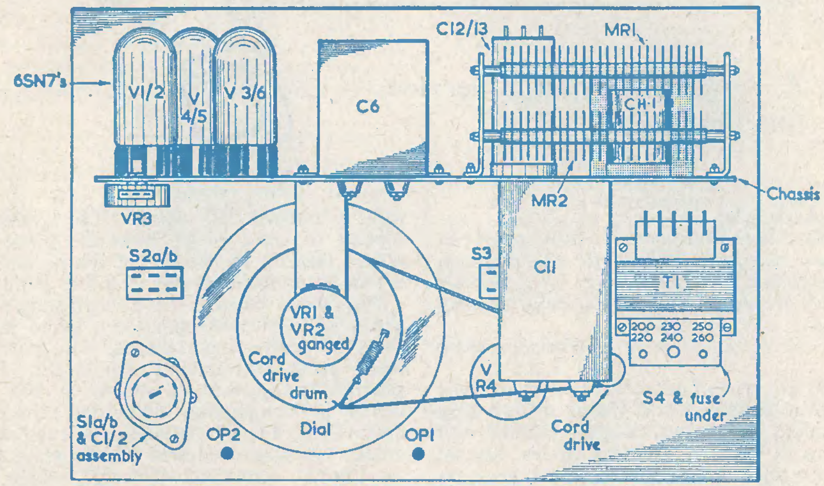


FIG.6. LAYOUT OF MAJOR COMPONENTS

Notice a margin left clear along each edge for the lip of the main case. The C1 & C2 assembly is mounted between the wafers of S1a & S1b

Query Corner

A Radio Constructor Service for Readers

Slot Aerials for TV

I have heard that a slot type of aerial can be very satisfactorily used for the reception of television. If you confirm this, perhaps you could supply me with some constructional details.

E. Winson, London

The slot type of aerial has not yet received much attention in the field of television reception, but it has recently become well known in VHF transmitting circles. Several articles appeared in the technical press on the subject a few years ago, when the BBC adopted the slot type of aerial system for their VHF transmitter at Wrotham. Some tests have now been made with slot aerials for TV reception, and the results are, in general, slightly better than would be obtained with a normal 'H' aerial. The physical aspects of the system, however, make it rather difficult to use out of doors, and it is thus recommended only as a loft aerial.

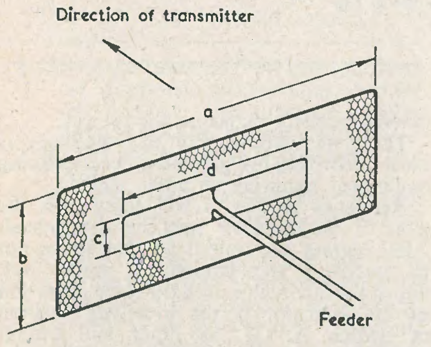


FIG. 1. Showing how slot is cut in wire netting. When used on a horizontally polarised transmission the slot must be vertical RC417

The aerial consists of a horizontal slot about half a wavelength long, made in a sheet of conducting material, wire netting being most conveniently employed. The general arrangement is shown in Fig. 1, which in conjunction with the table of dimensions, Fig. 2, indicates the minimum amount of space required to accommodate the aerial. The relatively small height of the system will prove to be an asset in lofts which will not permit the erection of a vertical rod arrangement. The slot aerial has a horizontal radiation pattern which is in the form of a figure eight; or, in other words, it is sensitive to signals arriving in either direction at right angles to the axis of the slot. The directional properties can be used to obtain the best ratio between the signal and locally-generated noise, and it is as well to experiment with various positions for the aerial in order to obtain optimum results.

Construction

The dimensions of the actual slot cut in the wire netting are important, and the values quoted in the table should be strictly adhered to. The size of the netting is not, however, very critical, and a reduction of some 10% can be made without seriously affecting the performance of the system. Having carefully cut the netting to the required shape, the edges of the slot are bound with copper wire; it is preferable to solder the joins between the netting and the binding wire to ensure a lasting connection.

Now we come to the problem of matching. The balanced transmission line is connected to the centre point of each of the horizontal sides where the characteristic impedance is

Station	a	b	c	d	e
London, Glencairn	14′	5′	1′	10′ 2″	5′ 1″
Holme Moss	13′	5′	11′	8′ 10″	4′ 5″
Kirk O'Shotts, Brighton	12′	5′	10″	8′ 4″	4′ 2″
Sutton Coldfield	11′	4′ 6″	9″	7′ 5″	3′ 9″
Wenvoe, Pontop Pike	10′	4′ 6″	8″	7′	3′ 6″

Fig. 2 Table giving the dimensions, for the various transmitters, for the slot aerial shown in Fig. 1.

in the region of 600 ohms. Standard 100 ohm line is used for this purpose, and in general the degree of mismatch will not be found to seriously impair the performance. A better method to obtain a perfect match is to employ a quarter-wave transformer between the aerial and the feeder. Such a transformer consists simply of a quarter-wave length of balanced feeder having a characteristic impedance of 250 ohms. Feeders of this type are available, but they can easily be made up by simply removing the outer screening from a screened balanced twin cable and spacing the two conductors by four times the wire diameter. Insulating spacers are placed between the two leads, the arrangement being shown in Fig. 3. The foregoing assumes that the aerial is to be employed with a screened balanced twin feeder having an impedance in the region of 100 ohms.

The slot aerial is, however, equally satisfactory when used with an unbalanced or co-axial type of feeder; indeed, a rather more simpler matching arrangement is then permissible. A length of wire or a thin rod is held by insulators in the centre of one half of the slot. This additional element is joined only to the centre of the co-axial feeder, the remote end being cut so that it does not touch the vertical side of the slot. The cable is led away down one side of the slot, and the outer is bonded at several points to one side of it. The diagram of Fig. 4 should make this arrangement clear. With this method of connection, the impedance of the aerial is reduced to 150 ohms at the feed point, which is sufficiently close to the feeder impedance to be accepted as a good match.

Lastly, a few points in connection with the erection of a slot aerial in a loft. The aerial should be located as far away from pipes and water tanks as possible, and with its axis roughly at right angles to the direction of the signal. Stout string can be used to support the wire netting from nails driven into the rafters and joists. Final position of the system is best made when the aerial is connected to a receiver, as it is then possible to find the position which gives the best signal level.

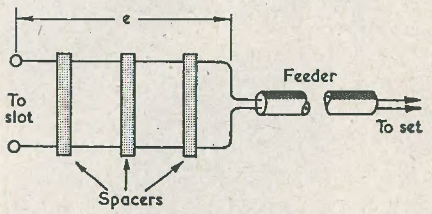


FIG. 3. Quarter-wave matching transformer

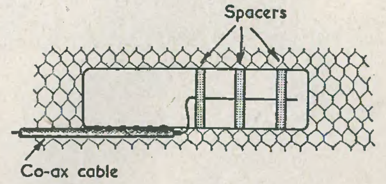


FIG. 4. Showing method of employing unbalanced cable with a slot aerial RC418

Query Corner

RULES

(1) A nominal fee of 2/6 will be made for each query.

(2) Queries on any subject relating to technical radio or electrical matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like.

(3) Complete circuits of equipment may be submitted to us before construction is commenced. This will ensure that component values are correct and that the circuit is theoretically sound.

(4) All queries will receive critical scrutiny and replies will be as comprehensive as possible.

(5) Correspondence to be addressed to "Query Corner," Radio Constructor 57 Maida Vale, Paddington, London, W.9

(6) A selection of those queries with a more general interest will be reproduced in these pages each month.

Barretters in TV Sets

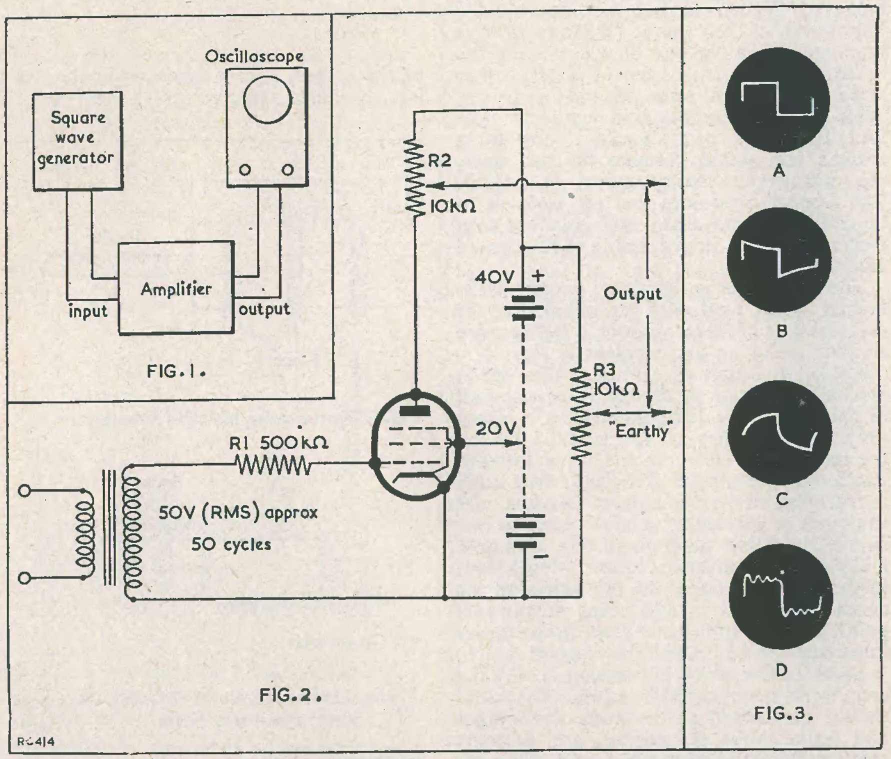
The barretter does not seem to enjoy the same popularity today as it did in AC/DC receivers before the last war. Why is this, and would it not offer some advantage in the universal type of television receiver?

D. Andrews, Slough

Barretters are not usually used in modern universal radio receivers for two reasons. Firstly, they are more expensive than a tapped resistance; and secondly, they do not have an indefinitely long life. The advantage which the barretter possesses is, however, a most important one, in that it stabilises the heater current of the valves against very wide variations in mains supply voltages. The effects of this upon the operation of the receiver is that it is less sensitive to changes in the mains voltage, and in general the life of the valves is improved. Now in a radio receiver quite wide variations in output power and sensitivity go unnoticed by the user, but this is not so in a television set where small changes in the picture are easily detected. Because of this, at least one large set manufacturer is employing barretters in the current range of TV sets.

OSCILLOSCOPE TRACES

No. 6: Square Wave Testing of Audio and Video Amplifiers



A VALUABLE AND SEARCHING METHOD of testing audio and video amplifiers consists of applying a square wave to the input terminals and analysing the output waveform with the aid of an oscilloscope. If the square wave has a reasonably accurate 50:50 characteristic, it is possible to check amplification for all frequencies above the fundamental frequency of the square wave. For this reason, the square wave fundamental frequency should correspond to the lowest frequency that the amplifier is capable of handling.

Fig. 1 shows a block schematic of the equipment needed for carrying out the test. The output of the square wave generator should be checked by the oscilloscope before being used.

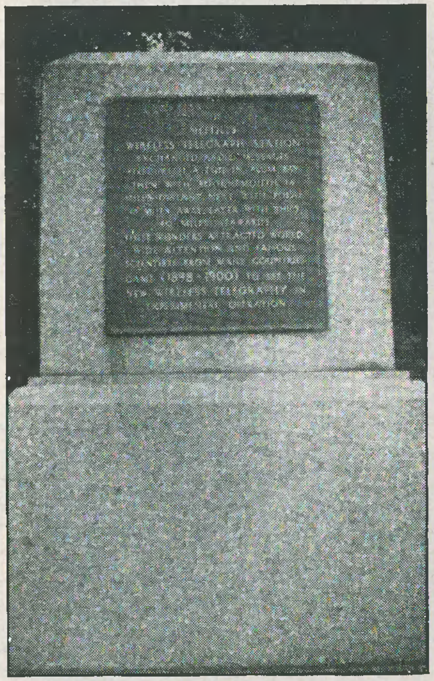
Trace **A** shows an example in which the amplifier gives a perfect response over its entire frequency range. Trace **B** shows the effect of poor low frequency response. This is caused, usually, by too low a value of coupling capacitor between stages, although there are other contributory causes. The slope of the trace indicates a low frequency phase shift.

Trace **C** illustrates the results obtained from an amplifier with poor high frequency response. Trace **D** shows the effect given by "ringing"; this being caused by inductive components in the amplifier. As may be seen, the sharp vertical side of the square wave causes a damped oscillation which gradually dies away. This is the type of distortion which often appears only with the application of inputs of certain amplitude and frequency, and which is usually the most difficult type of all to isolate.

The square wave generator will consist, in most cases, of a conventional multivibrator. Fig. 2, however, shows an alternative generator which may appeal to the experimenter. It consists of a non-vari-mu RF pentode heavily over-run by a source of supply at 50 cycles per second. The fundamental frequency of the square wave is, therefore, also at 50 cycles per second; this being low enough for most applications. A battery HT supply is used, as it obviates the complicated regulated supply that would otherwise be required. Potentiometer R2 is used as an attenuator, whilst potentiometer R3 is employed to so adjust the potential of the earthy output terminal that it lies in the "centre" of the square wave. The generator employs direct coupling to the amplifier.

Readers' Snaps

No. 1



THIS PHOTOGRAPH WAS TAKEN, whilst on holiday, by one of our younger readers, C. Gregory, aged 14½, of Luton, Beds. It shows a commemoration stone erected at the top of the path leading down to the beach at Alum Bay, Isle of Wight. By a coincidence, this photograph—one of the entries in our Radio Snapshots competition—arrived here the day after we received the article from Centre Tap which appears on page 268.

The wording on the stone reads as follows: " The Needles Wireless Telegraph Station exchanged radio messages first with a tug in Alum Bay, then with Bournemouth 14 miles distant, next with Poole 18 miles away, later with ships 40 miles seawards. These wonders attracted world wide attention, and famous scientists from many countries came (1898–1900) to see the new Wireless Telegraphy in experimental operation."

Congratulations to reader Gregory for a most interesting contribution.

Improved Fidelity at Low Cost

By AETHERIUM

IT MAY NOT BE GENERALLY REALISED that the cheaper types of commercial broadcast receiver are capable of reproducing music with a far greater degree of realism than is actually obtained from them. The more expensive receivers, being fitted with special boost circuits, tweeters, etc., have a long start over the average table model, and the purchaser expects, and usually gets, a higher degree of fidelity from them. In many cases the loudspeaker unit fitted to the two types of receiver is identical.

Why is it then that the cheaper model always sounds so inferior? The main reason is that manufacturers are forced to build down to a price rather than up to a standard, and it is obvious that some sacrifices have to be made in the quality of the components. For instance, the output transformer in the cheaper models is usually of a type far different to the one used in the more expensive model. As a result, the extremes of lower and higher frequencies are usually seriously attenuated, and the predominant response lies between 100 and 2,000 c/s.

This does not mean that no other frequencies are being reproduced. Tests with an audio oscillator prove that even on the cheapest of table models there is some output at 40 c/s, and also at 10 kc/s, but these frequencies are virtually inaudible because of the terrific middle register amplitude. In the majority of cases, this high and low frequency attenuation is due to the design of the output transformer, so there is little point in attempting to improve the response by negative feedback methods. What can be done, however, is to attenuate the middle register *in the speech coil circuit*, and thus obtain some boost of the extreme high and low frequencies when the audio gain control is advanced to compensate for the insertion of the attenuator.

The attenuator takes the form of a filter in series with the speech coil, and if the following instructions are followed carefully some surprising improvements will be obtained in the reproduction of musical items. (Note: Speech will *not* be improved. A suitable switching arrangement must be incorporated in order that the filter can be removed from the circuit for talks, etc.). Assuming that the speech coil has an impedance of 5Ω, the capacitor used in the filter must have a reactance of 5Ω at the approximate centre of the frequency band to be attenuated. In our particular case the centre of the band is approximately 1.5 kc/s. When used in conjunction with a 500μH inductance, the capacitor should be in the order of 12μF.

The inductance must be wound with the thickest wire possible, consistent with it coming out at a convenient physical size. The reason for this is that the DC resistance *must* be negligible compared to that of the speech coil. Incidentally, the capacitor must be of very high leakage resistance. Best results were obtained with TCC paper types, but tests with 2-25μF miniature electrolytics, wired back-to-back, produced quite good operation of the filter.

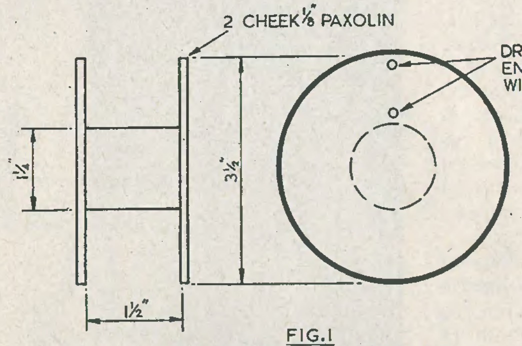


FIG.1
DETAILS OF FORMER. WIND ON 150 TURNS OF No.14 SWG ENAM. IN EVEN LAYERS

RC396

The inductance used to produce the necessary curve is shown in Fig. 1, and consists of 150 turns of 14 swg enamelled wire wound on to a 1¼" former in even layers. As a refinement, a layer of paper may be inserted between each layer to provide better insulation.

The actual connections are detailed in Fig. 2, and this arrangement will suit any speech coil impedance of between 3 and 5Ω,

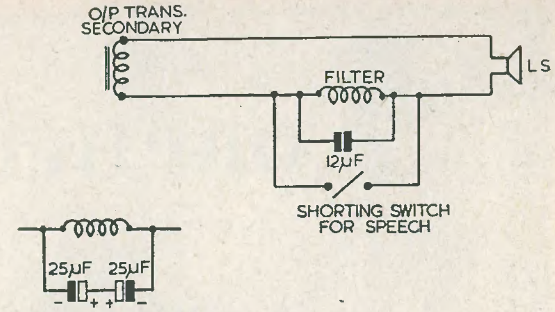
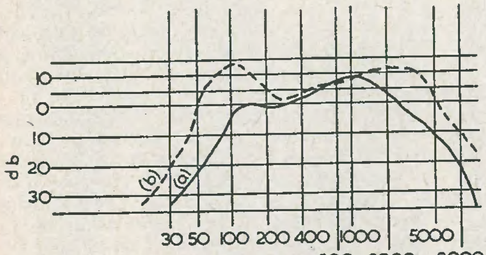


FIG.2
METHOD OF CONNECTING FILTER

RC397



AUDIO FREQUENCY
FIG.3
AVERAGE RECEIVER RESPONSE CURVE WITHOUT (a) AND WITH (b) FILTER

RC398

For coil impedances of between 10 and 15Ω, it is recommended that the inductance turns be increased to 200 and the capacitor value reduced to 10μF. The graph shows an average response curve, and the curve with the filter in circuit. It will be seen that when the gain control has been turned up to produce the same output as before at 1 kc/s, both bass and treble output are greatly increased. The improvement in overall fidelity will be quite startling, and the little trouble involved in making up this simple filter will be well repaid.

Can Anyone Help?

Dear Sir, I have a Labgear Electronic Fault Tracer and am anxious to buy or borrow the instructions and/or circuit diagram. I would be grateful if any reader can assist.—D. G. Shipley, B.SC.(ENG.), 86 Lord Roberts Avenue, Leigh-on-Sea, Essex.

Dear Sir, I purchased a National 1-10 receiver some months ago, but unfortunately I have not been able to get hold of Range A, B, C, E and F coils. I would be greatly indebted to any reader who can give me any information to wind these wanted 10 coils.—R. Chorlton, 685 Burnage Lane, Levenshulme, Manchester 19.

Dear Sir, I should like to avail myself of your kind offer to insert a request for any possible information on alignment data for the R1155A receiver.—J. Mould, 40 Felden Street, Munster Road, Fulham, London, S.W.6.

Introducing the

ORPHEUS

Tape Recorder

Described by A. S. TORRANCE

Introduction

WITH THE ADVENT of reasonably priced tape mechanisms, it has become possible to construct a complete instrument for a comparatively low outlay.

A tape recorder consists of a tape desk and an audio amplifier with RF bias oscillator. As in all cases where audio amplifiers are concerned, the equipment can be extremely simple, or most elaborate and correspondingly most expensive.

The first step, then, was the design of an amplifier which was as simple as could be, consistent with an adequate performance. The circuit finalised as a straightforward three-valver, plus oscillator and power supplies.

The use of a common amplifier for both *recording* and *playback* purposes tends to result in complicated switching, but fortunately this item is available with coloured identification leads for those readers who are chary of undertaking this confusing task.

The Radio Constructor is indebted to Trusound Ltd. for their co-operation both on the technical side and the supply of components. Our thanks are also due to The General Electric Co. Ltd. for so kindly demonstrating the *Orpheus* on their stand at the National Radio Show, and for the invaluable assistance given on the valves used in this recorder.

Mechanical Considerations

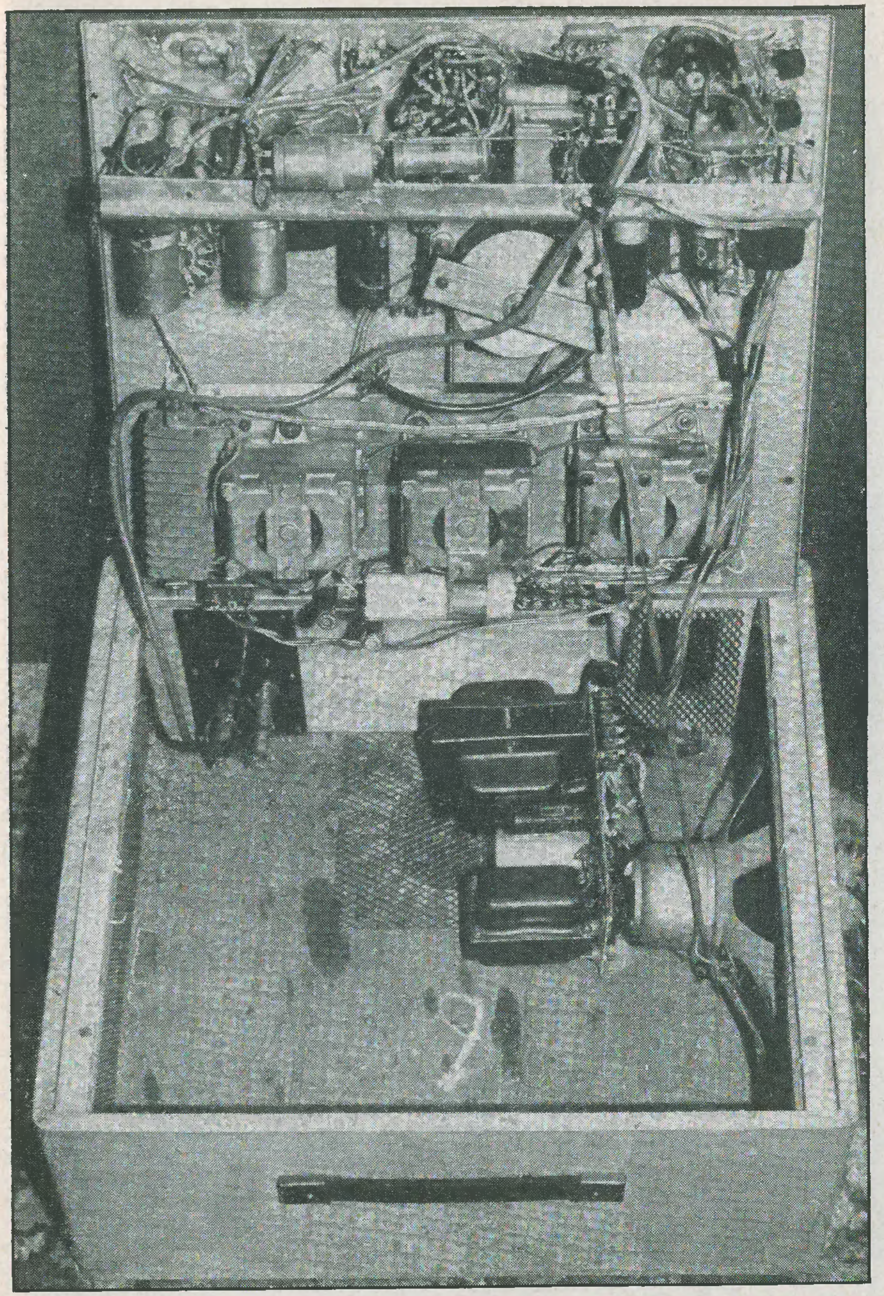
A tape recorder must be capable of many functions if it is to be really useful, and this has been kept in mind in the Trusound desk. Excellent braking, two speeds, fast rewind and fast forward speeds, and simplicity of loading are featured. Two heads are employed, and in practice erasure takes place automatically before each new recording when in either recording position. To keep permanently any recording, the selector switch is simple retained in the "play" position. A "mute" position is provided, and this should be used during rewind operations in order to silence "monkey chatter," as it is called.

It is advisable to use the "stop" switch (on the right hand side) when changing tape speed or direction. This is an excellent habit to form and will avoid that annoying "spilling" of the tape with its attendant danger of damage to this expensive item.

The two photographs (in this article and on the cover) will explain the general layout. A brief reference to the action of the three motors may be useful. The centre motor is, of course, the driving one. Power from this is taken by a belt drive to a heavy flywheel, coupled to which is an accurately-machined capstan. Pressure is applied to the latter through a spring-loaded pinch-wheel. At the same time, two felt-loaded sprung guides maintain the tape at correct tension in the two heads. This relationship of pressures, that is between the capstan and pinch-wheel and between the tape guides and the heads, must be maintained for optimum performance, but adjustment after wear is a simple matter.

The outer motors, which are used for take-up or re-wind, are cleverly switched through a resistor chain. When the tape is moving forward in the "record" or "playback" position, the left-hand motor works on low power. It therefore attempts to rotate in a clockwise direction, but, being under-run, is "braked" by the tension of the tape. The capstan moves the tape past the heads, and the left-hand motor takes up the slack as it becomes available, on to the take-up spool. The right-hand motor is similarly energised when the tape is being re-wound.

It is essential that stopping of the motors is controlled, to prevent the momentum causing the spools to over-run and so tangle up the tape. This can be simply achieved by applying a DC potential to the motors, an RM4 metal rectifier being switched into circuit on the HT transformer secondary to supply the necessary DC. Further reference to this will be made later.



Interior view of the "Orpheus" showing the layout of the various items

The Amplifier

Probably the ideal approach to this would be the use of three separate amplifying channels—one for recording, one for playback, and one for monitoring. Unfortunately this does not result in a portable instrument, and it cannot be inexpensive. The *Orpheus* uses one channel only, which by suitable switching fulfills all three functions.

There are two input jacks, one for high level inputs such as pick-up and radio, and one for low level purposes such as high quality microphones. External speaker and phone jacks provide for monitoring and the use of hi-fi external amplifier or speaker.

A tone control system is incorporated which is very simple, yet is quite effective. The recording level meter is based on a 1mA FSD movement. A scale will be printed, in *The Radio Constructor*, which may be cut out and pasted over the existing one.

A minor modification was made to the deck in the form of two small holes. The first was used for installing a switch which isolates the motors, and thus allows the amplifier section by itself to be used for other purposes than the primary one of recording and playing back. The second hole takes a variable resistor which allows the meter zero to be set—this could, of course, be done by a control fixed inside the instrument, and pre-set to the optimum position.

[*To be continued*

The Editor & Staff

wish all our Readers
a very
Merry Christmas
and a
Happy & Prosperous
New Year

Trade Review

We have had the opportunity of examining a receiver built to the design which has been developed by Messrs. R. C. S. Products, of 11 Oliver Road, London E.17, and which is currently being advertised in this magazine.

This receiver is of the "walkie-talkie" type, and we were very favourably impressed by its appearance (see page 295, this issue). The case is sturdily constructed from welded steel sheet, and is sprayed a deep grey. The panel markings are applied by the silk screen process, and are therefore permanent. Obviously a great deal of thought has been given to mechanical considerations—the layout is clean and compact, and everything fits in as " snug as a bug in a rug."

The circuit consists of a leaky grid detector with reaction, to which may be added, if desired, an audio amplifier stage. The valve on which the design is based is the 954 acorn, which is currently available from advertisers at a very reasonable price. The receiver is powered from self-contained dry batteries, which have a long life due to the very low consumption which has been achieved. The output is taken to high impedance headphones.

On test in a poor reception locality, and using the rod aerial provided, the local programmes were received well clear of each other at reasonable strength. In addition about a dozen other carriers were resolved.

The circuit, with very fully detailed constructional data and assembly and wiring diagrams, is obtainable at 2*s*. Messrs. R. C. S. Products can also supply, if required, any of the parts which may be needed, and to this end a price list is included with the circuit and other data.

Let's Get Started . . .

7 : THE SUPERHET RECEIVER

By A. BLACKBURN

AFTER A BRIEF DISCUSSION ON THE various disadvantages of operating the TRF receiver, we decided in the previous article that a different type of receiver was needed in order that these difficulties may be overcome.

Before we go ahead with an explanation of the superhet receiver as a possible alternative to the TRF, let's have a re-cap of the requirements necessary for improved performance. They are:

1. Stable gain before the detector
2. Good selectivity.
3. Constant selectivity over the whole tuning range.
4. Simplicity of operation.

Frequency Changing

It is a fact that high gains can be achieved more easily at lower frequencies than at high frequencies. It is also a fact that greater selectivity is obtainable at lower frequencies. We could fulfill two of the four particular requirements we expect from the receiver if the stations we wished to receive were operating at a low radio frequency; for example, in the long wave band.

The snag here, though, is that if the countless stations in operation today were all squeezed into the long wave band, the resulting congestion would be intolerable —quite apart from the sheer impracticability of such a scheme.

The solution is simple. The incoming signal is changed to a lower frequency, and then amplified.

Frequency changing is the result of "beating" two frequencies together. The simplest way of doing this is to apply two voltages of different frequencies to the grid of the valve. These, doubled, will appear at the anode, together with the sum and difference of the two applied frequencies. To illustrate this, suppose we apply to the grid of a valve two signals, one of 500 kc/s and the other of 400 kc/s. At the anode we should find 1,000 kc/s, 800 kc/s, and the sum and difference components, 900 kc/s and 100 kc/s. There is only one frequency here which is *less* than either of the original, applied voltages, and that is 100 kc/s.

It now remains to separate the 100 kc/s signal from the others, the simplest way being, of course, to make the anode load of the valve a tuned circuit, resonant at 100 kc/s.

Now suppose that the 400 kc/s signal were a radio carrier, and the 500 kc/s were supplied from an oscillator. As we have seen, the carrier will be changed to 100 kc/s, at which frequency it can be amplified before being applied to the detector. But how do we set about receiving a signal at the

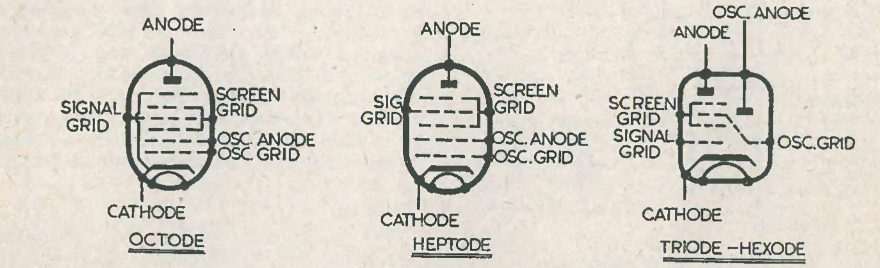


FIG. 1
FREQUENCY CHANGER

RC405

frequency of, say, 800 kc/s? Because the anode circuit is tuned to 100 kc/s, it follows that the difference frequency must remain at 100 kc/s. Taking this factor into consideration, the oscillator frequency must be changed to 900 kc/s; in other words, the

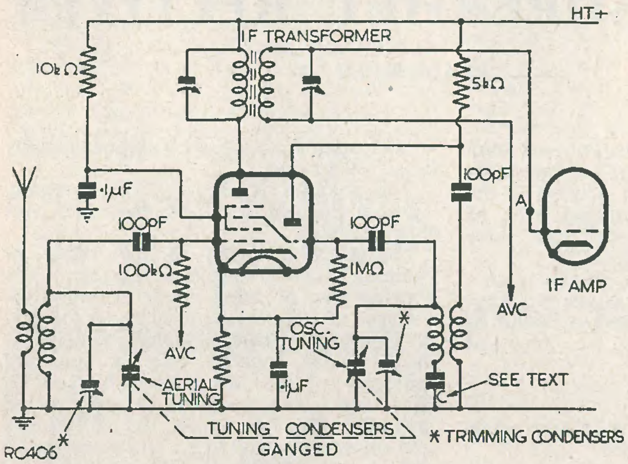


Fig. 2.

A TYPICAL FREQUENCY CHANGER STAGE

tuned circuit selecting the signal and that tuning the oscillator must be changed together, but the frequency difference between them must *always* be 100 kc/s.

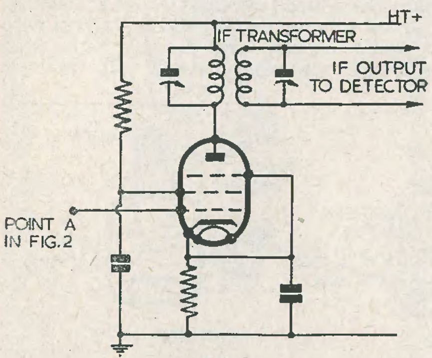


FIG. 3
IF AMPLIFIER STAGE

RC407

Valves

Frequency changers of the type which employ the method of separate voltage application to the same grid are seldom used nowadays. Special valves, with separate grids for the signal and oscillator voltages, have been developed which prevent the signal from "pulling" the oscillation to the signal frequency.

The octode, heptode and triode-hexode valves are the types most commonly used today, and these are shown in Fig. 1. In the octode and heptode valves, the oscillator grid and anode are in the same electron stream as the signal grid; the anode is wound like an ordinary grid. The triode-hexode, however, has a separate triode, the grid of which is internally connected to a grid in the main electron stream.

Valves employing two grids for frequency changing do not operate on quite the same principle as that described above. The frequencies appearing at the anode are the two applied frequencies (not doubled as before), and the sum and difference frequencies. With 400 kc/s and 500 kc/s applied as before, there would be 400 kc/s, 500 kc/s, 900 kc/s and 100 kc/s in the anode circuit. However, although the principle is slightly different, the result is the same, because the 100 kc/s component is present.

Tracking

For continuous tuning over a definite waveband, the signal circuits and oscillator have to be tuned in step, or ganged, but the difference between the frequencies must be constant. Unfortunately, this is more easily said than done.

If, for instance, the two tuning condensers were exactly the same, the tuning inductances would have to be different, in order that the signal and oscillator frequencies differ by the

Intermediate Frequency. Now, if we should require the signal frequency to be changed from 400 kc/s to 800 kc/s, the ratio of these two frequencies is 2 to 1. However, the oscillator must then change from 500 kc/s to 900 kc/s, a ratio of less than 2 to 1. The IF, therefore, would not remain constant, and as the subsequent amplifier would be tuned to 100 kc/s, the result would be loss of gain when the receiver were tuned to 800 kc/s.

One method of preventing this loss is to shape the plates of the oscillator section of the tuning condenser so that the ratios of frequencies are maintained constant. This scheme has been used with considerable success, but it requires a special tuning condenser. It is more common nowadays to use a component which incorporates two similar sections, and to insert a pre-set, or 'padding' condenser (C in Fig. 2). In this way the two tuned circuits remain substantially in step over the whole tuning range. Normally, the condenser is adjusted to ensure that the IF is correct at two or three points in the waveband, the error elsewhere being sufficiently slight not to impair the receiver performance unduly. The process of keeping the two circuits in line is known as "tracking."

IF Amplification

Having changed the signal frequency to a suitably low value, it is now necessary to provide amplification. In order to realise condition 2 — good selectivity — more than the one tuned circuit at present in the signal circuit will have to be introduced.

This can be done simply by tuning the IF amplifier. Fig. 3 shows an IF amplifier consisting of only one stage. Some high quality domestic receivers and communication receivers have two stages.

Because the IF is always the same, whatever the signal frequency may be, fixed tuning may be used throughout the IF amplifier. This factor contributes a great deal to the simplified design of the amplifier. Double-tuned circuits called IF transformers are used to obtain that all-important selectivity. However, not all the tuned circuits need be tuned to exactly the same frequency. If they are, the selectivity may be too great and result in loss of audio quality. Instead, they are often "staggered"; that is, tuned to frequencies slightly higher and slightly lower than the IF.

By this method the bandwidth can be adjusted to combine good quality reproduction with reasonable bandwidth.

The choice of intermediate frequency is very important. While a low IF would seem to be ideal for getting first-class selectivity, there is also the possibility that "second channel" interference may occur. This happens when an unwanted signal is of such a frequency that, upon beating with the oscillator, it produces the correct IF.

Let us go back for a moment to our original example, where the signal frequency was 400 kc/s, the oscillator 500 kc/s and the IF 100 kc/s. Consider what would happen if a strong signal of 600 kc/s reached the frequency changer. The difference in frequencies between the unwanted 600 kc/s signal and the oscillator would be 100 kc/s. The unwanted signal would, therefore, be amplified in the IF amplifier. Now, if the signal tuned circuit were not very selective, the 600 kc/s signal would probably get through with sufficient strength to become a nuisance, because the two signals are only 200 kc/s apart.

If the IF were raised to 400 kc/s the oscillator would have to be tuned to 800 kc/s to receive the wanted 400 kc/s signal. The frequency of a signal likely to cause second channel interference would have to be 1,200 kc/s. Wanted and unwanted signals are now 800 kc/s apart, and the rejection of the 1,200 kc/s signal by the signal circuit will be more effective than before.

Today, most commercial receivers employ an IF of 450-470 kc/s, depending upon the make. As the signal frequency is increased, second channel interference becomes more and more likely to occur. To combat this, some short wave receivers employ an IF of 1.6 Mc/s.

Of course, an RF stage before the frequency changer reduces second channel interference, and in short wave receivers such a stage is nearly always incorporated. But for medium and long wave reception, particularly if an IF of 460-470 kc/s is used, it is not really necessary.

Two other types of interference sometimes occur in superhets, but their effect is small compared to second channel. One is the possibility of a very strong signal beating with a harmonic of the oscillator. Clearly, for this to happen, the transmitter would have to be very close to the receiving aerial.

The second possibility is of a signal of the same frequency as the receiver IF reaching the IF stage. This is easily prevented by inserting an IF "wave-trap" (a circuit tuned to the IF) in the aerial circuit.

Fading

Varying conditions in the path of a transmitted wave cause variations in the strength of the received signal. This well-known and irritating effect is called fading, and it can be very annoying if volume level from the receiver varies too much. Modern receivers are fitted with a simple device to overcome fading, known as Automatic Volume Control.

The output of the IF stage is fed to a detector in the usual way. Normally a diode is used, and made to serve two purposes. You will remember how, in the leaky grid detector, the applied signal causes the valve to produce its own grid bias. In other words, the diode (or grid-cathode of the triode) produces a rectified AC modulation output, super-imposed upon a DC component, just as in the mains rectifier where the ripple is super-imposed on the required DC. Now, the DC voltage produced is proportional to the amplitude of the applied signal. Therefore, if the modulation and DC are separated, and the DC applied to the frequency changer and IF stages as grid bias, the bias they receive will be proportional to the signal they are providing. If, for example, the signal fades, three effects will result: the diode will produce less DC, the bias on the frequency changer and IF stage will decrease, and their gain will increase. Alternatively, if the signal increases in strength, the diode will produce more bias and the gain of the controlled stages will decrease. The receiver output volume remains practically constant.

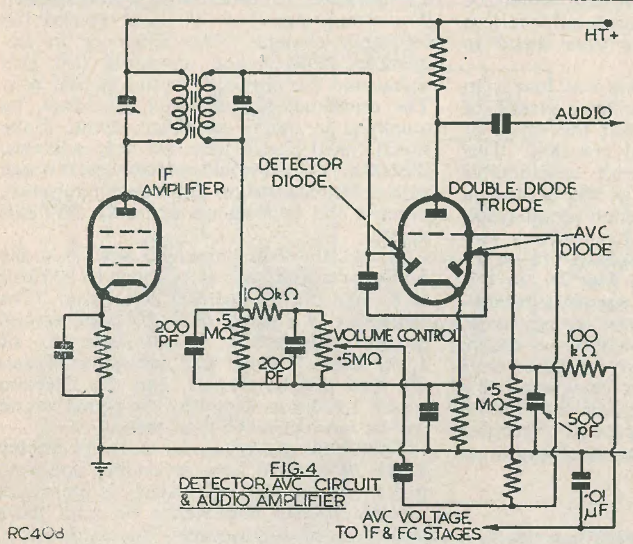


FIG. 4 DETECTOR, AVC CIRCUIT & AUDIO AMPLIFIER

Although both functions of detection and AVC can be carried out by the same valve, modern practice is to use two diodes, one for each purpose. Both these and an audio triode are often contained within the same envelope. A valve of this type is shown in the circuit, Fig. 4.

This circuit has a slight refinement, in the use of delayed AVC. This does not mean a time delay, but a voltage delay. It merely consists of biasing the AVC diode so that it is not effective on small signals. When the signal level exceeds the delay voltage, the diode operates and AVC follows. The advantage of this is that on weak signals the IF stages, etc. work at full gain the whole time.

Before leaving the subject, it should be mentioned that valves used in AVC-controlled stages should be of the variable-*mu* type. The control grid in these valves is wound in such a way that the grid requires very many bias volts to cut off the current through the valve. The amplification factor (µ, Greek "Mu", hence the name) of the valve can be varied over wide limits, therefore, with the gain of the stage accompanying the variations.

Rotary Transformers and Vibrators

By **F. G. RAYER**

MANY DIFFERENT TYPES of vibrator and rotary transformer are available, both new and ex-service—some at very low cost, indeed. These may readily be used to operate almost any receiver or amplifier from a low-voltage source such as that provided by an accumulator. In some cases it is feasible to operate mains-type receivers or other equipment in this way *without modification*, and this is particularly convenient when a mains-operated amplifier or receiver is wanted for occasional use in circumstances where no mains are available.

Most economical running is achieved when the equipment is especially designed for a low-voltage source of power, and uses a vibrator. However, the rotary transformer has certain advantages in some cases, as will become clear.

Vibrator Circuit

The interior wiring, etc., of a typical vibrator is shown in Fig. 1. When the coil is energised, the armature vibrates rapidly, exactly as with a buzzer or electric bell. This is achieved by wiring the armature and primary contacts to a source of current. These connections are marked 1, 2, and 3, and are the only ones present in the usual form of non-synchronous shunt driven vibrator.

The interrupted current thus obtained passes through the primary of a step-up transformer. The secondary of this transformer delivers a high voltage alternating current. This is rectified by a valve or metal rectifier, or by additional contacts in the vibrator. The latter are those connected to 4 and 5, in Fig. 1. When they are present, the vibrator is a synchronous, or self-rectifying, type.

Such vibrators are avilable for 2 volt use and upwards, the 2V types being intended primarily for circuits where HT current is to be obtained from a 2V accumulator, for battery-type receivers. If a car-radio or similar equipment is being built, the vibrator should be a 6V or 12V one, to match the supply voltage. With large equipment, or when power is obtained from a domestic lighting plant or similar source, a 24V vibrator may be required.

In all cases the valve heaters are operated directly from the accumulator. If 6.3V valves are used, the heaters can be wired in parallel, for 6V operation. If a 12V accumulator is used, 12.6V valves can be employed, or the 6.3V types wired in pairs. If the latter form of connection is used, each valve in a pair should have the same heater current rating. It may be necessary to use a series resistor or shunt to make up the heater circuit, if there is an odd number of valves, or if one or more valves have different current ratings. Alternatively, it is sometimes possible to complete the circuit by adding a dial or indicator lamp of appropriate rating.

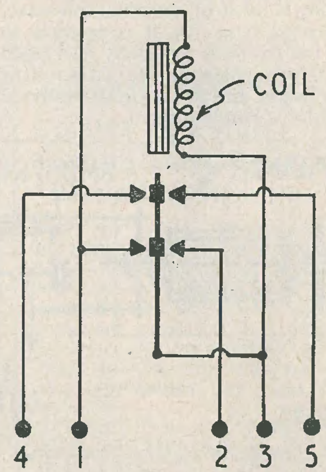


Fig. 1. Vibrator Circuit

Rectification and Smoothing

Fig. 2 shows a circuit for use with a non-synchronous vibrator. The leads marked

1 and 2 are connected to points 1 and 2 in Fig. 1. The centre-tap of the transformer primary is wired to the accumulator, the second terminal of the latter being wired to terminal 3 in Fig. 1. (An on/off switch would be added in one accumulator lead).

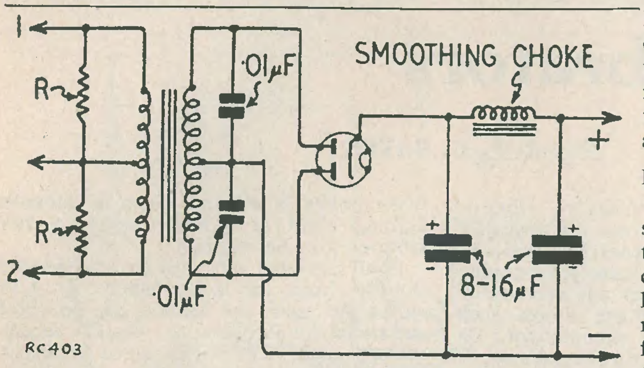


Fig. 2. Transformer and Rectifier Circuit

The rectifier and smoothing circuit is exactly the same as that obtained in an AC receiver with full-wave rectification, though two condensers of about .01 μF are added to reduce sparking at the vibrator contacts. The rectifying valve is of the usual full-wave, indirectly-heated type. Or it is possible to use one of the rectifiers especially developed for such circuits, such as the OZ4. This requires no heater current, since the cathode is heated by ionic bombardment.

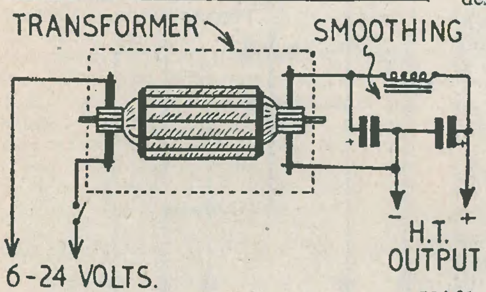


Fig. 3. Circuit for Rotary Transformer.

The positive and negative output leads are taken to the HT positive and HT negative lines of the receiver or amplifier. A single accumulator may, of course, be used for both heater and vibrator circuits. In the event of interference being introduced into the equipment from the vibrator, small chokes of low DC resistance may be wired in the leads from vibrator to accumulator.

A metal rectifier could be used instead of the valve. If a self-rectifying vibrator is used, the secondary of the transformer will be wired to the extra contacts available, and no additional rectification will be required. The smoothing circuit will have to be retained, of course. The self-rectifying type of vibrator is rather more prone to internal trouble due to sparking at the contacts.

Rotary Transformers

In general, these consume rather more current than do the vibrator circuits, but are capable of higher outputs. As they may be obtained so cheaply from ex-service stockists, they are particularly convenient for the intermittent use of "mains" equipment on battery supplies.

The primary, or input side, of the rotary transformer should have a voltage suited to the accumulator. This will be approximately 6V or 12V for equipment to be used in vehicles, rising to 24V for equipment to be used from 24V supplies.

If high-tension current only is required, then the transformer can be relatively small. The valve heaters would then be operated directly from the accumulator, as has been described. A number of rotary transformers also provide current for the valve heaters, however. Such a transformer is the ex-service Type 104, which provides 6.3V at 2.5 Amps and 230V at 65mA from a 12V input. In this case, the equipment may use 6.3V valves, all wired in parallel for 6.3V operation.

The correct polarity should be observed, both in input and output wiring. Care should be taken to see that the accumulator is not connected in the wrong polarity, or the polarity of output will be reversed, and the smoothing condensers may be damaged. An output of 65mA at 230V is sufficient for the HT requirements of many average 4 or 5 valve receivers, or amplifiers of moderate size not employing push-pull output. The output of the transformer will be DC but requires some smoothing, as shown, to eliminate noise. A choke of 5 to 15 Henrys, with 8 to 16μF condensers, is suitable, as with Fig. 2.

DC/AC Converters

These enable standard AC type equipment to be operated without modification, as they provide an AC output of up to 250 to 300V. They are more expensive than the smaller type, and consume a relatively heavy current. With their aid, a receiver, amplifier, or television set can be operated from an accumulator or household plant.

The input voltage of the converter should be suited to the voltage of the supply. The output should be of suitable voltage and wattage for the equipment. If necessary, an auto-transformer can be used between convertor and equipment, to obtain a correct voltage for the latter. However, this is not usually necessary.

An idea of the current consumption may be gained from the wattage consumption of the equipment or receiver operated. Assume that it is a receiver consuming 60 watts. If the converter were 100% efficient, this would give a consumption of 10 Amps from a 6V source, 5 Amps from a 12V source, or 2.5 Amps from a 24V source. However, to allow for losses these figures may easily be doubled. It will therefore be seen that an accumulator of large capacity, properly charged, is essential when a long period of use is required, especially with large amplifiers or receivers.

Other types of converter or rotary transformer provide a DC output of fairly high current, and this may be used to drive AC/DC type equipment. AC/DC type equipment may also be driven from those converters having an AC output. It should not be overlooked, however, that equipment made especially for AC (e.g., having a mains transformer) must on no account be connected to a DC source.

In general, then, the large type converter is most suitable when mains equipment is to be operated from an accumulator. (For example, when an amplifier is used for public-address or similar purposes, and no mains are available). Its current consumption is fairly high. Smaller rotaries may be used to obtain HT current alone. But when low current consumption is essential, the vibrator is most suitable.

Vibrator power-packs are also available ready-made, and can be used to obtain HT current from an accumulator. Such a unit is the Wright and Weaire VBP/6 (for 6V) and VBP/12 (for 12V), which can supply voltages between 150 and 450 or more, as the user desires. This would be suitable for car-radios, etc.

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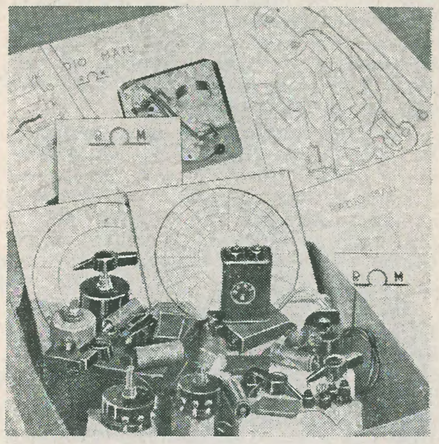

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★ Selective tuning
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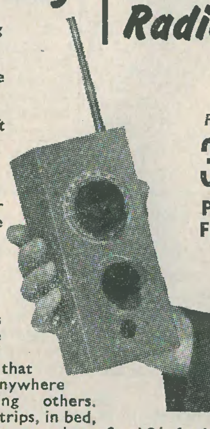

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Scanning coils. Low impedance line and frame, **7/6.** Scanning coils. Low imp. line and frame. Aluminium shroud **12/6**
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PRIVATE

FOR SALE OR EXCHANGE Eddystone 680 receiver, mint condition. Reeve, 6 Manor Mount, Forest Hill, London. *Telephone* FOR. 0231.

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EXCHANGE Budgerigars for Communication Receivers, Test Gear, Meters or what have you? Wood, East Harlsey, Northallerton, Yorks.

DISPOSING SWL gear, brand new variable condensers, valves, coils, etc. Edwards, 1 Nelson Drive, Littleham, Exmouth, Devon.

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FOR SALE Eliminator with trickle charger, 30/-. Ekco eliminator, £1. Mains energised speaker, 8", 15/-. P.U. 228 brand new less valves, in transit box, £2. RDF1 chassis less valves, 30/-. Oscillator unit 217, brand new, less valves, 10/-. Lot £6 10*s* 0*d*. Various other gear for disposal cheap. All prices include carriage. SAE please — Box No. C146.

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[*continued on page 299*

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Electronic Engineers and Laboratory Equipment Manufacturers

99 DUDLEY PORT, TIPTON, STAFFS.

Instrument cases in steel, complete with light alloy front panel Colours Black (Red and Green 10 per cent extra). Back punched for ventilation. 8"x9"x8" at 18/-, 10½"x12"x10½" at 21/-. Chassis to suit 7" square by 2½" deep (Light alloy, four sides) 7/6. Chassis to suit 10" square by 2½" deep (Light alloy, four sides) 10/6. Heavier steel case complete with alloy front panel, finished in Black (Red or Green 10 per cent extra). Back punched for ventilation, 9"x12"x9" at 30/-, chassis for same 10"x8"x2¼" (reinforced corners) at 10/6 each. Case complete with chassis and panel £2.0.0 Meter stands, ends only, 2/6 per pair, panel for same 6" square at 1/9. 9"x6" at 2/6 and 12"x6" at 3/3. Meters can be mounted at extra cost if required. Suppliers of technical publications. A full range of components, by well known manufacturers, are stocked, Mullard, Brimar, Cossor, T.C.C., Dubilier, Erie, R.E.P., Wearite, Elstone, Morganite, etc. High stability 1, 2 and 5 per cent resistors available from stock or to order.

ALL PARTS FOR THE KIDDIES' CRYSTAL SET

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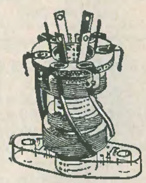

Dual Range Miniature Crystal Set Coil with Circuit **2/6**
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SMALL ADVERTISEMENTS

continued from page 297

FOR SALE "Hambander" 7 valve Communication receiver, 32-1.7 Mc/s in 5 switched bands. Also matching 3 valve Pre-selector and Speaker. All in good condition. Cost £34. £16 the lot. Box No. C145.

FOR SALE *Practical Television* Argus kit, plus 7" CRT, £7 10*s* 0*d* or near offer. Parrott, 45 Berkeley Buildings, Harrowby Street, London, W.1.

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[*continued on page 300*

TRANSFORMERS.—Manufactured to our specification and fully guaranteed. Normal Primaries. 425 v. -0-425v. 200 m.a., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3a., 0-2-4-6.3 v. 3 a., ONLY **72/6.** 425 v.-0-425 v. 200 ma., 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a. ONLY **50/–.** 350 v. -0-350 v. 160 ma., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a. ONLY **42/6.** 250 v.-0-250 v. 100 ma., 6.3 v. 6 a., 5 v. 3 a. ONLY **32/6.** The above are fully shrouded, upright mounting. Universal Mounting 350 v. -0-350 v. 80 ma., 0-4-6.3 v. 4 a., -0-4-5 v. 2 a. ONLY **18/6.** Top shrouded, drop through 260 v.-0-260 v. 70 ma., 6.3 v. 3 a., 5 v. 2 a., ONLY **16/6.** The following are upright mounting. EHT for VC97 Tube 2,500 v. 5 ma., 2. -0.2 v. 1.1 a., 2 v. -0-2 v. -0-2 v. 2 a. ONLY **37/6.** EHT 5,500 v. 5 ma., 2 v. 1 a., 2 v. 1 a. ONLY **72/6.** EHT 7,000 v. 5 ma., 4 v. 1 a. ONLY **82/6.** PLEASE ADD 1/6 PER TRANSFORMER POSTAGE. **TRANSFORMER,** for use on trains, models, etc., giving outputs of 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v., 30 v., at 2 amps from normal mains input. ONLY **17/6** (postage 1/–). **TRANSFORMERS.**—Ex. W.D. and Admiralty, built to more than 50 per cent. safety factor, with normal A.C. Mains Primaries. All Brand New and Unused. 300 v.-0-30 v. 200 ma., 5 v. 3 a., 6.3 v. 5 a., C.T., 20 v. 750 ma., 70 v. 100 ma. Weight 12 lb. ONLY **42/6** (postage, etc., 2/6). 330 v.-0-330 v. 100 ma., 4 v. 3 a. Weight 7 lb. ONLY **22/6** (postage 1/6). L.T. 5 v. -0-5 v. 5 a., 5 v. -0-5 v. 5 a., 5 v. -0-5 v. 5 a. By using combination of windings will give various voltages at high current. Weight 11 lb. ONLY **35/–** (postage etc., 2/6). L.T. 6.3 v. 7.7 a., 4.2 v. 2.5 a., 4 v. 1 a. ONLY **19/6** (postage 1/6). EHT 1,400 v. 2 ma., 520 v. 10 ma., 300 v. 10 ma. 2 v. 1.5 a. ONLY **21/–** (postage, 1/6).

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SMALL ADVERTISEMENTS

continued from page 299]

BLUEPRINTS. High Gain 10 Meter Converter, with a de-luxe circuit comprising EF91 RF stage, ECC91 double triode mixer and oscillator, EF92 IF amplifier, with stabilised voltage supply via a 7475. 1*s* 8*d* post free with full instructions. A.S.W.P., 57 Maida Vale, London, W.9.

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