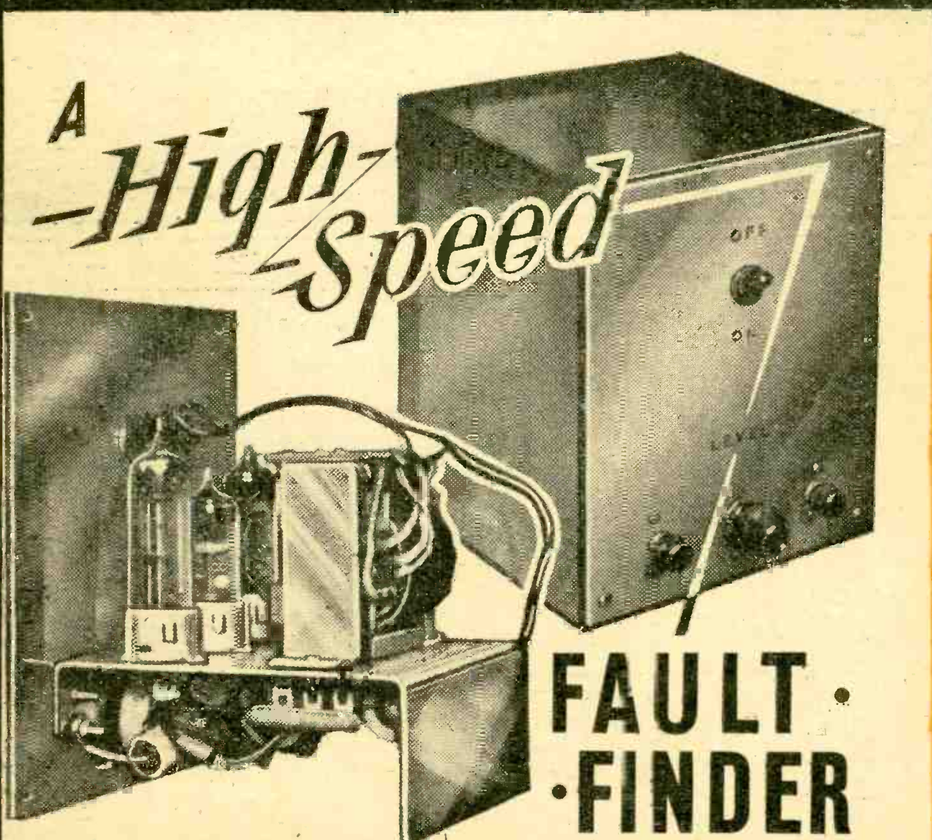
MORE ABOUT OUR ELECTRONIC ORGAN

1/-

Vol. 28. No. 553
NOVEMBER, 1952

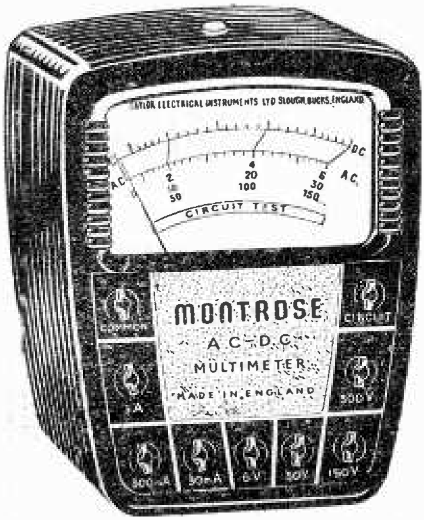
EDITOR:
F.J.CAMM

# PRACTICAL WIRELESS




IN THIS ISSUE:

A MODERN TWO-VALVER
REMOTE CONTROL
A TESTER FOR ELECTROLYTICS
GAS-FILLED RELAYS
EXPERIMENTS WITH THE HARTLEY CIRCUIT
ACOUSTIC CONTROL OF TONE
THE TUNED CIRCUIT, ETC., ETC.

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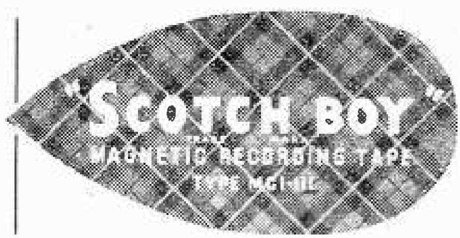


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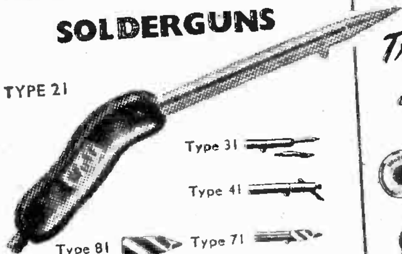


**OFF-STRAIGHT EASY-GRIP HANDLE • PERFECT CONTROL • QUICKER HEAT-UP • LOCALISED HEAT • LOW CURRENT CONSUMPTION • MAINTAINS CORRECT HEAT • MODELS FOR EVERY PURPOSE**

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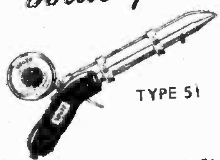


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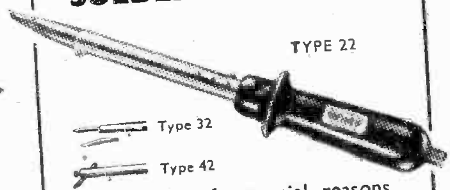


For all who, for special reasons, prefer the conventional straight-type handle. Identical as regards elements and bits to Wolf Solderguns, but with round hard wooden handle with heat-deflecting skirt.

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## *Another page from the* DENCO *catalogue*

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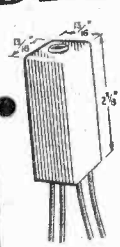
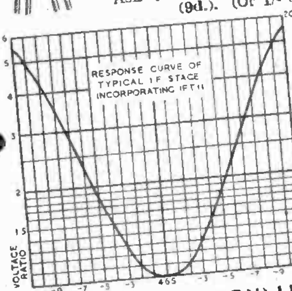
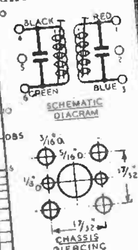


We are exhorted to combat higher wages by greater efficiency in order to keep down the cost. So far as radio and technical quality is concerned this is a problem! **BUT WE HAVE SUCCEEDED** . . . and here it is: Our new I.F. Transformer has: Litz wound coils. Silver Mica Condensers. Iron Core Adjustment. Four coloured PVC lead out wires (which saves you time in soldering and cost of material). **YET COSTS ONLY** 12/- per pr. Retail. Ask your dealer for our catalogue (9d.). (Or 1/- direct from us.)

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Designers of television constructor sets know that the efficiency of their equipment depends on the solder used by the constructor—that's why they recommend Ersin Multicore for trouble-free, waste-free soldering. Ersin Multicore, the only solder containing three cores of extra-active, non-corrosive Ersin Flux, is obtainable from all leading radio shops. Ask for Cat. Ref. C.16018, 18 S.W.G. 60/40 High Tin Television and Radio Alloy. The size 1 Carton contains 37 feet of solder, costs 5/-.


## Ersin Multicore Solder

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Practical Wireless

EVERY MONTH
VOL. XXVIII, No. 553 NOVEMBER, 1952

Editor F. J. CAMM

20th YEAR
OF ISSUE

COMMENTS OF THE MONTH

By THE EDITOR

# Afterthoughts On Earls Court

NO less than 289,899 paid to see the exhibition at Earls Court this year and this is an increase of 58,965 over the figures for 1951. This provides cause for congratulations to all those responsible for its organisation. At the same time there is room for criticism as well as for suggestions for next year's Show. In the first place, firms who are put to considerable expense to provide the stands and exhibits, which *are* the exhibition, expect to have the public attracted to their stands. This year there were so many very attractive side-shows that we fear that a high percentage of the public passed through the portals only to see them and then to pass out again, passing by the exhibits themselves. The timing of some of these side-shows, particularly the BBC shows, was bad in that they finished too late to enable evening visitors to see the exhibits as well as the shows, with the result that they eschewed the exhibits!

There was general comment amongst experimenters and constructors that so few exhibits appealed to them and such complaints were justified. The Radio Component Manufacturers' Federation run their own exhibition each year and so does the Radio Society of Great Britain. We suggest that these two smaller exhibitions should form part of the main Earls Court exhibition and not be run separately. By no stretch of the imagination can the R.S.G.B. exhibition be called a "national" exhibition. Excellent though it is for that comparatively small band of loyal supporters, it can only attract at most, in view of its modest size and unpretentious presentation, a few thousands every year. Similarly the R.C.M.F. exhibition does not attract a large attendance and in its present form appeals only to manufacturers and a comparatively small section of the public.

It should be apparent to the trade from the great interest evinced in the exhibits of firms who cater for constructors, and of publishers of technical literature and blueprints, that this market is ever increasing, especially now that television has given an enormous fillip to it. Yet the trade continues to neglect this growing and profitable market by practically eliminating from its annual exhibition anything which would encourage a man to build his own receiver. Constructors, however, are not discouraged in this way, and those firms, many of them our advertisers, who continue to cater for them report ever-growing business and increasing turnovers. Surely it is just as important to exhibit at Earls Court the component parts as well as the completed job? Why not incorporate next year the R.C.M.F. exhibition and the R.S.G.B. exhibition and cut out some of the side-shows which only appeal to those without a technical interest, although they may help to swell the gate?

The trade should not neglect the radio amateur as it has done since the war, for none of the post-war exhibitions has been designed to appeal to him. War disposal equipment has helped the radio amateur enormously, but we still feel that there is a vital need for an exhibition which appeals to the experimenter and the amateur.

We wonder how many of the older firms in the industry carried their minds back to their early days when they were glad to cater for constructors; when Lord Burleigh said on opening the exhibition: "This is the 19th show which the industry has organised and what an astonishing change you have seen over the passing years. Only just over a generation ago, but a handful of people were employed endeavouring to develop a receiver so efficient, cheap and attractive that it would become a necessity and not a luxury. Most of their contemporaries looked on this as a pipe dream, yet to-day there are 196 firms in the industry employing 130,000 people and with a factory output of £85 million a year."

That industry was built by experimenters and constructors. They not only provided the cash but the personnel.

## THE "PRACTICAL MECHANICS" TAPE RECORDER

OUR companion journal, "Practical Mechanics" (which has reverted to its pre-war style of three-colour covers with increased pages inside) contains in its October issue full constructional details for building the very latest type of tape recorder, giving over an hour's recording with play-back and fast rewind.—F. J. C.

# ROUND the WORLD of WIRELESS

### Marconi Premium

THE British Institution of Radio Engineers has made the award of the Marconi Premium to Mr. E. G. Rowe, M.Sc., A.C.G.I., Chief Engineer of Standard Telephones and Cables Ltd., Valve Division, for his paper on "The Technique of Trustworthy Valves."

This was considered by the Council to be the most outstanding Engineering Paper published in the Institution's journal during 1951, and the Presentation was made by the President at the Annual General Meeting on Wednesday, October 8th, 1952.

### Transit Radio

IT is reported in the *Radio and Television News* that Transit Radio, providing for the pickup of programmes in buses or street-cars, which has been subjected to some rough treatment in the courts, finally won its freedom, and from the highest bench in the land. In a 7-to-1 vote, the Supreme Court declared that it is perfectly legal to broadcast news, music, and commercials to vehicles, and it is not an invasion of privacy as cited by the Circuit Court of Appeals a year ago.

### Radio Exhibition at Singapore

OVER 55,000 people, of which 45,000 paid the 50 cents admission fee, visited the recent Radio Exhibition, Singapore, during its first week.

"Its success," said Mr. D. Humphries, of the G.E.C., Singapore, who is the working committee's chairman, "has already prompted requests for the Exhibition to be sent complete to Bangkok, Colombo and Manila. The U.K. Trade Commissioner is also urging British manufacturers of other products to arrange similar exhibitions."

### Mr. J. Foster Veevers

THE PLESSEY CO., LTD., announce that Mr. J. Foster Veevers, M.I.E.E., M.I.P.E., M.I.I.A., has been appointed general manager of the Swindon works which contains one of the largest automatic machine shops in the country, with a weekly output of some millions of repetition parts.

Previous to joining the Plessey Co., Mr. Foster Veevers was with G.E.C., Ltd., as manager of the Stockport works of Salford Electrical Instruments, Ltd.

### Ekco Car Radio at Motor Show

E. K. COLE, LTD., will exhibit their full range of car radio receivers and equipment at the Motor Show, to be held at Earls Court from October 22nd to November 1st. Receivers mounted in the dashboards of different makes of cars will show how Ekco sets fit into cars of any make or year.

Among the sets displayed will be the new CR181/F, introduced for installation in the latest-style dashboards of the Ford "Consul" and "Zephyr Six" saloons. The CR61, which covers seven short-wave ranges and incorporates bandspread tuning, will also be exhibited.

### Mr. G. H. Foot Joins Mullard

G. H. FOOT, B.Sc.(Eng.), A.C.G.I., A.M.I.E.E., recently joined the equipment division of Mullard, Ltd., in charge of the telephone product group.

Mr. Foot brings to the Company wide experience in world telephone practices, both operating and manufacturing. For some years he was with the Companhia Telephonica Brasileira at Rio de Janeiro, and prior to that was with Siemens Bros., Ltd., at Woolwich.

### B.I.R.E.

THE following meetings of the British Institution of Radio Engineers will be held during October.

*London Section.* — Wednesday, October 8th, at 6.30 p.m., London School of Hygiene and Tropical Medicine, Keppel Street (Gower Street), London, W.C.1. Annual general meeting followed by presidential address of W. E. Miller M.A.(Cantab.), M.Brit.I.R.E.

*North-eastern Section.* — Wednesday, October 8th, at 6 p.m., Institution of Mining and Mechan-

*Major H. MacCallum, radio pioneer responsible for the first 2LO outside broadcast by Marconiphone, was recently presented with a Marconiphone television receiver, and members of the press are seen here looking at the Ideal Home Combination Model of 1922.*

ical Engineers, Neville Hall, Westgate Road, Newcastle. "Germanium Crystal Walves, Their Characteristics and Application."—B. R. Bettridge.

*West Midlands Section.*—Tuesday, October 28th, at 7.15 p.m., Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton. "A Survey of Television Development and its Problems."—H. J. Barton-Chapple, B.Sc., M.Brit.I.R.E.

**Football for Patients**

CHELTENHAM TOWN FOOTBALL CLUB have started a relay system whereby a commentary on all their home games is replayed to patients in the General Hospital.

The commentary begins from the first whistle, and as the match progresses the recording tapes are rushed to the hospital and replayed in the men's wards over the hospital's wireless earphone service.

**Twenty-five Years of Service**

ON August 2nd Mr. A. E. Lucas, Mullard valve sales promotion representative for Manchester area, completed his 25 years' service with the Mullard Co.

To mark the occasion Mr. T. E. Goldup, a director of Mullard, Ltd., presented Mr. Lucas with an inscribed gold watch and a cheque.

**Show Aids Sales**

THE advertising value of the Radio Show is illustrated by the fact that a Letchworth firm of castor manufacturers has received so many orders since the exhibition began that more employees have been engaged to meet the demand.

**Commercial Cut**

THE increased popularity of television in America has caused radio companies to cut their advertising rates by anything up to 30 per cent.

As more families buy television receivers, the sound radio public decreases, especially during the evening. In the morning programmes with an appeal for the housewife are broadcast.

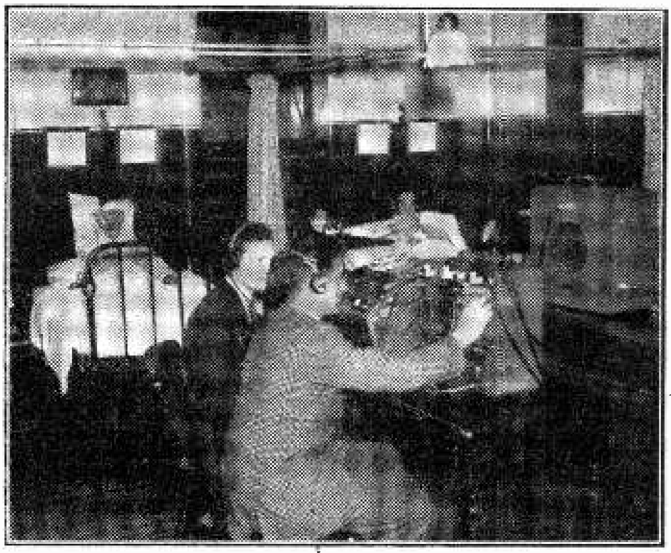
**BBC Show Band**

THE new BBC show band, conducted by Cyril Stapleton, will be heard regularly at least three times a week following its inaugural broadcast last month.

**Radio Exports**

MORE radio components are exported by Great Britain than by any other country in the world.

The chief buyers of our goods are the Commonwealth, Europe and the United States.



*Mr. G. D. Lawson (left), the hospital radiologist, and Mr. Eric Baylis, owner of the recording machine, replay the commentary to patients in Cheltenham General Hospital. The two men in bed are H. Hipkiss and R. Robertson.*

**Channel Swimmer**

IT is possible that the first radio amateur to try to swim the English Channel is Mr. R. T. Glynn, G3AKZ, of Kayte Lane, near Cheltenham, who made the attempt at the end of August.

Mr. Glynn was forced to give up when seven miles from the English coast. Tides did not favour his effort which had lasted 12 gruelling hours.

**Agency Appointment**

RADIOVISER PARENT, LTD., manufacturers of photo-electric equipment, announce that they have appointed Messrs. J. Broughton & Son (Engineers), Ltd., of "Security" Works, 234, Pershore Road South, Kings Norton Factory Centre, Birmingham, 30, sole selling agents for their photo-electric press brake guard.

It should be noted, however, that all other Radiovisor products are still handled by Radiovisor Parent, Ltd., from their head office at 1, Stanhope Street, London, N.W.1.

**Radio at Jamboree**

WHEN Boy Scouts of 25 different nationalities congregated at the recent Jamboree at Belchamps, Essex, an amateur radio station was operated by the Southend and District Radio Society.

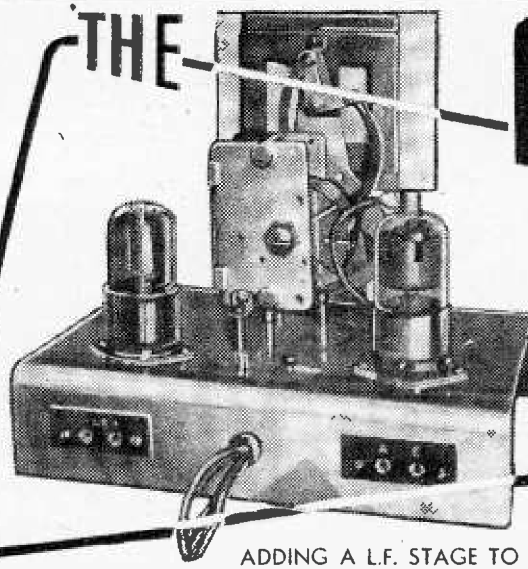
The station received a good will transmission from the Australian Broadcasting Commission and demonstrated walkie-talkie apparatus on the camp site.

**Broadcast Receiving Licences**

THE following statement shows the approximate number of licences issued during the year ended July, 1952:

| Region | Number |
|---|---|
| London Postal | 1,817,846 |
| Home Counties | 1,509,794 |
| Midland | 1,404,104 |
| North Eastern | 1,834,793 |
| North Western | 1,493,756 |
| South Western | 1,064,921 |
| Welsh and Border | 727,934 |
| Total England and Wales | 9,853,148 |
| Scotland | 1,147,061 |
| Northern Ireland | 213,228 |
| Grand Total | 11,213,437 |

# THE MODERN 2 VALVER



## For the Beginner

### ADDING A L.F. STAGE TO THE 1-VALVER DESCRIBED LAST MONTH

THOUGH the "Modern 1-Valver" can give very good results it is, of course, unsuitable for loudspeaker operation. However, those who wish to use a speaker can add an output stage without much difficulty, thereby arriving at a 2-valve circuit. Used with an average aerial and earth, the volume obtained from such an arrangement equals that provided by the 4-valve superhet all dry receiver of equivalent type and employing a frame-aerial as the only source of signal pick-up. With a short indoor or temporary aerial good volume is still obtainable, largely due to the presence of reaction to build up weak signals. Such a 2-valve circuit accordingly recommends itself where economical operation and low initial cost are important, and where portability is not an essential requirement.

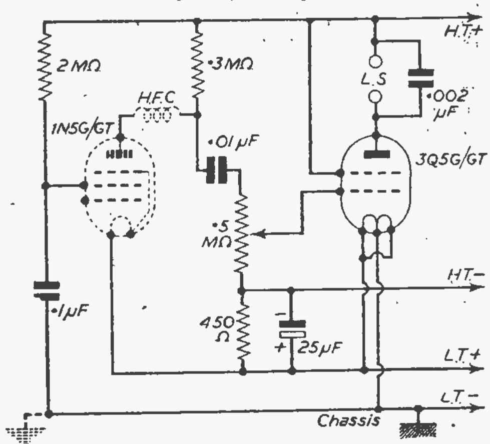
Filament current can be obtained from any 1.4 v. dry battery, of which many types are available. For H.T. purposes a 90 v. battery is recommended. If size and weight are to be kept down, a layer-type, such as the Drydex 526, is suitable. If size is not important, a battery with standard cells can be used with advantage, since these are both cheaper and have a longer life. As standard 90 v. batteries are readily available from a variety of manufacturers it is not proposed to specify any particular kind. It should also be noted that the receiver will give good results with a 60 or 67½ v. battery, though volume is naturally slightly reduced. The total filament consumption of the 2-valver is .15 amp., the output valve being a 3Q5 beam tetrode, which will deliver approximately 0.27 watts with a 90 v. H.T. battery. Equivalent valves are the Marconi-Osram N15, and Mullard DL33. 3Q5 valves with the G/GT designation are also equally suitable.

**Circuit Details**

The wiring already in the 1-valver remains unchanged except for 'phone leads and H.T. negative connection. The output sockets on the rear runner are now wired for the speaker, and the H.T. negative lead is removed from the tag in contact with the chassis, going instead to the condenser and resistor which provide auto-bias for the output valve.

An additional ⅜in. diameter hole is drilled centrally in the front runner to take the .5 megohm volume control; the wavechange switch and reaction condenser are left untouched, together with their wiring. It is also necessary to drill a further 1⅛in. diameter hole for the additional valveholder, with three 6 B.A. clearance holes to mount the holder and bias condenser.

The N15 detector now functions with a high anode impedance (.3 megohms) and gives very excellent results with this. Since the valve cannot function properly if the screen-grid voltage exceeds the anode voltage a 2 megohm screen-grid dropper is introduced, with a .1 μF by-pass condenser to chassis. Grid bias is developed by the voltage drop across the 450 ohm resistor, the grid of the 3Q5 being thereby maintained at about 4.5 v. negative, in respect to the filament.




*Theoretical circuit, showing additional wiring.*

To preserve stability this resistor is shunted by a condenser of high capacity. Volume may be adjusted from zero to maximum by means of the .5 megohm potentiometer, and the receiver remains equally suitable for headphone use. The .002 $\mu$F condenser wired in parallel with the output sockets serves to reduce top-note response slightly, thereby making reproduction more natural.

**Points About Wiring**

An examination of the diagram should make all connections perfectly clear, but one or two items might be mentioned to ensure that no difficulties arise.

The lead which previously went from the H.F. choke to one 'phone socket is removed, the .3 megohm resistor and .01 $\mu$F coupling condenser instead going to the choke tag. The lead from tag 4 of the detector valveholder to H.T. positive is also removed, the 2 megohm resistor and .1 $\mu$F condenser being added as shown. Filament current for the 3Q5 is taken from tag 2, as illustrated. The 3Q5 has a centre-tapped filament, the halves here being used in parallel for 1.4 v. operation. No changes in other wiring are made, but the .0001 $\mu$F anode by-pass condenser in the 1-valver will have to be moved a little from its original position to make room for the new .1 $\mu$F condenser.

**COMPONENT LIST**

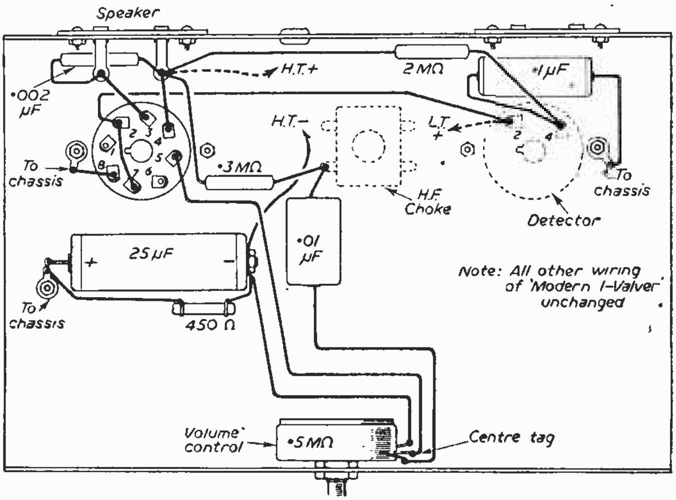
- **2 megohm, .3 megohm, and 450 ohm resistors.**
- **.1 $\mu$F paper by-pass condenser. (T.C.C., etc.)**
- **.01 $\mu$F mica coupling condenser. (T.C.C., etc.)**
- **25 $\mu$F 6 to 12 volt bias condenser. (T.C.C., etc.)**
- **.002 $\mu$F paper tone-correction condenser. (T.C.C., etc.)**
- **.5 megohm volume control and knob.**
- **3Q5 or equivalent valve.**
- **International octal valveholder.**

The bias condenser is soldered to a tag bolted to the chassis. It is important to note that the *positive* tag of the condenser goes to the chassis. The negative tag, and metal casing, if common to this tag, must be kept away from the chassis. If this is not done no bias voltage will be developed, with a consequent reduction in volume, quality of reproduction, and valve life. H.T. consumption will also be considerably increased.

The mounting bush of the volume control must be "dead" and not in contact with the slider, or centre tag. This is so with modern controls of reputable manufacture, but must be watched if an old control or surplus component is employed. In the event of bush and slider being in electrical contact, the control should be insulated from the front runner by means of ebonite or similar washers.

**Speaker Matching, etc.**

The receiver will give excellent volume and quality if used with a loudspeaker of reputable manufacture. Correct impedance matching is necessary, and the optimum load of the 3Q5 is 8,000 ohms. If the speaker has the usual impedance of 2 to 3 ohms a transformer of approximately 60 : 1 ratio is required. In the event of a speaker of 15 ohms impedance being used, the ratio should be about 23 : 1. It will, therefore, be seen that it is essential that the speaker and transformer be selected for use together, or poor results will arise. A coupling transformer intended for a 2 to 3 ohm speaker is not suitable for the 15 ohm type. It should also be noted that ordinary D.C. measurements of the resistance of the speaker speech-coil will not reveal its impedance, since the D.C. resistance of the 15 ohm type may not exceed 2 to 3 ohms. This also applies to the primary and secondary of the output transformer, where the values, read with a D.C. meter, will be very much lower than the impedance. Nor will the secondary




*Components and wiring for the L.F. stage.*

of the output transformer and speech-coil, measured separately, necessarily have the same D.C. resistance, since the gauge of wire used is normally very different.

However, many manufacturers produce speakers complete with output transformer, and several suitable "Stentorian" models can be recommended. Some manufacturers classify their output transformers according to the type of output valve with which the transformer is to be used. If this is so with the type obtained, a transformer for "High impedance *battery* pentode" should be obtained. A transformer for *mains* pentode is unsuitable, since the optimum load of these valves may be as low as 2,500 ohms or less. If a multi-ratio transformer is used, the tags giving best results should be used.

Finally, for best reproduction the speaker must be mounted in a cabinet or secured to a baffle board. For normal use a 5in. to 7in. speaker is most suitable. (This dimension refers to the diameter of the cone.) It must, of course, be of the permanent magnet type.

# Acoustic Control of Tone

## SOME METHODS OF IMPROVING TONAL QUALITY

By Wm. Nimmons

THAT acoustics have a profound effect on the tone or quality of reproduced sound is a matter, not of opinion only, but of observed fact. Anyone who has switched on a wireless set in a room in which the furnishings have been temporarily removed, for spring cleaning, for example, will have noticed how much "deeper" the set sounds as compared with the same set in normal surroundings.

In the majority of cases, however, the surroundings of the set are fixed and static, and there is little that can be done. So why an article on acoustic control of tone? The reason is that I have considered the term acoustic to include the loudspeaker, the most important link in the chain, in its relation to the distribution of sound. As soon as the sound leaves the diaphragm it falls into the domain of acoustics, and as such it is perfectly legitimate to speak of acoustic control of tone since there are methods whereby we can raise or lower the tone by purely acoustic, i.e., non-electrical, means. Most of these are concerned with manipulating the actual baffle opening, the precise method employed depending upon whether we want the tone of reproduction raised or lowered.

Ideally, the receiver should simply recreate the performance at the microphone, with no added tone or colouring. This is not possible in practice, and the aim is to get as close a rendering to the original as possible. Every device we employ to achieve this end is legitimate, even if it departs from theory.

For example, theory demands that a loudspeaker be surrounded by a close-fitting baffle, in order that the low notes may be prevented (or baffled) from passing direct from the front to the back of the diaphragm. Yet we sometimes see in commercial sets that the loudspeaker is held a little way out from the baffle by distance pieces placed at the mounting bolts, so that there is a clear air space between the loudspeaker surround and the edge of the baffle hole. Such a device is legitimate in order to secure clarity of tone, since cabinet resonance or other defects may cause the set to emphasise the bass. This is an example of departure from theory in order to achieve a compromise between conflicting factors, and from the acoustic side it is a step in the right direction since it ensures clarity of reproduction, however much it may be deplored from the theoretical side.

### Excess Bass

In this case the set is suffering from too much bass, especially if not exclusively at high volume levels. Other methods of reducing the disadvantage, besides standing the loudspeaker out from the baffle, might include (a) the use of a different type of loudspeaker, (b) the use of a tweeter to bring up the general level of the high notes, and so mask to some extent the disagreeable preponderance of the low notes, or (c) modifying the circuitry in order to produce a more acceptable output characteristic. Other methods aimed at preventing undesirable resonances might be the strengthening of the cabinet by cross-stays, packing with sound absorbent material, or even cutting holes in the sides and back of the cabinet. So we see there is no easy road to acceptable reproduction: each case is decided on its merits, and the method employed by some commercial concerns of mounting the loudspeaker away from the baffle has the merit of simplicity.

### Excess Top

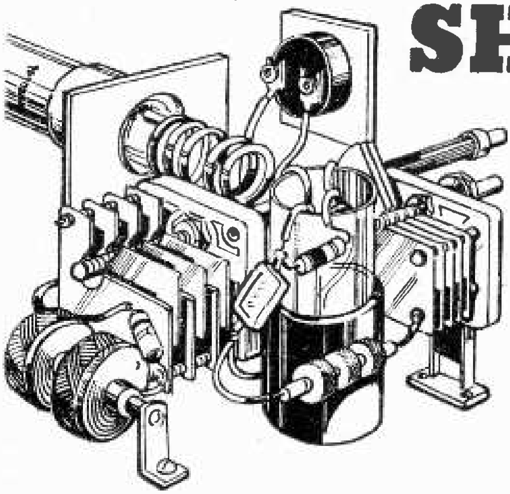
In the case of the opposite sort of response, i.e., too high-pitched reproduction, there are several palliatives which can be applied which belong to the realm of acoustic control of tone. In this case the high notes are shot straight out, and are not nearly so pronounced at the side of the loudspeaker as they are at the front. If we arrange a sloping board in front of the loudspeaker these high notes can be deflected away from the region immediately in front of it, thereby rendering the response more even to the ear of the listener; but here much depends upon the surrounding surfaces as they may bounce off a hard, polished wall and return to the ear of the listener so that no perceptible benefit results. Drapery, or a curtain hung in the direction of the projected beam of sound, will effect a great improvement in the overall response, providing, of course, that the objection is due to high-lift only and not to distortion.

Another palliative of high-note response is to fit a small opening to the loudspeaker aperture. Thus, if we have an 8in. or 10in. loudspeaker, the actual opening should be 6in. or even only 4in. across. It does not matter if the opening be circular, square, or any fancy shape, providing it is substantially smaller than the area of the cone. This method of palliation can conveniently be fitted over an existing opening, and will be found to tone down the high notes considerably.

Many cases of high-pitched reproduction are simply due to inadequate baffle area. By increasing the baffle, music and speech acquires a roundness or body, the depth of which is complementary to the high notes: the high notes are, in fact, essential to give proportion to the whole, but if present alone can be somewhat distressing.

A large scale or tuning dial in close proximity to the loudspeaker opening materially reduces the baffle area. In this case it may be worthwhile to fit an additional baffleboard inside the cabinet, located in such a manner that it covers up or short-circuits the large scale opening. Much depends upon the actual layout, and often nothing can be done short of supplying a separate loudspeaker.

The situation of the set often plays a large part in the response obtained. It should not be placed close to a wooden wall or partition, particularly if the back of the set is open. A brick wall is much better in this respect, and quite often a corner will give better reproduction than if placed in the centre of the room wall.



# SHORT-WAVE SECTION

## EXPERIMENTS WITH THE HARTLEY CIRCUIT

By A. W. Mann

IT is many years since the writer of this article built and used a Hartley short-wave receiver, and so far as the simpler types are concerned personal preference centres on aperiodic coupled circuits and the T.R.F. Superhets are in general use, of course, but while their many advantages are appreciated, their shortcomings are not overlooked.

The ideal receiver would be one possessing the sensitivity of the superhet together with its selectivity and the signal-to-noise ratio of a one-valve battery type receiver. While this ideal is unlikely to be realised the signal-to-noise ratio of present day commercial communication receivers is a step in the right direction.

### A Hartley Receiver

For those who wish to build a simple receiver at the lowest cost, and incorporate components to hand, a Hartley receiver as here described is the answer.

Fig. 1 shows the theoretical circuit. A leaky-grid detector is followed by a single stage of transformer coupled L.F. amplification, and the provision of de-coupling as an aid to stability.

An anode by-pass condenser of the pre-set type is included in the detector stage as an additional aid, and by careful adjustment enables smooth regeneration to be obtained.

The fact that neither side of the reaction condenser can be connected to earth is undoubtedly a great disadvantage, and contributes towards the possibility of unstable operation. It is therefore necessary to include the components and values recommended. Follow the method of construction, and leave out any original ideas until the set is tried out and found to be satisfactory.

If an aluminium panel is used, the reaction condenser will require insulating from the panel by means of an insulating bush. This, however, would not guarantee entire freedom from hand capacity effects.

### The Coil

This type of receiver requires a coil which consists of but one winding. This is, in a way, an advantage from the constructor's point of view, as single winding coils are easy to wind and the cost of coil making is reduced.

The coil as shown is centre tapped. By means of a spring clip the turns between the centre and earth end can be tapped off. More will be said concerning this later.

Using the method outlined enables part of the coil to be used for reaction purposes, while the aerial is tapped on to the grid end.

Standard ribbed coil formers could be used and mounted in a horizontal or alternatively a vertical position. This, however, would increase the cost. To my mind the Hartley offers plenty of scope for the use of home-made coils at minimum cost.

The coil consists of a 1½ inch diameter Paxolin former, slotted as shown in Fig. 2, mounted on two low-loss insulators one inch or so above the base, which could be made out of Perspex or other insulating material.

The centre tap lead is taken to a terminal or plug socket fitted into the small panel as shown. This tap may be permanent or variable by means of a spring tapping clip. Thus flexible wire can be used

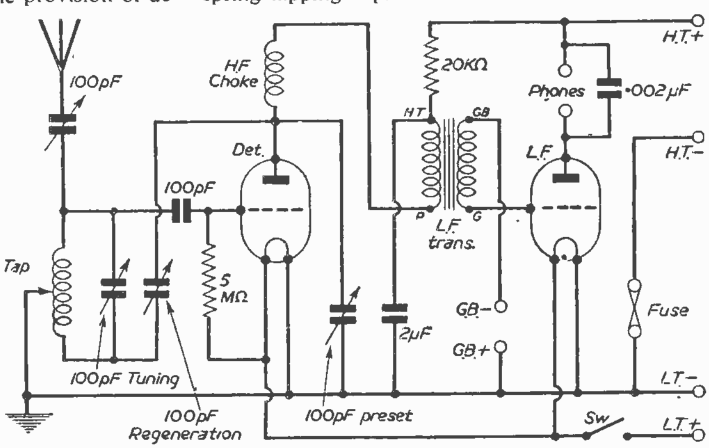



*Fig. 1.—Theoretical diagram of a 2-valve Hartley Circuit.*

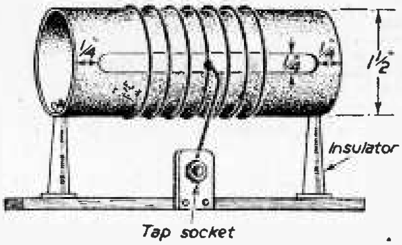



*Fig. 2.—The home-made coil.*

between the terminal shank and spring clip, and a rigid wire between the terminal head and earth.

Coils of this type must be wound in order to ascertain the length of wire required, and then unwound in order to measure and mark the mechanical centre, which, while not the same as the electrical one, is accurate enough for our purpose in this instance.

The writer, in the interests of receiver calibration, is not in favour of spring clip methods of tapping off turns, and considers that it would be much better to make up a set of centre tapped coils incorporating a permanent tap, whatever the kind of formers are used.

Much has been written during the past ten years about short-wave coil winding, some pre-war experts making a full set in about half an hour. The hand winding of such coils, especially of the three winding type, present some little problems and to make a good neat job requires time and patience. (See "*Wireless Coils, Chokes and Transformers.*")

**Construction**

This type of receiver when popular was built on baseboard lines. Built on a simple chassis, however, it would certainly be an improvement on those earlier models.

As in the case of other receivers described by the writer, it is suggested that so far as possible readers should use components which are to hand. It is for this reason that the chassis and panel dimensions are left for the constructor to decide.

The cramping of components should be avoided, but on the other hand excessively long leads cannot, in the interests of efficiency, be tolerated.

The use of extension rods, when building receivers in which the rotor vanes are at earth potential, is not favoured, unless some additional and useful purpose is to be served. So far as a Hartley circuit receiver is concerned, I regard it as sound practice.

A specimen layout is shown in Fig. 3 and should prove to be a useful guide. If, for example, an L.F. transformer of compact design is used the chassis should be made deep enough to fit the transformer, H.F. choke, and the decoupling components underneath.

**Chassis and Panel**

The chassis and panel can be of plywood, the chassis top being covered with tin foil or aluminium sheet on the underside before the end runners, made from $\frac{1}{2}$in. thick white wood, are screwed to the top piece.

If these are of small size comparatively, the complete receiver can be designed and laid out in a very compact form. Band spread has not been included, but should it be required an additional tuning condenser of 15 pF capacity wired in parallel with the main tuning condenser will be required. Space should be allowed for an additional drive control, and an extra extension rod will be required if panel control is required.

A sub panel for tuning and reaction condenser mounting is shown, but separate brackets could be used if desired.

Four inches is sufficient length for the extension rods.

**Coil and Aerial Suggestions**

When the spring clip method of coil tapping is to be used the spacing between turns should be not less than $\frac{1}{8}$in.

Now as the Hartley uses a single-winding coil there is ample scope for the construction of the so-called self-supporting type. I would suggest a stout gauge wire but less than 16 gauge tinned copper the coils to be $1\frac{1}{2}$in. internal diameter, of 8, 12 and 16 turns respectively, turn spacing $\frac{1}{8}$in. Accurate spacing could be achieved by threading the finished coil through accurately-drilled spacers, three of which would be required.

The performance of a Hartley type receiver under present day conditions can only be judged by practical tests. I would suggest to anyone who cares to try it to combine the experiment with a series of tests using comparatively short aerials from 15ft. to 30 ft. in length, including down lead.

Vertical wire types could also be tried, and would no doubt prove efficient. The solid copper rod type also comes to mind. Such aerials should be rigid,

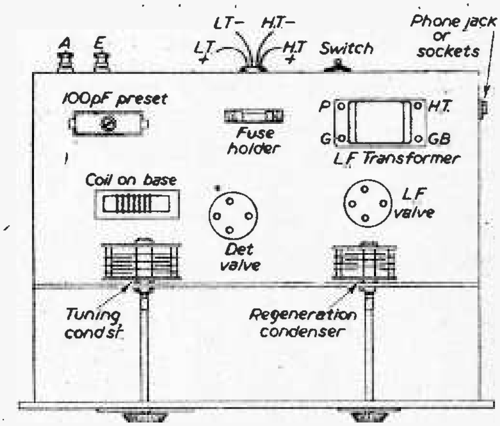
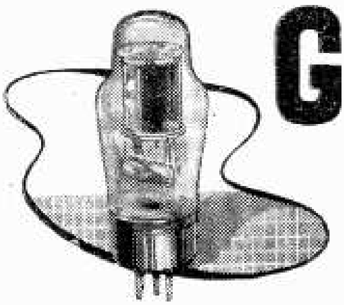



*Fig. 3.—Component lay-out.*

and on no account should the whip type be considered. Rod aerials should be mounted and supported so that they are absolutely rigid.

Due to the fact that the whip type of aerial sways in the wind, the writer does not consider it suitable for use with receivers other than A.V.C. controlled superhets, and really good, stable T.R.F. receivers.



# GAS-FILLED Relays

VALVES of this category are more or less a development of the mercury vapour rectifier, although to-day they are filled with gases other than mercury vapour. Such gases include helium, argon, neon, xenon and hydrogen. However, the surplus types available are mainly those of the mercury vapour or argon filled class, and exist as triodes or tetrodes.

These relays are known as thyratrons or controlled grid rectifiers, and in the case of a triode, they contain an anode, heater and control grid. The tetrode, however, has a further grid inserted between the control grid and the anode. This grid partially encloses both the control grid and the anode, an arrangement which allows a much smaller structure to be used for the control grid and it does, therefore, reduce the control grid current. The extra grid is known as the shield grid and can be used to shift the control characteristic.

The operation of the triode relay is more readily appreciated if the reader thinks of it as a triode valve in which the current is carried by the gas present in the bulb. That is to say, the current is carried by the gas ions that are produced by the collision of electrons from the cathode with the molecules of gas present.

Furthermore, as in mercury vapour practice, the same characteristic blue glow applies to the mercury filled relay, whereas, for neon filled, a reddish glow and a yellowish-orange for the argon types.

This glow phenomenon is known as ionisation and serves the purpose of neutralising the space charge around the cathode which in turn reduces the internal resistance of the valve. It can, therefore, be appreciated why this property gives the gas-filled relays their regulation characteristic, and furthermore, it enables fairly large currents to pass between the anode and cathode.

The voltage drop in mercury vapour filled relays is approximately 15 volts, and it is of the utmost importance that this value be maintained during the actual operation of the valve, otherwise ionic bombardment of the cathode will result in the eventual destruction of the emissive property.

An important point to remember in gas-filled relays is that the grid potential only determines the value of anode potential necessary before current will flow, and not, as in high vacuum valves, wherein the grid voltage actually controls the anode current.

It can, therefore, be stated that for any specified voltage applied to the grid of the relay, there is a definite anode voltage necessary before ionisation will commence.

Furthermore, once the ionisation has started the grid has no more control over it. As a point of interest, a characteristic known as the control grid ratio is important to the user of such valves because it does give the relationship between the grid and anode voltages required before ionisation will occur.

This ratio is equal to the anode voltage divided by the grid voltage.

A further point in connection with such valves is that as in mercury vapour rectifier practice, the cathode voltage should be applied at least five minutes before the anode potential. But it is advisable in the case of surplus types to run filament only for at least thirty minutes.

Nevertheless, when installing such valves always ensure that they are mounted in a well ventilated position so that the temperature does not rise appreciably during operation.

The principle use of gas-filled relays is in the control of circuits by the variation of the voltage on the grid. They are therefore useful in linear time-base circuits as used in cathode-ray oscilloscopes as well as the scanning circuits of television receivers.

| Surplus No. | Commercial No. | Fil. Volts | Fil. Current | Peak Anode Voltage | Peak Inverse Voltage | Peak Anode Current | Max. Volts Drop | Ratio | |
|---|---|---|---|---|---|---|---|---|---|
| FG17 | FG17 | 2.5 | 5.0 amps | — | 5,000 | 2 amps | — | — | * |
| FG27A | FG27A | 5.0 | 4.5 amps | — | 1,000 | 10 amps | — | — | * |
| FG67 | FG67 | 5.0 | 4.5 amps | — | 1,000 | 15 amps | — | — | * |
| 3C23 | 3C23 | 2.5 | 7.0 amps | — | 1,250 | 6 amps | — | — | * |
| CV647 | 884 | 6.3 | 0.6 amps | — | 350 | 0.3 amps | — | — | * |
| CV797 | 2D21 | 6.3 | 0.6 amps | — | 1,300 | 0.5 amps | — | — | * |
| VGT121 | T41 | 4.0 | 1.5 amps | 400 | — | 0.5 amps | 70 | 20 | † |
| VGT128 | GT1C | 4.0 | 1.3 amps | 500 | — | 1.0 amps | 16 | 28 | † |
| NGT1 | GDT4C | 4.0 | 1.75 amps | 350 | — | 1.0 amps | 20 | 40 | † |
| CV2638 | 393A | 2.5 | 7.0 amps | — | 1,250 | 6.0 amps | — | — | * |
| 393A | 393A | 2.5 | 7.0 amps | — | 1,250 | 6.0 amps | — | — | * |
| NGT2 | GT1C | 4.0 | 1.3 amps | 500 | — | 1.0 amps | 16 | 28 | † |

* American manufacture. † British manufacture.

# THE PW Electronic Organ

AMPLIFIER DETAILS AND THE METHOD OF MAKING UP THE TONE GENERATOR

By W. J. Delaney (G2FMY)

### Modifying the Switches

BEFORE mounting the tone control switches they should be modified. In the original condition they provide three positions each firmly held by a spring-loaded ball and projections on the main plate. Dismantle the switches carefully and you will find a projection between the ball-locating dents. With the plate lying flat on a metal surface place a flat punch (the end of a ⅜in. steel rod will do) over the *upper* projection and hit it firmly with a fairly heavy hammer. The object is to flatten the projection without destroying entirely the locating medium. When re-assembled the key should be easily dropped from its horizontal or central position to a downward position and as simply returned to the centre. It will be understood that the switch should be mechanically noiseless in operation, but should remain firmly in either the central or down positions without having to be "levered" into either position—a mere flick of the finger making the necessary change. By leaving the other projection there is less likelihood of the switch being put into its upper position. Make certain that the switches operate satisfactorily, and when connecting them use that pair of contacts which make it a simple "on" and "off" switch—"on" or short-circuited when the key is horizontal, and "off" or open circuited when the key is depressed.

For the normal domestic instrument the small amplifier shown in the first section of this article will suffice, and will deliver about 5 watts at maximum setting of the volume control. For professional use a more comprehensive amplifier will be required, rated at 12 to 15 watts, and a suitable circuit, with full details, is given in Fig. 13. A list of the extra components needed is given on page 511. For both amplifiers the same size of chassis will suffice, and Fig. 12 shows the chassis drilling details for the domestic unit. An additional hole for the second push-pull valve will be required for the larger amplifier, but the remaining details should be satisfactory. The large holes "A" are for the Octal valveholders, that on the side runner being for a valveholder into which the inter-connecting power cable is plugged. Holes "B" are ⅜in. and holes "C" ⅛in. The hole on the rear runner is provided with a grommet and the loudspeaker feed leads are brought through this, the transformer being mounted underneath the chassis. If required, of course, both of these amplifiers may be replaced by a favoured unit, or alternatively, the tone generator section alone may be constructed and the output socket connected to the normal domestic receiver at the pick-up or input sockets.

### Completing the Keyboard

Last month the construction of the keyboard was described up to the fitting of the double-ended tags which are to carry the tuning resistors, and this is undoubtedly the most tedious part of the work. As pointed out in the first article, it is not practicable to work out the resistor values mathematically, as apart from the intricacies of the mathematics the values arrived at would be such that it would be found that suitable resistors could not be obtained. They must, therefore, be chosen by trial and error methods, and the procedure is not difficult, but calls for the use of a properly-tuned piano, or pitch pipes

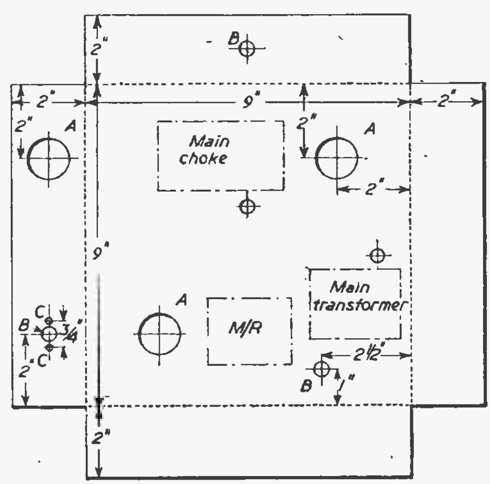



*Fig. 12.—Drilling and cutting data for the amplifier chassis.*

or tuning fork. The keyboard constructed according to the details given last month will range from C through one complete octave and then up to B, the central C being tuned to middle C on the piano when the octave switch is set to "Bass." The full compass of the instrument is therefore from C below middle C to the top B on the piano (seven notes from the end). This appears to be the most useful range, but the entire keyboard may, of course, be pitched at any desired position, the highest note being governed by the value of R11. It will be obvious that the larger the value of the resistance between the grid of V2 and R12, the lower the note, and in the original, tuned as above, R11 consisted of 27,000 ohms in series with 1,000 ohms. R11 and all the remaining resistors are, of course, only of the ½ watt type. The 1,000 ohm resistor may be one of the special Egen flat types with slot-controlled slider, and this will enable perfect tuning to be accomplished. Switch to the highest octave range (the single .005 $\mu$F condenser), and then adjust R11 as just stated until the top B is correct. Before carrying on with any further notes, adjust the octave switch on both the tenor and bass ranges to produce pure octave tones of the first note. The padders should enable this to be carried out, but small silver-mica condensers may be included in circuit if necessary to obtain true pitch. Once this switch has been adjusted it will hold for the complete range of the keyboard.

### Separate Notes

As the instrument will only play a single note, it always selects the highest note when two or more are pressed, and the initial tuning must be carried out from the top downwards, and no subsequent modification can be made to any intermediate resistor value, as it will throw out all below it. To assist in obtaining the various notes a small half-ounce weight or piece of metal is useful and is placed on the key to hold it down whilst adjustments are made. A selection of 3.3 K$\Omega$, 2.2 K$\Omega$ and 1 K$\Omega$ resistors is then obtained, and a 1 K$\Omega$ bridged from the first to second contact (Ra). It will be found desirable to solder it in place as the capacity of the body, if holding the component, will affect the subsequent pitch. If it is found to make the note *too low* (or flat), bridge a 3.3 K$\Omega$ across it, and then, if sharp, replace this by one of 2.2 K$\Omega$ or even 1 K$\Omega$. The tolerances of normal 25 per cent. components should enable combinations to be found fairly easily to cover all notes exactly, and in the prototype this was done satisfactorily from a collection of one dozen of each of the values mentioned above. As the tolerances vary so much it is not possible to state exactly what values will be required, but on the original keyboard the lowest measured value is 900 and the highest just over 4 K$\Omega$, the majority being between 2 K$\Omega$ and 2.5 K$\Omega$.

### Tone Filters

Some queries have been raised concerning the chokes L1 and L2 in the tone filter stage, and it may be stated that these are in no way critical, any chokes to hand being used, and the characteristics modified, if required, by suitable parallel condensers and/or resistors. L2 was originally a Bulgin iron-cored H.F. choke which is not now manufactured, but any all-wave choke may be used here, and if the tone is not to the liking of the builder a small L.F. choke may be used, or part of the unused winding of the push-pull transformer used for L1. If this has tapped secondaries various points may be

**LIST OF COMPONENTS**

**ADDITIONAL PARTS FOR "PROFESSIONAL" AMPLIFIER**

**RESISTORS**

| | |
|---|---|
| Two at 100 $\Omega$ | Three at 47k $\Omega$ |
| Five at 1k $\Omega$ | Two at 100k $\Omega$ |
| One at 1.5k $\Omega$ | Two at 1M $\Omega$ |
| Two at 10k $\Omega$ | One at 240 $\Omega$ 3 watt. |

**CONDENSERS**

Three at .1 $\mu$F
Two at 8 $\mu$F 500v. working.
Two at 50 $\mu$F 25v. working.
Three octal valveholders.
One 6SN7 (or 26J5s) and two 6V6s.

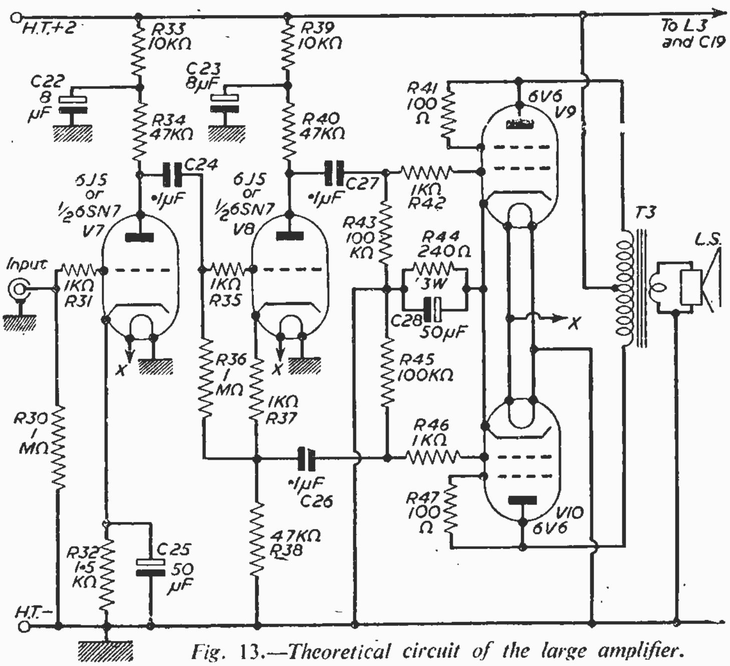


*Fig. 13.—Theoretical circuit of the large amplifier.*

tried and the most suitable tone finally chosen. Similarly, changes are permissible in all of the values given in this particular part of the circuit, the simulation of various orchestral instruments being obtained by mixtures of different values of resistors and condensers as required.

*(Note.—In response to numerous enquiries, we shall issue full-size blueprints of the Electronic organ, and an announcement will be made when they are ready.—*Ed.*)*

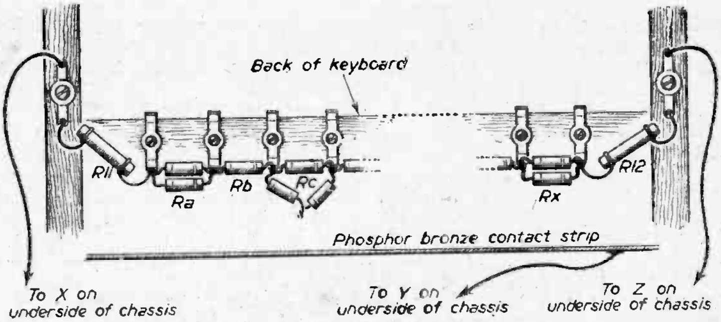



*Fig. 14.—Arrangement of resistors to obtain correct tuning as explained this month.*

# Experiments With Tape Recording

## A READER RECORDS HIS EXPERIENCES

MAY I put forward my claims for success regarding tape recording using homemade, self-designed equipment, obtaining a faithful reproduction of any type of material recorded.

I do not experience any kind of trouble with wow or flutter with the recording medium, tape.

What slight wow and tape flutter I did have is now cured, and in the latter case was traced to bad guide from the feed spool to the heads.

### Tape Speed

For high quality recording I use a tape speed of 10in. per second for standard use including dictation 7½in. per second, which gives two frequencies of 50 c/s.-10,000 c/s. plus or minus 3 db. and 50 c/s.-8,000 c/s. plus or minus 2 db.

The recording apparatus consists of a heavy, carefully balanced solid alloy flywheel driven by its own motor through a reduction system.

The other parts are all lathe made, as was the flywheel and the capstan parts to a limit of .0003in. of error, which as the wavelengths of 50 c/s. at 7½in. per second is .15in. and 8,000 c/s. at the same speed is .0009in. gives a fair measure of tolerance at the high frequencies regarding wow and flutter. The heads are bought as even I would not attempt so difficult a job, besides the time wasted in making half a dozen test heads and choosing the best one, only to get poor results.

I use three heads, erase, record and monitor, which enables me to hear what actually goes on the tape before I do the playback.

### The Amplifiers

The recording amplifiers consist of separate units for each specific purpose, mixers/faders for four inputs all fed from equalised pre-amplifiers to match ribbon, crystal and moving coil mikes and also radio or gram input.

These outputs from the mixer are all equalised to give 2 volt A.F. output whether single or the lot of inputs are used at the same time.

From this unit the output is fed to the recording amplifier comprising 6J5 driver to ECC32 twin triode as phase inverter, then to a pair of KT61, in class A.B. push-pull as triodes with 50 per cent. negative feed back. Negative feed back is used wherever permissible in the earlier stages.

I was going to give circuit details, but as a recent edition of "P.W." publishes a very good circuit for tape recording there is no point except to stress that whatever kind of circuit is used it must be a good one, particularly made for the job and not just an old cast-off strung together for the job.

### Transcription

When it comes to the process of tape transcription to disc I simply use a separate pre-amplifier for the tape heads and then feed an output from this direct to the disc-recording amplifier and modulate the cutter head of the disc recorder through the tone compensation stage of the disc amplifier.

If there should be any cause for any kind of lack of bass or treble in the output of the tape before the transcription to disc, due to the actual material recorded such as quality of the broadcast or item undertaken, then it is a very simple matter to provide the necessary boost in the disc recording amplifier to disc.

The result of this transcription is that I can obtain results such as can be had from any commercial record and in many cases better low-note reproduction due to variable pitch grooving.

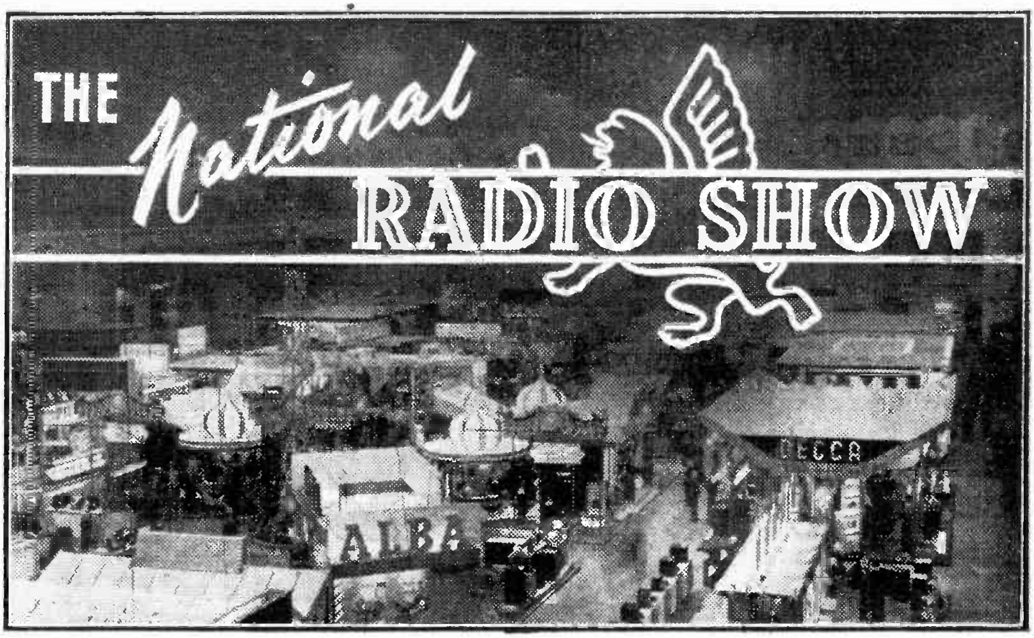
The disc recorder I have made and designed myself, but as I will enter it provisionally under patent I cannot obviously give details, except to say that very much like the tape recorder the tracking gears and the driving system must be made to a very fine limit on a first-class lathe.

### Results

It is possible with a disc cut with a groove pitch of 200-250 and at 33⅓ r.p.m. to get as good reproduction as from long playing records and with extended top-note quality from 80 c/s.-10,000 c/s.

At a tape speed of 10in. per second I get roughly about 25 minutes' playing time, using 1,200 ft. of tape of the E.M.I. type 65.

Another point is that I make my own tape cement for joining tape for editing, or broken tape ends, which consists of one part celluloid, six parts acetone, and three parts amyl acetate.—Z. M. E. Preece (Hayes).




By the Marquis of Donegall

THE Nineteenth Annual Radio Exhibition at Earls Court was not full of novelties. But it did contain some extremely interesting demonstrations, such as the functioning of the underwater television camera, as used in the discovery of the wreck of the submarine *Affray*.

Messrs. Pye enabled you to call up a remote stand on the telephone and see the person to whom you were speaking; a gadget I am glad to say that is reputed to cost £1,000 and is therefore likely to remain out of our lives for some time to come.

There was the remote-controlled television camera; a radio-controlled guided missile about which everybody was extremely secretive; an R.A.F. radio-controlled model aircraft; a small boy's delight in the shape of an anti-aircraft gun with which you could shoot things down; a demonstration of how the G.P.O. detects pirate viewers; a frequency-modulated radio altimeter by which the pilot of an aircraft is able to read off the clearance between his machine and the ground; a robot commissionaire who talks in sixteen different languages; self-priming batteries and the £20,000 television studio provided by the Radio Council for the BBC, which is said to have been the largest television studio in the world. It measured 160ft. long, 50ft. wide and 27ft. high. The auditorium seated about 1,000 people.

There was a wider choice of television receivers than ever before and, on the whole, prices have tended to come down since last year. The screen sizes of direct viewing models varied from 9in. to 21in.; and the projection models which were shown had screens up to 4ft. by 3ft.

For the first time a trade union was exhibiting—the Electrical Trades Union—showing skilled men and women from a factory making some of the 20,000 soldered joints that go into a television camera.

There were only two 9in. screens in the show—one by Bush at 49 guineas and the other by Defiant at 45 guineas.

The cheapest radio set in the show—£7 13s. 1d.—was shown by Ever Ready; the most expensive set in the show, combining TV and Radiogram in walnut—£757—was by Decca.

The largest direct-viewing receiver in the show was the 21in. tube by H.M.V. giving a picture 18in. by 14in. and a forward-projection receiver giving a picture 4ft. by 3ft., by Valradio, is now made for the export market in multi-channel versions for the 525 and 625 line systems.

Decca was again to the fore with projection models, one being a set with triple-speaker acoustic system giving a picture 40in. by 30in. in a de-luxe cabinet.

Philips showed a projection model in two cabinets giving a picture 4ft. by 3ft., which is also the size of the picture on one of the models shown by White-Ibbotson. Stella is a newcomer to the projection field with its screen of 16in. by 12in.

In the projection field the cheapest receiver I could find with a screen 13in. by 10in. was the Philips at 89 guineas.

Obviously, projection as a whole is creeping up and it looks as though my prediction of several years ago that television will some day be 100 per cent. projection may well be fulfilled.

One of the main trends that I noticed was the increased number of large direct-viewing screens made possible by the manufacture of rectangular 17in. tubes. These are wide-angle types and the picture size is increased without adding to the length of the tube and the depth of the cabinet.

It would seem that all manufacturers have been interested in the problem of interference. Devices to eliminate this nuisance include automatic interference suppression circuits, effective at all levels of brightness, and auto and fly-wheel synchronisation devices which keep the picture stable at long ranges from the transmitter. Anti-flutter devices profess to minimise interference from aircraft and there are more intermediate frequency filters to reduce interference, such as harmonics from short-wave stations. In some receivers the number of controls has been reduced to two: five channel adjustments are more general and generally more acceptable. Outside aerials tend to be less conspicuous—a trend of a questionable popularity—and indoor aerials have improved.

This year there were 80 television receivers in operation in the 34 booths in the Hall of Television or "Television Avenue."

I walked slowly past all of the receivers, but I confess that I was unable to detect the slightest difference in quality between any of them. I mean, of course, quality of picture, because the cabinets are as varied as you could wish, and many plastic materials with formidable names are being used for the first time for this purpose.

It would be interesting at this point to see how the various sizes of tubes are faring. Tube sizes of 14in., 15in. and 16in. have risen from less than 1 per cent. of monthly sales immediately before the 1951 Radio Show to 24 per cent. of monthly sales now. Correspondingly, 12in. tubes have gone down from 78 per cent. to 68 per cent. in the same period. The total number of television sets in use is approximately 2,000,000 and they are divided thus: 12in., 63 per cent.; 9in. and 10in., 30 per cent.; 15in. and 16in., 4 per cent.; projection, 2 per cent.; and 14in., 1 per cent.

As far as prices go, between £60 and £75 is the most popular price. The majority of these are 12in. table models, but the proportion of 15in. table models in this price range is on the increase. Nearly all the modern sets are made for operating on all the five United Kingdom channels.

## RADIO SHOW HISTORY

1922 The National Association of Radio Manufacturers and Traders ("Narmat") was formed and held first exhibition at the **Central Hall**, Westminster.

1923 **White City, Shepherds Bush.** entertainment possibilities of radio demonstrated.

1924 **Royal Albert Hall.** Home construction of sets the vogue.

1925 **Royal Albert Hall.** Crystal sets. Kits for home assembly still the feature. Multi-valve set the exception.

1926 **Olympia.** Organiser the late Alex Moody who remained organiser until his death in 1948. Big valve sets. "Ease of manipulation" the theme, though there were still six or more knobs to twiddle.

1927 End of "knob-studded panels with trailing wires and unsightly batteries." Novelties: the all-mains supply set and the super-heterodyne circuit, since become standard, and the gramophone pick-up.

1928 **Portable** sets in leatherettes and suedes. Standard three-valve receivers for ten guineas. First radio-gramophones and first mention of television receivers.

1929 No more crystal sets. Valves had improved; general craftsmanship had improved. Portables and mains sets now familiar, but the kits for amateur constructors sold well.

1930 Handsome looking sets. Manufacturers vied with one another in producing sets which put amateur constructors to shame though "kits" still sold like hot cakes. Attendance 161,128.

1931 "Radio-autogram" appeared—six valve superhet radiogram with automatic record changer. Also sets for three wave-bands—first whispers of ultra-short waves. Attendance 198,144.

1932 Press-button tuning, automatic volume control and one knob tuning. Attendance 180,747.

1933 More refinements in tuning, suppression of interference. Attendance 209,463.

1934 Attendance of 238,285 remained a record until 1947. Multi-wavebands and many other refinements.

1935 Portables, more portable; car radio; magic eyes. Attendance 192,202.

1936 Attendance 202,517.

1937 Attendance 174,818.

1938 Attendance 144,363.

1939 War—exhibition closed down after a few days' run.

1947 **Olympia** still. Record attendance of 443,433. Television studio and television viewing halls a feature. First exhibits of electronics.

1949 **Olympia**—attendance 398,550.

1950 **Castle Bromwich**, Birmingham (National Show). Attendance 128,260.

1951 **Earls Court**, London. Attendance 232,752.

1952 Northern Radio Show City Hall, Manchester. Attendance 100,793.

Last year the Radio Industry Council found that their Control Room caused so much interest that they really made a feature of it this year with several new departures.

It contained all the apparatus for the regulations and distribution of the sound and television programmes which were used for demonstrations throughout the show.

Glass windows along both sides of the Control Room gave a very good view of the equipment, and the Programme Officer was seen at the control position at which the Television programmes were selected and fed to the receivers in the show.

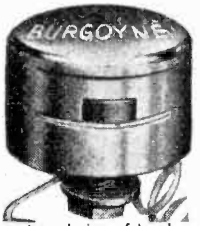
The announcer's studio was designed so as to allow as many visitors as possible to look at her through the windows.

This studio contained the control console from which the announcer played gramophone records—including long-playing—or made her announcements. There was a television camera facing her which enabled the poor thing to be

(*Continued on page* 517.)

*One of the show novelties—The Pye Television-telephone.*

## TAPE RECORDING SPECIALISTS



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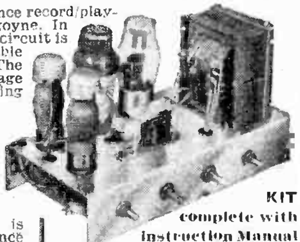

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**TEST PRODS,** for test meters. Red and black, **4/6** pair.
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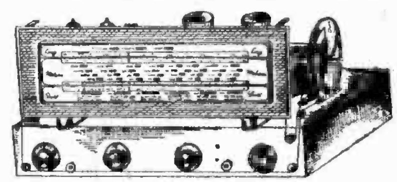

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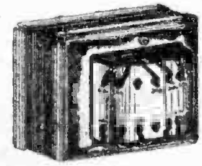

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(*Continued from page* 514.)

seen as well as heard throughout the Exhibition Hall.

The first battery/mains portable radiogram, at 30 guineas, was shown by Alba. It operates on A.C. or D.C. mains and has a two-wave band superhet radio. It is a very neat job indeed.

There were many attractive portable radios, both with the tuning panel on the top and of the type that opens like a small attaché case.

The new Simon tape recorder shown at the Radio Show has tape speeds of 3.75in. and 7.5in. per second, twin-track recording, a frequency range of 50-10,000 c/s. and a power output of 8 watts. It has a single lever for play/record, brake, re-wind and wind-on, and provision for remote control. This remote control is a pedal which stops the machine instantly and enables it, therefore, to be used for dictation.

Simon Sound are at present engaged on installing their monitoring/recording equipment on all air/ground communication and V.H.F. telecommunication channels for the Ministry of Civil Aviation.

For this purpose standard 35 millimetre acetate safety film is used as the recording medium.

Dictation leads us to the electronic stencilling machine shown by Roneo. This is an entirely new application whereby a stencil can be made in a few minutes from almost any original—photograph, line-drawing, pulls from line or half-tone, pencil sketches or water colours. The stencil is made direct from the original without any intermediate photographic work. The principle, I take it, is similar to that whereby photographs are sent by radio. The resulting stencil is duplicated in the usual way.

Altogether I enjoyed the 1952 National Radio Show more than any of the others that I have had the pleasure of reporting for you. Somehow there seemed to be more life, more gadgets to play with, more opportunity of really finding out how things work; and the three Fighting Services are to be congratulated on excellent shows, providing the public not only with the chance to look at but also to operate for itself some of their delicate equipment.

And if the 10,000 people who were expected to visit the giant television and radio studio did so, their journey to Earls Court was worth while, quite apart from all the other attractions that the show had to offer.

## EXHIBITS IN BRIEF

Radiogram for playing indoors and outdoors—the first A.C./D.C./Battery model—selling at 30 guineas (ALBA).

The cheapest radio set—£7 13s. 1d. including tax (Ever Ready); the cheapest TV set—£45 including tax (Defiant); the most expensive set in the Show—combined TV and radio gram in walnut, £757 (Decca).

For high-fidelity sound enthusiasts—auto-radiograms selling at 248 guineas and £317, tax paid (Ferguson, Decca).

TV set with cabinet designed for adding a radio unit when desired (McMichael).

First 17in. table model TV receiver (Alba). Largest direct-viewing TV receiver in the Show, as on the last occasion, the 21in. tube giving a picture 18in. by 14in. The set is instantaneously tunable to any existing or projected TV station (H.M.V.).

FM receivers incorporated optionally in 14in. TV models (Felgate, and also McCarthy).

A new type of filter screen (Pilot). A picture 20in. by 15in. is given on what is described as an entirely new screen so clearly that the makers claim that even 350 watts of normal room lighting will not affect it (White-Ibbotson).

The TV forward-projection receiver giving a picture 4ft. by 3ft. as seen in the last National Radio Show is now made also for the export market in multi-channel versions for the 525 and 625 line systems (Valradio).

A range of wall projectors for different sizes of picture for industrial and educational use (Valradio).

Projection set with triple speaker acoustic system giving a picture 40in. by 30in. in a de-luxe cabinet (Decca).

First time shown—a projection model in two cabinets giving a picture 4ft. by 3ft. The smaller cabinet contains the receiver and projection system and is connected to a larger cabinet containing the loudspeaker and housing for viewing screen (Philips).

A rear projector TV set giving a 4ft. by 3ft. picture for educational and commercial use, the whole apparatus being housed in one cabinet (White-Ibbotson).

A newcomer in the projection field with screen of 16in. by 12in. (Stella).

TV receiver with device for minimising "flutter"—interference caused by aircraft (Marconiphone).

Probably the cheapest projection receiver with screen just over 13in. by 10in. selling at 89 guineas including tax (Philips).

**Accessories, Components and Valves**

A radio and TV listening aid for the deaf (Masteradio).

Assembly of valves so small that three go into a thimble (Mullard).

New home charge for 6- and 12-volt car radio batteries (Standard).

A new departure in gramophone units—plays batches of 10 records of 10in., 12in. and 7in. diameter at 78, 45 or 33⅓ r.p.m. (Garrard).

Newly developed 7in. by 4in. and 10in. by 6in. elliptical loudspeakers and high-fidelity 8in. reproducer with aluminium voice coil (Goodman).

"Three-dimensional" rigid cone loudspeaker demonstrated for the first time and highly praised by the radio critics (G.E.C.)

Five machines for automatic testing of components (T.C.C.).

Free suppressors for anyone producing a driving licence. (Champion).

Model motor-cars, suppressed and unsuppressed passing a model house and showing the difference of effect on a television screen (Belling and Lee).

## Radio Technicians' Courses

FULL-TIME three-year courses for radio technicians have been organised by the Ministry of Education and commenced in September at five centres in London, the Midlands and the North.

The courses are an indication of the concern felt by the radio industry and the Government at the present shortage of technical trained personnel.

The full-time courses now announced have been devised specially to meet the needs of the industry, the objective being to provide students so well trained in the theory and practice of electronics that they will be able, on completion, to take their places at once as assistants to qualified research and development engineers. The entry age will be 16 or 17 years. In the present session courses will be held at:

Northern Polytechnic, Holloway Road, London.
Norwood Technical College, Knight's Hill, West Norwood, London, S.E.27.
E.M.I. Institutes, Ltd., 46, Pembridge Square, London.
Coventry Technical College, The Butts, Coventry.
Bolton Technical College, Manchester Road, Bolton.

Details of the courses are obtainable from the principals of the colleges concerned.

*Transmitting Topics*

# The Principles of N.B.F.M.

By Wm. A. Hope

NARROW-BAND Frequency Modulation has been known for many years and has great advantages where T.V.I. is encountered.

Most amateurs use some type of amplitude modulation in their transmitters, C.W. being a definite form of A.M. since the radiated carrier has maximum amplitude when the morse key is depressed and zero amplitude when up. There lies the chief difference between A.M. and F.M. In A.M. the frequency of the carrier is kept constant while the amplitude is varied. In F.M., on the other hand, the amplitude is kept constant while the frequency is varied by speech. Let us now look at the prospects of F.M.

Let us suppose that the transmitter carrier is not modulated in any way, i.e., the carrier amplitude and, we hope, the carrier frequency are constant. The effect of the carrier should be observed on the C.R.T. of the nearest TV set; and, if the result is nil, you can rest assured that F.M. will rescue you from the "enraged viewers" who may be after your blood.

### Circuit Requirements

The modulation equipment is thus very simple, one valve, in most cases, being sufficient. The audio voltage, for the purposes of modulation, is found to be in the region of 2.5 volts R.M.S. If a crystal microphone is used, a small two-stage pre-amplifier will be necessary. Direct connection can be effected if a carbon microphone is to feed the modulator valve.

There is a widespread belief that special F.M. receivers are needed to receive F.M. transmissions; this is not strictly true. An F.M. carrier can be readily received on the normal communications receiver in the shack, since the selective properties of the stages prior to the detector stage convert the F.M. signal into the usual audio signal. It must be stressed here that the receiver must be tuned on to the carrier sideband as the audio component of the carrier is there. A perfect F.M. carrier should produce modulation only off the peak frequency, i.e., on the sidebands. This can constitute a check for correct F.M. It must be remembered that each receiver has its own selectivity, and thus its ability to receive an F.M. signal must depend on the receiver in question.

As we have seen, in F.M. the fundamental frequency, known as the "mean carrier frequency," is that frequency obtained from the V.F.O. without modulation applied. It is essential that this mean frequency be kept constant within limits, since any variation of the mean frequency will cause interference to amateurs working on nearby channels. A simple example will help to clarify this point.

A mean carrier frequency of 10 Mc/s is modulated by a pure 10 kc/s audio tone to produce a peak frequency deviation of $\pm 20$ kc/s. If 100 per cent. modulation is employed, then sidebands of 9.980 Mc/s and 10.020 Mc/s will be produced; i.e., a carrier bandwidth of 40 kc/s. This is a carrier frequency deviation from 9.980 Mc/s to 10.02 Mc/s at a nominal rate of 10 kc/s. Just presume, for a moment, that the V.F.O. mean carrier frequency should, through factors of stability, rise to 10.005 Mc/s which is now a new mean carrier frequency. It is now apparent what will happen. The upper and lower sidebands will now be 10.025 Mc/s and 9.985 Mc/s respectively. The bandwidth is still 40 kc/s, but the transmitter channel has been changed. Stability of the V.F.O. mean carrier frequency is therefore essential; stabilisation of all power supplies to the V.F.O./Modulator is advisable.

### Theoretical Aspects

The modulator valve is often referred to as the "reactance modulator"; the reason for this will soon be apparent. We have previously defined F.M. as a carrier whose frequency is constantly varying

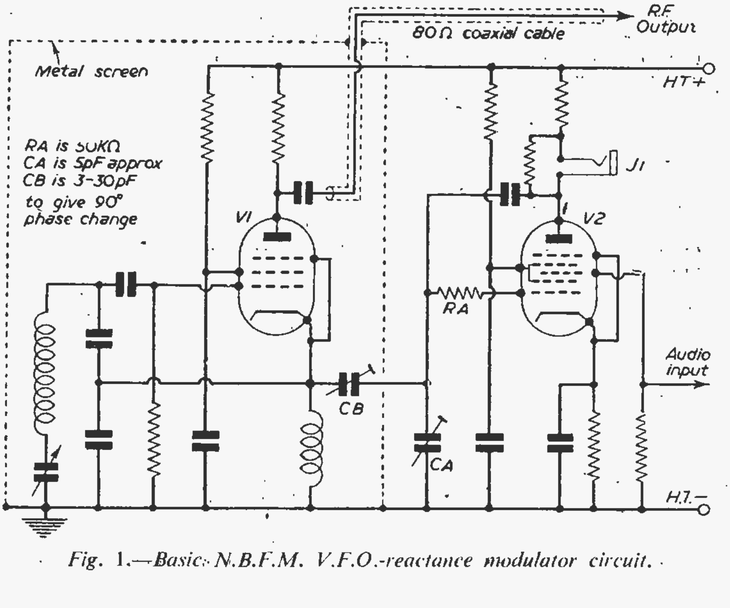



*Fig. 1.—Basic N.B.F.M. V.F.O.-reactance modulator circuit.*

while its amplitude is constant. Let us examine the formula:

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

Since $\pi$ is constant in this formula, we can alter the resonant frequency, f, by either:

(1) Varying the inductance L,

or (2) Varying the capacitance C.

Thus, if we could by some means vary either L or C in our V.F.O. circuit at audio frequencies we should have created frequency modulation. It should be stated that the oscillatory circuit is normally V.F.O. for F.M. control, since employing a Crystal Oscillator would entail a few complications in the modulation equipment. From A.C. theory we know that:

$$Xc=\frac{1}{WC}$$

where $W=2\pi f$ in radians/sec. If we vary the frequency of the A.C. applied to capacitator C, we see that its capacitive reactance (Xc) is also varied. This is the reason for the word "reactance modulator," since its purpose is to alter the values of either L or C in the oscillator tuning circuit, under the influence of the audio input to its control grid. Fig. 1 shows the basic V.F.O./R.M.; where V2, the R.M., is coupled to V1 operating in a conventional Clapp circuit. Ca and Ra constitute a 90 deg. phase change circuit, the purpose of which will be evident later. V2 draws a little R.F. from the Clapp circuit and, because of the phase shift network Ca and Ra, the current flowing through Ca will lead the current in the anode circuit of V2 by 90 deg., the reactance of Ca being much larger than the resistance of Ra. The result of this is to increase the total capacitance in the Clapp circuit and hence the V.F.O. frequency is moved. This deviation in frequency is very small indeed on the fundamental frequency of the Clapp, but it is also multiplied as we multiply the fundamental frequency of the V.F.O. Thus we can run the Clapp on 3.5 Mc/s and multiply up to the 28 Mc/s band, since this is the *only* band where F.M. is allowed at the time of writing. If we could vary the mutual conductance of V2, we could then alter the frequency deviation. This is done by varying the audio input to the grid of V2. The Clapp V.F.O. is considered by some as being of a far too stable nature for this circuit, but the author considers that a little experimenting along these lines will reap benefits in the end.

### Initial Setting Up

By inserting a pair of 'phones in J1, in the anode circuit of V2, ensure that the speech is clear and beyond reproach. It is useless to go on any farther unless this is obtained. The next obvious thing to do is to check the note emitted from the V.F.O. with the receiver B.F.O. on; the resulting note should be T9. Failure to obtain this indicates that Cb is not correctly set; this should be done until a T9 note is heard. Switch the B.F.O. off and tune the Rx on to the carrier sideband; and on advancing the gain control clear speech should be heard. On advancing the gain control farther, a point will be reached where the speech becomes distorted. This is caused by over-modulating and the frequency deviation is now far too great for this particular receiver.

In concluding, the writer would like to stress the fact that under no circumstances should the R.M. be run at operating voltages other than those stipulated in the maker's data, as the R.M. may become paralysed due to excess of R.F., in which case the unit's operation is unsatisfactory.

# British Wireless Equipment in Norway

WIRELESS equipment, designed and manufactured by Marconi's Wireless Telegraph Co., Ltd., is finding one of its biggest customers in the Norwegian Government, who are using it to surmount barriers to communication in their mountainous country, and in coastal waters.

"Walkie-talkies" on loan from Norsk Marconikompani, sister company to Marconi's Wireless Telegraph Co., Ltd., have been successfully tested by ski detachments of various mountain rescue groups. In this way the detachments have been able to keep in touch with base, and each other, when traversing lonely, hilly country.

### Duplex

Spanning the 120 kilometres between the capital, Oslo, and Rjukan to the west are two 10-watt very-high-frequency transmitter/receivers, one at each station. These are operated duplex, are remote controlled and frequency modulated; they have been in constant operation for more than 24 months.

Another network, simplex operated, has main stations at Rjukan and Oslo, both remote controlled. These installations are for use in connection with inspection work on the widespread electricity distribution system, the Norwegian National Grid. Cars used by inspectors, who supervise the working of the grid, are fitted with 10-watt V.H.F. transmitter/receivers for communication with the fixed stations.

Duplex equipment has been installed at some power stations for communication with their distribution centres.

### News Reports

The Norwegian news agency, N.T.B., quick to realise the value of using radio for transmitting reports over a wide area, is using two Marconi "walkie-talkies" and one L67 for reporting inside the Oslo area, particularly for sporting events. The main station is installed on top of the famous Holmenkollen Ski jump and remote controlled from the head office.

A 10-watt V.H.F. transmitter/receiver is operated by Oslo Harbour authority to send orders to their harbour patrol vessel, which is fitted with a 2-watt V.H.F. transmitter/receiver.

Norsk Marconikompani have themselves an important scheme in hand for developing the communications system between the mainland and the numerous islands scattered on the coastline. These are a series of 10-watt installations, duplex operated, and will be designed and manufactured by the Norwegian company. The installations will incorporate a selective calling system.

# Remote Control for the Radio Set

## A FOUR-SPEAKER SYSTEM OPERATED FROM TWO POINTS

By A. D. Stubbs

IN my domestic installation I have four speaker plug points remote from the set, and although it so happens that I have only two units, in addition to the moving-coil speaker on the set itself, I can plug in either of the two at any point and, if the mood takes me, continue the wiring to other rooms.

The actual house wiring was the only job of any consequence to me, because I had the relay equipment all ready in stock, but in order to keep the house tidy I had to take up a few floorboards.

However, at the back of my radio set is a miniature 2-pin socket, rated 1 ampere. A 6ft. length of silk-covered flex wiring, with a plug at each end, couples the set to a second socket fixed on a ceiling beam immediately over the set. From the socket run two single core 1/.044 t.r.s. cables in small slots on the upper side of the first floor beams, set 4in. apart to reduce capacity.

The pair of cables run to three bedroom points and down to a ceiling beam in the dining-room, each terminal being, of course, a 1 ampere 2-pin socket. This system precludes the possibility of a stranger plugging a speaker into my 10 ampere mains power circuit.

Any extension speaker can be utilised, assuming that its resistance is suitable for the output transformer of the set and assuming also that you have an O.P. transformer, but an on-off switch is essential on each speaker case. You *could*, of course, just plug-in and pull-out if the socket is in a convenient position. If your set has a choke-capacity output you can use this same remote control.

Wired in parallel with the mains transformer is a second transformer, shown at the foot of the wiring diagram, the secondary of which is coupled to a Westinghouse rectifier and smoothing condenser.

Through resistance R1 is fed a relay, the circuit being completed through one or both speakers L.S. and earth.

One side of the output transformer secondary is earthed, the other side goes, via a 2 MF condenser, to the remote wiring 2-pin sockets and plugs, the speakers and back to earth, so from the radio set only the audio-frequency component of the output runs around the house.

When a speaker circuit is closed by either speaker switch, 5 milli-amperes D.C. flows through the speaker circuit and it is of consequence in that each speaker must be plugged in so that the D.C. current is in the right direction. The normal diaphragm control requires initial adjustment, of course, to allow for this loading current.

As a matter of fact, my rectifier is a 180 volt 30 mA model, that being the smallest spare one which I had available. My relay is a Standard Telephones and Cables, Ltd., product, model 4751-H-227, and it goes home with no hesitation whatsoever at 5 mA, its own resistance being 1,300 ohms. As purchased there is a spare pair of terminals, not necessary in my circuit.

You can, therefore, choose your transformer, rectifier and resistance to suit the resistance of your speakers. In practice, two speakers of varying resistances operate quite successfully and the relay circuit acts as a choke, effectively sending all the audio-frequency output from the receiver to the speakers.

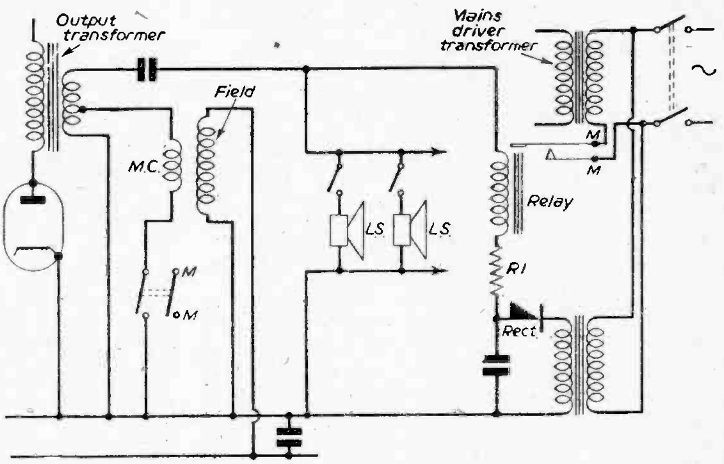
Because the speaker on my radio set is a moving-coil model I had to exclude it from the extension speaker circuit.

The diagram shows that my output transformer has a tapped secondary, the moving-coil winding circuit being broken by a double-pole single-throw switch on the speaker case. The other switch terminals, MM, are wired to MM on the relay, this latter switch breaking the mains transformer circuit.

So the field of my moving-coil speaker is energised when any one speaker switches on the set. Closure of the moving-coil speaker switch completes the mains circuit and the set is switched on. Closure of an extension circuit at any point pulls in the relay, which closes the mains circuit.

The set remains alive until the last speaker is switched off and the switching off of any one speaker makes that one silent independently of the rest.

My complete remote control unit is housed inside the radio set.




*Circuit diagram of the remote control system.*

# A Bench Power Pack

THE THIRD AND CONCLUDING ARTICLE EXPLAINING THE CONSTRUCTION OF A STABILISED POWER SUPPLY FOR THE WORKSHOP

By R. Hindle

(*Continued from page* 450, *October issue*)

IN the first position the series resistance, R1 alone, is small enough to pass sufficient current to maintain the glow in the neon. Consequently current is not drawn from the condenser, which remains charged and there is no flashing of the neon after the first strike.

The second purpose is to check the leakage of a condenser that fails to strike the neon in the other switch positions. If the neon fails to strike in this position the leakage is worse than 1 megohm. It will be seen, therefore, that the three switch positions allow the grading of condensers according to leakage into four grades:

1. Better than 20 megohms—the neon strikes with R3 in circuit.
2. Between 5 and 20 megohms—the neon strikes with R2 in circuit but not with R3 in circuit.
3. Between 1 and 5 megohms—the neon strikes with R1 in circuit but not with either R2 or R3 in circuit.
4. Worse than 1 megohm—the neon will not flash in any switch position.

Sufficient time must be allowed, of course, after connecting the condenser for the neon to strike before condemning the condenser. The initial charging process takes longer than the subsequent interval between strikes.

The neon indicator used for the condenser testing circuit is an Acru neon indicator lamp model No. 67C. This is particularly suitable for the purpose as the neon tube is placed sideways in the holder and the whole of the discharge is clearly visible. It is very easy to fit, being of the one-hole fixing variety, and it sits very neatly on the panel. When not used for condenser testing the neon serves as an indication that all is well with the stabilised output so long as the flying leads are not allowed to come into contact, in which case the neon would be shorted and prevented from striking. The Acru neon used is without series resistance and this should be specified when purchasing. The effect of any series resistance included within the neon unit would be only to slow down the condenser discharge and so lengthen the interval between flashes. A second Acru neon type 67C is included in the design to indicate that the power pack is switched on, shown as N3 in Fig. 4, connected across the mains input. This is a standard type incorporating a resistance. Care must be taken that the two neon units are not interposed. The tube without resistance must not be connected directly across the mains.

It will be appreciated that the condenser testing circuit does not necessarily require an elaborately stabilised supply. It is convenient to put it across the stabilised supply when such is available because the estimate of capacity will then be a little more reliable, but if the stabilised pack as a whole is too ambitious it will still be worth while to have available the condenser testing circuit, which can then be operated from any ordinary power pack, or from the H.T. supply of any mains receiver or even from a dry battery of suitable voltage.

### Heater Connections

The power transformer used is one of the universal replacement type providing a centre-tapped heater supply giving alternatively a 4 volt or a 6.3 volt output. All the leads are brought out to terminals, thus providing A.C. voltages of approximately 1 volt, 2 volts, 3 volts, 4 volts, 5 volts, and 6.3 volts for test purposes and to supply the heaters of any equipment being operated from the pack.

The problem was which of the leads to earth? First consideration suggests the earthing of the centre-tap, but it was found that in the majority of cases the equipment operated from the pack had one side of the heater earthed internally. It was found more convenient, therefore, not to earth the heater supply inside the pack but to bring out all the connections to the terminals and then the appropriate earth connection could be made by means of a wire link. For normal work the link is left between earth and A.C.0V. terminals.

V2 and V3 heaters are at the stabilised output voltage (maximum 250 volts) above earth and consequently a separate heater supply "X" is provided, tied to the cathodes, as shown. V1 cathode is above earth by the voltage across N2 (105 volts), but

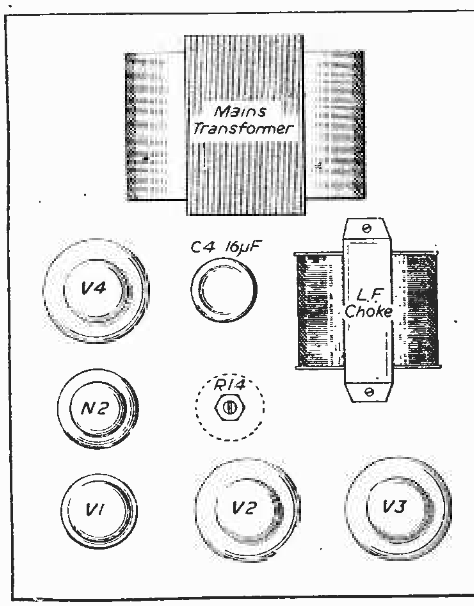



*Fig. 5.—Chassis layout.*

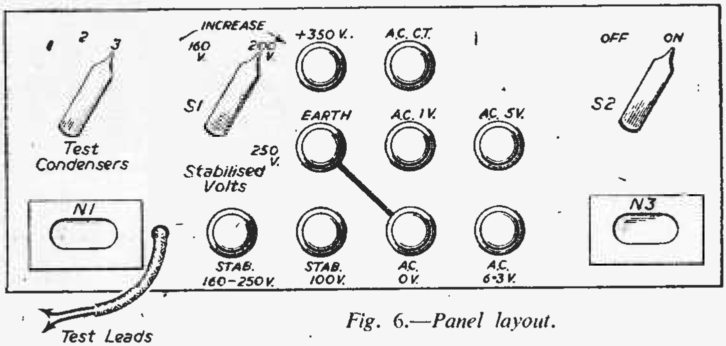



*Fig. 6.—Panel layout.*

as the transformer used had only two heater supplies available this valve was fed from the 6.3 volt output that is normally earthed.

No difficulty is likely to be experienced in the construction of this pack. Layout is a little more critical than usual for a power pack in view of the possibility of instability due to the feedback and high gain circuits but so long as leads are kept short and the stopper resistances wired directly to the appropriate pins of the valveholders trouble is unlikely. A suitable layout is given in Fig. 5 with the panel layout in Fig. 6.

**Setting Up**

When the wiring is completed and checked the valves can be plugged in and the power switched on. N3 should glow to indicate the completion of the A.C. circuit and N1 should glow to indicate a voltage across the stabilised output terminals after the interval required for the valves to warm up. The voltage between the unstabilised output terminal and the earth terminal can be checked to ensure that all is well with the basic power supply.

To set up the stabilised supply it is best to connect a voltmeter across the stabilised output supply. A load should be placed across the stabilised supply terminals also, sufficient to draw 100 mA. Most conveniently this consists of a 2,000 ohms 20 watt vitreous resistor or an assembly of resistors totalling this figure. Suitable resistors are available for a few coppers on the surplus market. Now adjust R5 to give exactly 200 volts on the meter. Disconnect the load with the pack switched on and without disturbing the rest of the circuit and note the change in output voltage. Now, by trial and error, find the setting of R14 that gives the best regulation of the output (i.e., the least change in output voltage when the load is disconnected). When properly adjusted there should be only the slightest flicker of the voltmeter needle when disconnecting the load and it should immediately settle back to 200 volts so that there is no readable change in output voltage between full load and maximum load. Then R5 should be adjusted to various settings, giving various output voltages, and the regulation checked at each point in a similar manner. When satisfied that the best setting of R14 has been found, R5 can be calibrated in voltage steps by comparison with the voltmeter. In view of the regulation it is immaterial whether a load is connected or not whilst calibrating. The voltmeter can then be disconnected and subsequently it will be found possible to rely on the calibration to pick off any voltage required between the limits of 160 volts and 250 volts.

If it is found that R5 at either extreme runs-out of the controllable voltage range, the limits can be marked on the calibration or, alternatively, the sizes of R4 or R6 as necessary can be changed.

Finally, the condenser testing circuit can be tried out on old and new condensers. The leakage test is severe and there are many positions in equipment where a condenser failing to pass the test will be satisfactory, if the capacitance is of the right order, in spite of leakage. The cathode bypass condenser is a case in point. A new paper or mica condenser should give positive results, however, and the writer invariably throws aside any condenser that prevents the neon from striking. It will be realised that in the case of a coupling condenser the leakage resistance should be of a very high order. Supposing that a condenser with a leakage of 20 megohms is used to couple a valve with 200 volts on its anode to a second valve with a grid return resistance of 1 megohm. The result is a positive bias on the second valve equal to $\frac{1}{20+1} \times 200$, or very nearly 10 volts, with most undesirable results!

Another point is that leakage across the condenser, even if sufficient to prevent the neon from striking, will slow down the rate of flash. If, therefore, the condenser under test gives a flash speed lower than would be expected from the marked capacity, it should not be used for intervalve coupling under any circumstances.

**COMPONENT LIST FOR FIG. 4**

(*page* 449, *October issue*)

R1—1 M$\Omega$ ½ watt.
R2—5 M$\Omega$ ½ watt.
R3—20 M$\Omega$ (4 x 5 M$\Omega$ in series).
R4—7K$\Omega$ (or 10K$\Omega$ w.w. and 20K$\Omega$ in series).
R5—25K$\Omega$ pot. w.w.
R6—22K$\Omega$ w.w.
R7—100K$\Omega$ ½ watt.
R8—33K$\Omega$ ½ watt.
R9—330K$\Omega$ ½ watt.
R10—33K$\Omega$ ½ watt.
R11—100$\Omega$ ½ watt.
R12—100$\Omega$ ½ watt.
R13—100K$\Omega$ 2 watt.
R14—25K$\Omega$ w.w.
R15—10K$\Omega$ 1 watt.

C1—.25 $\mu$F 350 volt working.
C2—20 pF 350 volt working.
C3—2 $\mu$F 350 volt working.
C4—16 $\mu$F 500 volt (electrolytic).
C5—4 $\mu$F 500 volt (paper).
N1—Acru type 67C.
N2—VR105-30.
N3—Acru type 67C.
V1—6AC7.
V2—6L6.
V3—6L6.
V4—5Z4.
Ch. 20H. 150 mA.
Tfr.—350-0-350v. 150 mA 4v-6.3v. centre tapped 6.3v. 5v.

# On Your Wavelength
## By Thermion

### L.P.R. Developments

THE announcement that the large British gramophone companies are to produce long playing records, both for 33⅓ r.p.m. and 45 r.p.m., came as a surprise in view of the previously stated policy of E.M.I., H.M.V. and Columbia. These companies have also announced record players for these low speeds. When another company, some time ago, followed American practice and introduced L.P.R., the statement was made that it would be a long time before this became general in this country. There is undoubtedly a demand for these new records but it will still be many years before all of the old recordings can be re-recorded in the new style. Some, of course, never can be. I do not foresee that there will be an overwhelming demand for long playing records for many years. People who have a large stock of 78 r.p.m. recordings are not likely to scrap them if they are unable to replace them by L.P.R., which, presumably, will apply only to new recordings. As with the Edison Bell phonograph with its cylindrical records it will be many years before the new replaces the old; which means that L.P.R. will appeal chiefly to the up and coming generation.

### At the Show

MY meanderings around the aisles of Earls Court gave me plenty of opportunity for meditation, for in spite of the increased attendance the roominess eliminated the cheek by jowl jostlings of Olympia and I was able to inspect and to compare. I gathered from several of the standholders that they would prefer the intimacy of Olympia to the roomy detachment of Earls Court. As there are fewer firms in the industry now than when the Show was last held at Olympia, it may be that a Radio Show there would be more spacious and eliminate criticism of overcrowding which was one of the causes of the change of venue.

Earls Court has a long way to go as an exhibition centre. The catering arrangements alone left much to be desired and the air conditioning for all practical purposes was non-existent. There was insufficient seating accommodation for the ladies who, it must be remembered, are frequently not present as a matter of interest in the exhibits, but go there willy-nilly because their menfolk wish to do so. I observed some of them squatting on sheets of newspaper and this should not be in a new building like Earls Court.

Constructors with whom I chatted deplored the fact that there were so few exhibits of special interest to them, but I think next year will see a change in that direction.

There were few surprises, although a mains-battery portable radio weighing 7lb. and the very first mains-battery operated portable radiogram did help to maintain interest in commercial sound radio receivers. I was astonished at the virile interest in home-constructed receivers, both radio and television. The trade will one day remember this fact. Where it cannot sell receivers it will be able to sell components. Most manufacturers in an effort to encourage sales had cut their prices. This is a welcome tendency, but they are still ham-strung by 66⅔ per cent. purchase tax. If the public did not buy, and large-scale unemployment in the radio industry resulted, that tax would soon come off!

### The Status of the Service Engineer

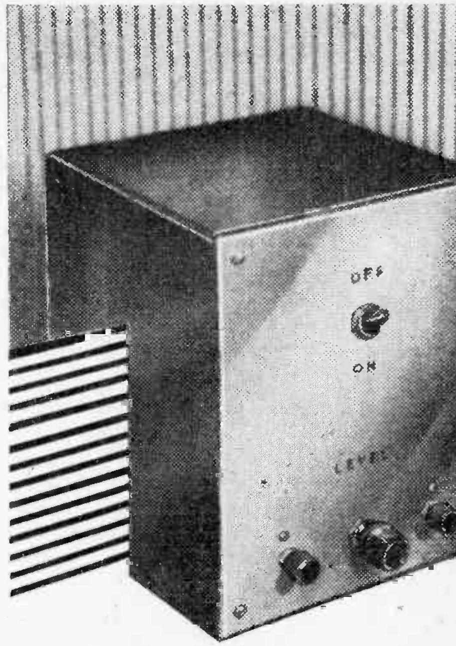
ACCORDING to a correspondent in a trade contemporary, service engineers seem more concerned with their status than with the service they give. There is a Guild of Radio Service Engineers which has set minimum rates of pay but according to the correspondent the ability to service television receivers is worth only a few shillings more per week than radio repair work; although the bench mechanic who obtains an R.T.B.E. certificate is worth another £1 a week. The correspondent thinks that the reason for this is that sales and service are run as an entity and that higher-priced service would have a bad effect on sales. He is quite right! The cost of servicing to-day is altogether too high and out of all proportion to the skill, labour and time involved. Any attempt to benefit the service engineer at the expense of the public would do sales great harm. An attempt should not be made to cash in on the ignorance of the public as far as the servicing of television receivers is concerned.

An average wage for a service engineer is between £8 and £9 per week. This seems to me to be reasonable when compared with the wages paid to skilled engineers who have had to go through the rigours of an apprenticeship. Some of them, of course, earn more than this, perhaps as much as £12 a week. If a man is good, he is worth it. So many of them are not worth it.

The Guild of Radio Service Engineers should be concerned with the qualifications of membership as much as with the wages its members will receive. If there is a general mistrust of service engineers because of unsatisfactory work and high charges therefore, they have only themselves to blame. There is a vast volume of evidence to support the public view point in this connection and it is particularly unfortunate for the really skilled service engineer that he too is labelled with them. I do not deny that there are many skilled service engineers throughout the country but they are certainly in the minority. Scarcely a week passes without the receipt by me of a letter of complaint of high charges and unsatisfactory work—backed up by correspondence and receipts. Of course, I know that not every complaint is justified and that there are members of the public who believe that they are always being "done." Complaints such as these are easily recognised. Few, however, fall into that category.

ONE of the main things in radio servicing is to be able to find faults quickly, although with the amateur who has a large amount of time it is not quite so important from a financial point of view. But where prestige is concerned, a man who can clear faults quickly and efficiently is considered to be an expert at servicing. This instrument was designed with the object of faster fault finding for those who want an inexpensive small instrument that will do many jobs of not too high a precision nature. The instrument provides a wave that is very full of harmonics, and the output impedance is low. The wave is roughly square in shape, and the harmonics are detectable with a four valve superhet up to and above 10 mc/s. The impedance is low, at full output about 90 ohms, but as the output control is varied the impedance rises. This very low output impedance allows for the testing of the speech coils of low-impedance speakers, a thing that cannot be done with a signal generator.

With the question of size in mind the writer chose valves in the B8A range. The oscillator is the well-known multivibrator circuit and as a very high range of harmonics were required in the output, the Mullard double triode, the ECC40, was chosen as it has a very low transit time—so low in fact that the makers state that it can be used as high as 300 mc/s. The output valve chosen is the EL41 as with its exceptionally high slope, it has, in cathode follower circuits, an impedance of 90 $\Omega$ or even lower. The rectifier is the EZ40 another member of this range.




THE CONSTRUCTIONAL DETAILS OF A '
CONSTRUCTED BY THE NEWCOMER TO
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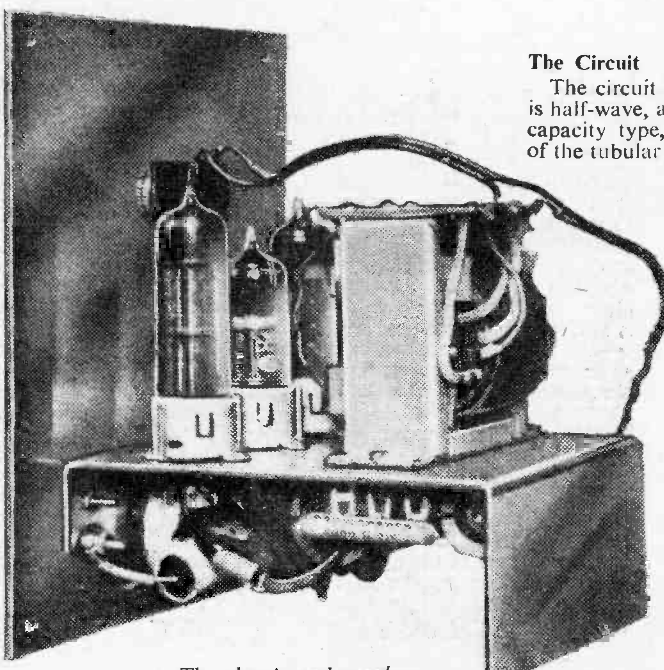

*The chassis and panel.*

### The Circuit

The circuit is shown in Fig. 1. The rectification is half-wave, and the smoothing is of the resistance-capacity type, consisting of two 16$\mu$F condensers of the tubular type. One Dubilier 500 volts working (type BR1650) was used for the reservoir, whilst a Radiospares was used for the smoothing. The

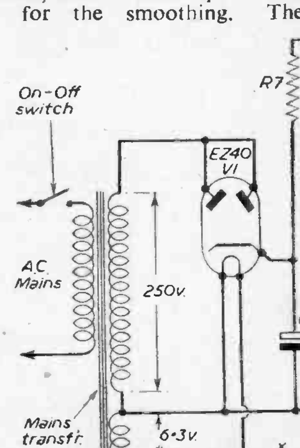


*Fig. 1.—Theoretical cir*

# A HIGH SPEED FAULT FINDER

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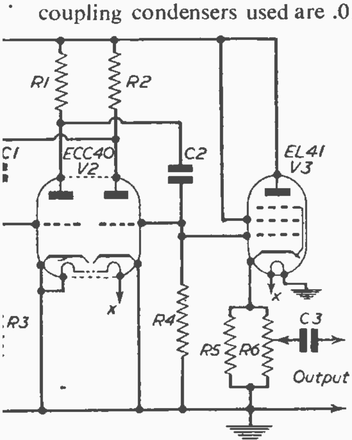
RATORY OR SERVICING WORKSHOP

smoothing resistor is a 2 K$\Omega$ of the vitreous type and of three watts rating. This gives an ample degree of smoothing. The oscillator consists of four 30 K$\Omega$ resistors of $\frac{1}{2}$ watt rating, this size being chosen as it was at hand. The coupling condensers used are .01$\mu$F

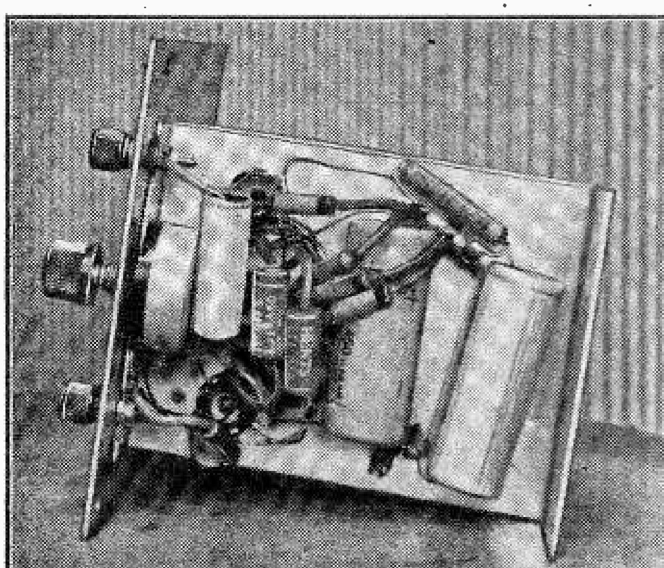



e High Speed Fault Finder.

plastic 350 volt, made by Hunts. The layout of the underneath of the chassis is shown in Fig. 2.

**The Chassis**

The chassis itself was made out of 16 S.W.G. aluminium and marked out as shown in Fig. 3, the $\frac{3}{8}$in. hole in the centre is to take the leads from the mains transformer. The two three-way mounting strips are mounted on the under side of the chassis under the transformer and secured with the transformer fixing bolts. In the front of the chassis there are three cut-outs made, so that it will not foul the terminals and the output control. The valve holes are cut out with a Q-Max cutter. The writer prefers this cutter to the tank cutter as it cuts a far neater hole—as good as a pressed hole—in far less time with far less exertion. There is one disadvantage and that is that different size cutters have to be obtained for each size of hole. If the constructor is going to do an amount of construction work it is very useful to have a set of them. The folds should be marked out on the underside of the metal, as otherwise the score mark on the outside of the fold will tend to split along the mark, with the consequence that the fold is weakened. The metal should not be of the hard type. The writer has had experience of light alloys being sold as aluminium. This material has a tendency to break if tempered too hard. The hardness known as " quarter hard " is quite useful but the folds should not be too sharp or there will be a tendency again to split. A radius on the inside of the bend equal to the thickness of the metal is quite suitable. The chassis is symmetrical so that no mistake can be made as to whether it is top or bottom view. The front panel was made from a piece of metal 5$\frac{1}{2}$in. × 7in. drilled as shown in Fig. 4. This has to be modified slightly if a co-axial



*Underneath view of chassis.*

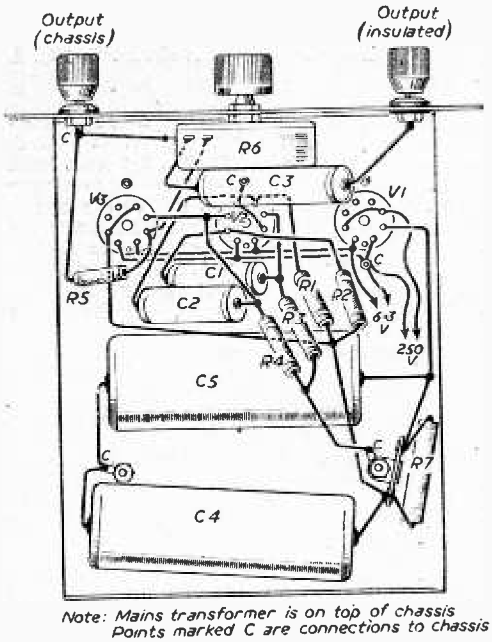



*Fig. 2.—Wiring diagram of the High Speed Fault Finder.*

output is to be used, but this is to be preferred to the normal terminal although the earthed terminal should be used for joining the fault finder to the set under test.

The case of the instrument was made out of sheet aluminium. The use of a metal case reduces the stray radiation fields from the tester when it is in use. Any metal could, of course, be used but aluminium was chosen because it was light in weight and easily worked. The box was held together by the use of self-tapping screws. These screws are hard and act with metal the same as wood screws do with wood, they can be used from the outside and as they cut their own thread do not require any nuts.

The top and bottom and sides of the case are made out of four pieces of metal 7in. square. The corners were cut out ⅜in. square as shown in Fig. 5. On two of these, the four sides are folded so as to form a tray ; these pieces are used for the top and bottom of the case. The other two have only two sides folded, these form the two sides of the case. The projected sides of the two side pieces are fixed to the folded sides of the top and bottom. When this is done there will be a folded flange around the front and back of the case to allow the fixing in place of the back. This is made out of a piece of metal 7in. × 5½in. with piercings made to allow ventilation. The drilling of the front panel with the exception of the fixing screws holes is shown in Fig. 4.

**Testing**

Having constructed the unit it should be switched on, and if the output is connected across an ordinary moving-coil speaker a note in the middle of the audio spectrum will be heard if the operation is correct.

The method of fault finding with this instrument is

(*Continued on page* 529)

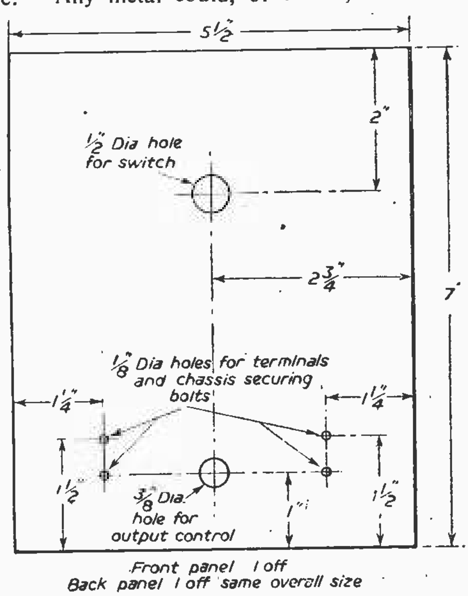



*Fig. 4.—Drilling diagram for panel.*

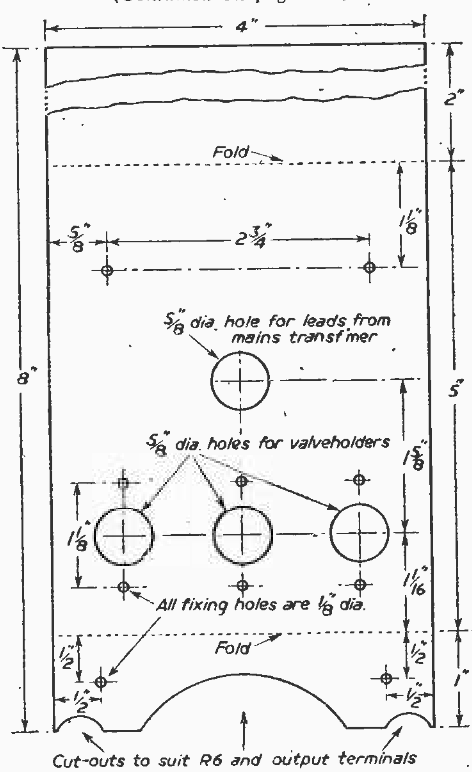



*Fig. 3.—Drilling diagram for chassis.*

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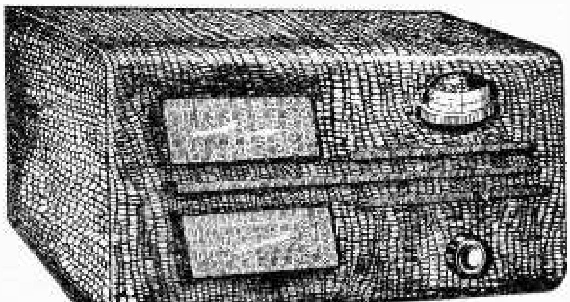

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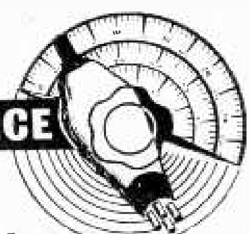

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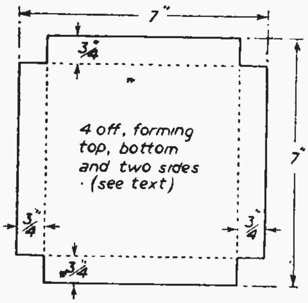


*Fig. 5.—Details of the case.*

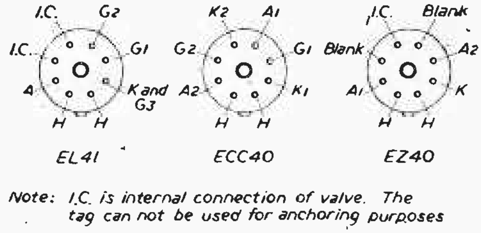


*Fig. 6.—Valve-base connections.*

(*Continued from page 526.*)

to apply a signal to various parts of the receiver under test by means of a length of co-axial cable to various parts of the receiver. The fault is in the part of the receiver between the component where there is a signal and where there is none. For example, the writer had a receiver in the lab. for testing ; it was one of home construction. The amateur had spent many hours testing it but try as he would he could not find the fault. His only piece of equipment was a voltmeter and all the readings on the receiver were within the tolerance of the readings. The signal was injected to the grid of the double-diode-triode, there was no sound. The grid of the 6V6G was the next point of test, from there a test was made across the coil of the speaker and the test was O.K. The next point was naturally across the primary of the output transformer ; again no signal. The power was put on and the voltage drop measured across the primary, it was zero ! ! ! ! The transformer has been wired-in in reverse ! ! ! Silly, but true.

**LIST OF PARTS**

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|---|---|
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| C4 & C5, 16 mfd. 450 Electrolytics. | V2—ECC40. |
| | V3—EL41 |
| **RESISTORS** | **OTHER PARTS** |
| R1, R2, R3 & R4—30 k ½ w. | Three B8A valve-holders. |
| R5—2 k 1 w. | One On/Off switch. |
| R6 5k pot. | Two terminals. |
| R7—2 k 3 w. (vitreous). | One Elstone TV pre-amp transformer. |
| | Two three-point tag strips (radio spares). |

Another case was an old receiver with negative line bias. The signal was applied to the grid of the TDD4, but it was weak and about the same at the anode, but when applied to the grid of the PX4, there was a loud signal. On further investigation a grid stopper resistor was found, and on applying the signal to the condenser end of this component the signal was greatly attenuated, the same volume as at the anode of the TDD4. On taking a voltage measurement at the end of the stopper it was found there was a positive voltage ; this was due to the coupling condenser having broken down. These are but two examples. Another fault that the writer has met several times is an open circuit in an anode conponent of a resistance capacity drive stage. The test signal is applied to the grid of the valve and a very weak signal is heard, but when the signal is applied to the anode the signal is louder. This would be the condition if the valve were faulty or the anode load resistor "open circuit," this can be quickly checked with the aid of a voltmeter.

There is, however, one more use of this tester and that is for the setting of the padder condensers of a superhet receiver. After the I.F.s have been aligned with the aid of a signal generator, set the dial of the receiver to one end of the scale, and at the high-frequency end adjust the trimmers for max. signal, and at the low-frequency end adjust the padders for max. signal. This process can be repeated several times until no further adjustment is required. The setting to which the dial has to be returned, does not have to be exactly the same each time as the aerial coil will be capable of passing only a very narrow band of frequencies from the fault finder. These frequencies cover about every half kc/s up to just over 10 mc/s.

Alignment of the I.F.s should be carried out in the correct manner with the aid of a signal generator, and not on a station, as the required bandwidth cannot be gained. The writer has cleared many faults of the "Birdie" type by the correct use of the signal generator.

This instrument will, if constructed, save many hours of work in fault finding and even if a signal generator is owned will prove indispensable.

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# A Tester for Electrolytics

## SURPLUS COMPONENTS MAY BE USED TO MAKE THIS INVALUABLE SERVICE ITEM

By J. S. Kendall

NEXT to faults due to the failure of valves come those due to electrolytic condensers. As it is essential that the valves in a faulty set should be tested quickly and accurately, so it is essential that the electrolytics should also be tested. This tester tests both the impedance and the insulation resistance. The latter is not over high and cannot be done with the normal Megger as the voltage is too high. The capacity tolerance of electrolytics varies from make to make. Some makers specify the capacity as being minus nothing to plus 100 per cent., whilst others specify it as being between minus 10 per cent. and plus 50 per cent., so that the precision of the test does not have to be too high. In the circuit an oil-filled condenser of 10 $\mu$F is specified as it can either be made up from lower values in parallel or purchased in one unit. These oil-filled condensers are readily available on the ex-W.D. market, and are very reliable as they are robust : the working voltage can be almost anything over 700 volts. It would be best if the constructor who has access to a capacity bridge obtained a condenser of, say, 8 $\mu$F and placed smaller condensers in parallel until exactly 10 $\mu$F was obtained.

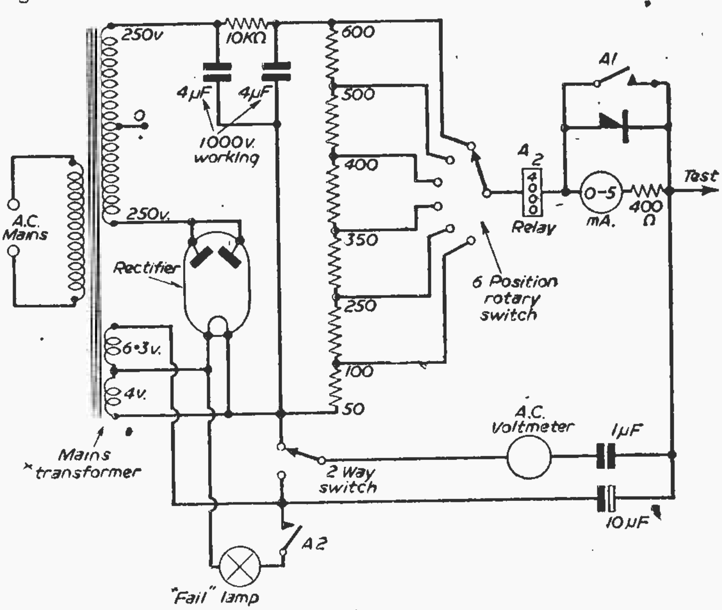
The principle of the device is very simple. If two capacitors are placed in series, the ratio of the voltage dropped across the condensers is inversely proportional to the capacity of them and is independent of the test frequency. For example, if a condenser of 1 $\mu$F is being tested with 11 volts against a standard of 10 $\mu$F, there will will be a drop of 10 volts across the 1 $\mu$F and 1 volt across the 10 ! ! ! ! This seems a little peculiar to the beginner, but if the calculations are made by first calculating the impedance of the condenser by the well-known formula $Z=\frac{1}{2}\pi fC$ (Z being the impedance, $\pi$ 3.1416, f the frequency, and C the capacity in Farads) and Ohms law applied, the method will be found to be correct in both theory and practice. This method is suitable for calculating any type impedance by direct reference to a standard. Where the circuit is used for impedance measurements a resistive standard should be used. There will be some cases where the sum of the voltages is more than that applied.

The transformer chosen was one out of an old Philips set as it had a 4-volt and a 6.3 winding, and the two in series gave near enough to 10 volts and formed a suitable reference. The rectifier circuit is slightly different from the conventional, as the two heater windings are used in series and will, if examined, be seen to be the same in principle as the conventional half-wave circuit. The voltage appearing at the reservoir condenser is just under 700, so the writer advises the use of 1,000 volts 4 $\mu$F condensers for the smoothing. The test voltages are supplied by a network of resistors in series, and they must be of sufficiently high wattage rating to stand short overloads of several hundred per cent. The writer recommends vitreous resistors.

The current meter should be about 5 mA full-scale deflection, and in order that it should be protected against overload, have a 200-ohm resistor in series and shunted by a single element metal rectifier. Also, a relay is advised so that the meter can be shorted out if the condenser is short-circuited. It should be pointed out that the relay may operate during the charging of the condenser ; this happens with the large types used in TV sets. The relay should be of as high an impedance as possible, one of 4,000 ohms resistance is quite good, and it should not have any large metal rings around the core as these reduce the impedance to A.C., and it is important that the shunt effect of the relay is negligible when the capacity measurement is being made.

The A.C. meter can be a separate unit or one built into the set. The latter is recommended as it can be calibrated directly in capacity. The minimum value of condenser that can be measured with the unit is

(*Continued on page* 533.)

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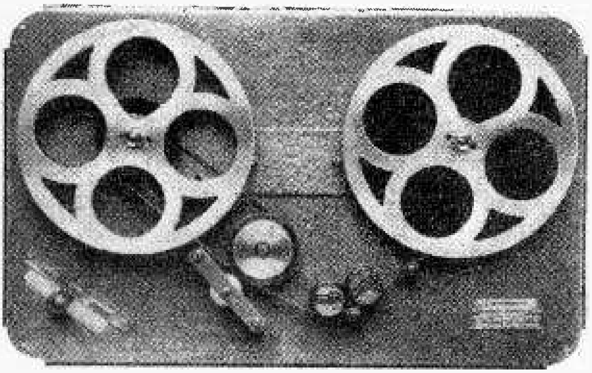

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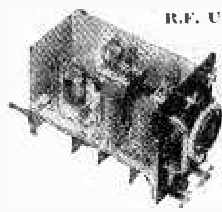

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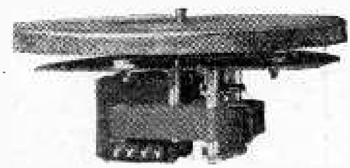

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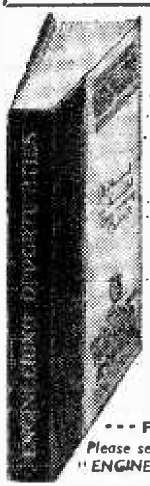

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(*Continued from page* 530.)

about 10 $\mu$F as the error due to the voltmeter starts to become noticeable at this point. With 50-cycle testing, a 1 $\mu$F condenser will have an impedance of about 3,000 ohms, and a 10-volt meter at 1,000 ohms per volt 10,000 ohms. The writer has found the use of a Universal Avominor on the 25-volt scale quite good, and with this it is possible to measure from 1 $\mu$F to 100 $\mu$F. Where the ratio is high, the lower voltage can be measured on, say, the 5-volt scale.

The main faults in an electrolytic are reduced capacity, increased internal resistance and low insulation, or perhaps a mixture of the three. The reduction of capacity and the raising of the internal resistance will show onthe tester as a reduction in capacity, due to them both causing a rise in impedance. The direct current passed by the condenser should not as a general rule be higher than 2 mA, so the 0-5 meter is marked green from 0-2 mA and yellow from 2-2.5, and the rest of the scale red. With a fault light that comes on with the operation of the relay, the unit will be complete. The action of the rectifier across the meter and resistance ensures that the full current goes through the meter until there is just under half a volt across the rectifier; it then starts to conduct and act as a shunt across the meter. This protects the meter before the relay operates. Care should be taken in testing bias condensers as the peak A.C. plus the D.C. used in testing should not exceed the working voltage by more than 10 per cent. Also the peak negative of the A.C. wave must not be more than the D.C. test voltage or the electrolytic will conduct in a negative direction.

It will be seen from the foregoing that the unit has a few limitations, but it will find that faulty condenser faster than any other tester that the writer has met, and if constructed will help the radio and TV engineer to service receivers quicker and be sure that they will not be returned because a condenser has failed after the set has been repaired. A word of warning—remember that it is best to disconnect the condenser whilst under test, as the voltage used for the reservoir condenser will rupture another of lower test voltage in another part of the circuit. Also remember that there may be a resistance network from H.T. plus to chassis that will draw several milliamps.

# The Elimination of Surge Voltages

By F. J. Eglen

THE incorporation of safety devices in circuits is usually the direct result of breakdowns. This circuit is no exception. To ensure long, trouble-free service of a large, domestic amplifier, it was decided to incorporate paper smoothing condensers. No trouble was expected since the condensers were rated at 400 volts and the H.T. line was working at 310 volts. After some weeks of operation one condenser went short-circuit and was replaced. Later, when a second followed the first, it was decided to try to stop the apparent voltage overloading. The first point to receive attention was the H.T. voltage variation while warming-up. A voltmeter was connected between H.T+ rail and chassis. When the amplifier was switched on the cause of the trouble was apparent. The rectifier warmed up very quickly, with the result that the H.T. volts were available before the output valves were hot enough to draw their current. This current formed the bulk of the total H.T. current. The rectifier therefore was passing near the peak value of voltage from a 350 v.-0-350 v. transformer with a negligible current drain. This voltage was over 400 volts and approaching 500 volts.

There was clearly only two alternative methods to remedy the situation :

(1) To fit condensers of higher voltage rating. This was quite practical but involved discarding the existing condensers.

(2) To devise a method whereby the H.T. voltage would not be able to rise above 400 volts.

This latter scheme held more interest as the junk box contained various oddments, including a small relay. The basis of the scheme was simply to ensure that at all times the full load current was drawn—thus eliminating the warming-up surge. If the other components can stand for a short time overload, then the full load current may be exceeded over this period of time. The only permanent load is resistors, so suitable resistors were placed across the H.T. supply to form a dummy load. These are removed by the relay when the output stage is drawing normal current. The circuit shown is the finally developed circuit. In this the dummy load is shown by $RL^1$. The value of this load is easily calculated by dividing the normal H.T. voltage by the load current (in amps.). The load current is in milliamps, then the result is in thousands of ohms, i.e. :

$$\frac{310 \text{ volts}}{100 \text{ milliamps}} = 3.1 \text{ thousands} = 3{,}100\Omega$$

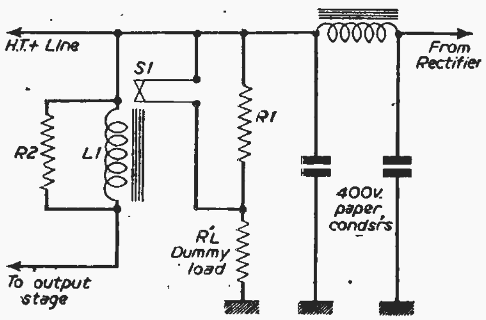
The size of this resistor is very important, should the resistor have too lower wattage rating it will overheat. There is no objection except for size of a resistor of higher wattage rating. The wattage of this resistor can be calculated by multiplying the H.T. volts by the H.T. current in amps., i.e., 310 volts $\times$ .1 amps. $=$ 31 watts.

Since this resistor will only be in circuit for a short time it is safe to reduce this figure by one-third. That is 20 watts. The main factor which governed the wattage was the selection in the junk box. The type of resistor picked was of the wire-wound vitreous ceramic type. Since the value was not available or even near, to 3,100$\Omega$, it was decided to fit several in parallel. Great care is necessary when fitting resistors in parallel. The load is distributed according to their ohmic values.

The lowest value carries the highest current and dissipates the highest wattage. If, however, the resistors to be placed in parallel are identical, then the situation is rather different. In this case, to find the resultant value, it is only necessary to divide the ohmic value of one unit by the number of units. The total wattage is found by multiplying the wattage of one unit by the number of units. The selection made was 5 identical resistors of 15,000Ω with a wattage rating of 10 watts. The result was, therefore:

$$\frac{15{,}000}{5} = 3{,}000\Omega \text{ and } 10 \text{ watts} \times 5 = 50 \text{ watts.}$$

This arrangement forms a suitable dummy load, but has a large bulk. These resistors were finally mounted on a tag-board and fixed in an empty position above chassis.




*Circuit of the power unit as suggested in this article.*

It is necessary to reduce this load when the amplifier has warmed up. This reduction was effected by placing a high ohmic value resistor in series with the dummy load. In this case a 50,000Ω, 10 watt resistor was used. This arrangement drew six milliamps consistently from the H.T. supply.

The relay coil was connected between the H.T.+ and the centre tap of the output transformers. This arrangement will make the relay independent of any H.T. current variations due to feeder units used in conjunction with the amplifier having the same H.T. supply line.

When switching on the operations then become as follows:

(1) When the rectifier passes current, it automatically feeds the dummy load, therefore, a fixed minimum load current is maintained.

(2) As the various valves draw current this minimum current is increased. The rise in load current brings about corresponding fall in H.T. voltage.

(3) When the output stage reaches a predetermined current level, the relay operates.

(4) The relay contacts S1, open and insert R1, in series with $RL^1$. This appreciably reducing the H.T. load current. This allows the H.T. voltage to rise. If this point is premature, then the current will fall below the predetermined minimum value, thus allowing the H.T. voltage to surge above the working value.

This, however, can be remedied as follows:

The resistor R2 is added across the relay winding; this will decrease the sensitivity of the relay and delay the operation by a certain time interval.

To find the ohmic value of R2, it is best to wire a 500Ω potentiometer across the relay winding, connected as a variable resistor. In addition put a voltmeter from H.T.+ to chassis. Switch the set on and with the potentiometer set at 500Ω; watch the H.T. reading fall. As the relay closes it may be noticed that the H.T. volts momentarily surge up. Switch off and adjust the potentiometer to less than 500Ω.

With several attempts the correct point will be found which will just prevent this unwanted momentary surge. In the case in question R2, was found to be 200Ω.

If the relay has several sets of contacts available, then these are best wired in parallel. Care must be taken to ensure that they all close together, as this will assist to distribute the dummy load current.

The resistors are best mounted above the chassis preferably on a tag board as this will assist any heat to radiate. The relay should be placed in a convenient position. Dirt on the relay contacts always proves troublesome, therefore, the relay is best completely enclosed in a separate can or box.

# News from the Clubs

### THE GRAFTON RADIO SOCIETY

Hon. Sec.: A. W. H. Wennell, 145, Uxendon Hill, Wembley Park, Middlesex.

AT the seventh annual general meeting held on Friday, September 5th, it was announced that Grafton's founder and popular secretary, Mr. W. H. C. Jennings (G2AHB) was forced to resign owing to new business commitments. The following officials were therefore elected:—President, J. H. Clarke (G2AAN); Vice-presidents, C. T. Bird, A.M.I.(Mech.)E., W. H. C. Jennings (G2AHB), P. Beresford (G3AFC), L. Kippen (G8PL); Hon. Secretary and Treasurer, A. W. H. Wennell (G2CJN); with P. Whittle (G2AOW) serving on the Committee.

Grafton have resumed full activity with the usual three evenings a week (Mondays, Wednesdays and Fridays at 7.30) at Grafton L.C.C. School, Eburne Road, Holloway, N.7 (near "Nag's Head"), and visitors and new members are always welcome.

### LIVERPOOL AND DISTRICT S.W. CLUB

Hon. Sec.: A. D. H. Looney, 81, Alstonfield Road, Knotty Ash, Liverpool, 14.

THE club meet for their A.G.M. on the first Tuesday in October, having completed a very successful year. Membership has increased and newcomers are finding a very happy club atmosphere.

Recent activities include a very interesting Sunday afternoon spent at Liverpool Airport. Technical classes and Morse classes have been started and another year of activity is expected. We extend to any unattached amateur in the district a welcome hand. Any short wave listener who has not joined a club can come along and meet his fellow listeners in the district.

### BRIGHTON AND DISTRICT RADIO CLUB

Hon. Sec.: R. T. Parsons, 14, Carlyle Avenue, Brighton, 7.

AFTER an informal August, when Tuesday evenings were devoted to discussion and morse practice, the club starts its autumn programme with some interesting talks and demonstrations. October 14th: Dr. Alexander of the BBC—Lecture on Studio Acoustics, Microphones, etc. October 28th: Thermionic Products, Ltd., with demonstration of Soundmirror Tape Recorder. Intermediate weeks will be informal evenings.

### CLIFTON AMATEUR RADIO SOCIETY

Hon Sec.: F. Caro, 11, Boyson Road, Walworth, London, S.E.17.

ON September 7th, 1952, The Clifton held its final D.F. Field day of the year, which was held as usual at Orpington, Kent. Some 20 members participated in the event, which was won by Mr. J. Lambert, G3FNZ.

September 12th.—Annual General Meeting. Four officers for year 1951-52 were elected, consisting of Hon. Chairman, Hon. Secretary and two Committee members. A very lively discussion followed on the subject of affiliation to the Radio Society of Great Britain.

Other items on the agenda included:
1. Annual Subscriptions.
2. Report on future activities of the Club.

September 19th.—Lecture on Radio Mathematics.
September 26th.—Debate.
October 3rd.—Junk Sale.
October 10th.—Radio Theory (Part 1), R.A.E. Course.
October 17th.—Quiz Evening.

As always, The Clifton extends a cordial welcome to prospective members and visitors any Friday evening, 7.30, at the above address.

# THE TUNED CIRCUIT

## SOME DETAILS AND CALCULATIONS OF INTEREST TO THE STUDENT

By Gordon J. King, A.M.I.P.R.E.

IN the early days long before the crystal set one of the first circuits to be evolved by the pioneers of wireless was the resonant or tuned circuit. This very same circuit is just as important to-day as then, indeed more so, since without such a device there would be no such thing as radio or television. The whole of such networks are comprised, in one way or another, of the tuned circuit. Therefore, the study of the tuned circuit can be of great value to the practical experimenter, and, needless to say, very few aspects of radio can prove so absorbing.

### Reactance

Before pursuing the subject further we shall need to digress a little to discover what effect a capacitor or inductor may have on an alternating current.

As a true resistance impedes a flow of current through a circuit, similarly a capacitor offers an impedance to a flow of alternating current, although for direct current it would assume an open circuit. The resistance offered to A.C. by a capacitor is known as the capacitive reactance, and for convenience is notated by Xc. The value of Xc is expressed in ohms, the same as its D.C. counterpart. Although the capacitive reactance of a circuit has the same apparent effect as true resistance, its value varies with the frequency of the applied voltage according to the formula: $Xc=\frac{1}{2\pi fC}$. It may be seen, therefore, the value of Xc reduces with an increase of frequency, whereas the value of a true resistance remains the same irrespective of frequency.

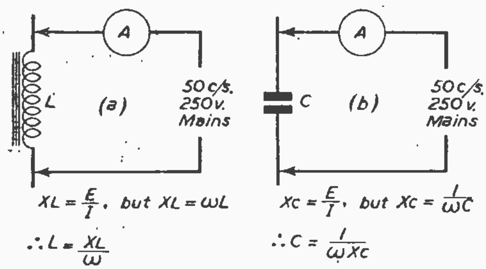



*Fig. 1 (a) and (b).—Method of measuring the value of L or C.*

Similarly, the reactance offered to an alternating current by any inductor is dependent on the frequency of the applied voltage, but in this case the higher the frequency the greater will be the reactance offered in direct proportion, and as will be noted is opposite to Xc. Inductive reactance is notated by $X_L$ and its value is equal to: $2\pi fL$.

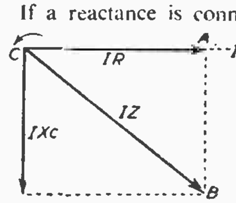
Graphically, a complete sine-wave may be represented by a circle and, generally speaking, if a rod similar to the hand of a clock is arranged to rotate from a centre axis within the circle at speed f, a single revolution will indicate one complete cycle of the sine-wave. Now a circle is composed of $2\pi$ radians, and therefore the angular velocity at which the rod is rotating may be expressed as $2\pi f$. The usual symbol for angular velocity is the Greek letter $\omega$ (omega). The capacitive reactance formula may now be reduced to: $\frac{1}{\omega C}$, and the formula for inductive reactance to: $\omega L$. This is very convenient since it will be found that $2\pi f$ crops up quite frequently in A.C. theory.

The Ohms law formula may be applied to a reactance the same as a resistance, but in the former case, instead of writing R for resistance, either Xc or $X_L$ is substituted, thus: $Xc=\frac{E}{I}$, where E is the applied voltage and I the current, or: $X_L=\frac{E}{I}$.

If a 50 c/s. A.C. mains source, and a means of measuring alternating current is available, by connecting a circuit, as shown in Fig. 1(a) or (b) it is possible to measure the value of L or C. The current taken by the circuit is measured, and from Ohms law the value of Xc or $X_L$, at 50 c/s. is calculated. Assuming it is first wished to measure the value of the capacitor: it has been shown $Xc=\frac{1}{\omega C}$, and by cross multiplication $C=\frac{1}{\omega Xc}$, knowing the value of Xc and f, calculation of C is possible. The same reasoning applies in the case of $X_L$, but owing to the D.C. resistance of the winding a slight error will be introduced in the calculation, the effect of this will be fully dealt with later.

### Impedance

If a reactance is connected in series with a true



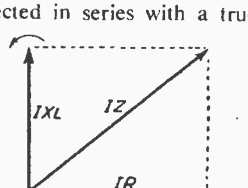
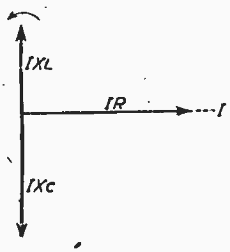




*Fig. 2. (Left)—Showing how the voltage IXc across a condenser lags the current by an angle of 90 deg. Fig. 3. (Right)—Showing how the voltage IXL across an inductor leads the current by an angle of 90 deg.*

resistance, the circuit is said to possess a certain impedance, which is notated by the capital letter Z. As is well known, if more than one resistor be connected in series the total resistance of the circuit is: R1+R2+R3+, etc. To calculate the impedance of a coil or capacitor, and taking into consideration the effect of the series resistance, the problem becomes a little more involved than with true resistors, since reactances and resistances cannot be added together in the normal way to produce a total impedance. This is because the current flowing through the circuit is 90 deg. out of phase with the voltage across a pure inductance or capacitance, whereas the current through a true resistance is always in phase with the voltage. There is also another fundamental difference; energy is dissipated in a resistance, but never in a pure reactance, which stores it during one half cycle and returns it to the circuit during the next.

In order to find the impedance of a series resistor and capacitor combination, the phase difference between the current and the voltage will need to be



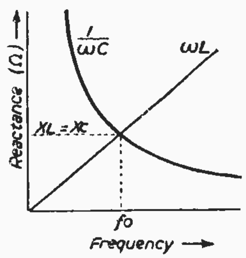




*Fig. 4. (Left)—R, XL and Xc in series.*
*Fig. 5. (Right)—At one point foXL=Xc.*

taken into consideration. The current through a capacitor will *lead* the voltage by an angle of 90 deg., and as mentioned previously the current through the resistor is in phase with the voltage. The total current flowing through the circuit, therefore, will be composed of two component currents, one flowing against the resistor, and the other flowing against the capacitor. The voltage driving the current against the resistor will be: E=IR (Ohms law) while the voltage driving the current against the capacitor will be: E=IXc (again Ohms law). These two component forces may be represented by the vector diagram of Fig. 2, where IZ indicates the magnitude of the resultant voltage. Further, since the line AB is equal to IXc the voltages may be represented by the right-angle-triangle CAB, of which CB is the hypotenuse. From simple geometry it is known that the square of the hypotenuse is equal to the sum of the squares of the other sides, but CB=IZ, therefore: $(IZ)^2=(IR)^2+(IX_c)^2$, or: $IZ=\sqrt{(IR)^2+(IX_c)^2}$

By dividing both sides of the equation by I it is found that: $Z=\sqrt{R^2+X_c^2}$. Fig. 3 indicates the phase relationship between the voltage across a resistor and inductor in series. It will be noted in this case the current through the inductor will *lag* the voltage by an angle of 90 deg. Therefore, by employing the above reasoning the formula for calculating the total impedance presented by an inductor and resistor in series is:

$$Z=\sqrt{R^2+X_L^2}$$

In a circuit which contains resistance, capacitance, and inductance in series (indeed, every circuit has all three properties, but usually one of them is much larger than the others, which, therefore, may be neglected), the voltage acrosss the reactive elements are anti-phase. A simple vector diagram, as in Fig. 4, may be drawn to represent the magnitude of voltage across each element and their respective phase to the series current, showing the 180 deg. phase shift between IXc and IXL. Counter-clockwise rotation, as shown by the arrow, is always considered positive, so that vector IXL leads vector IR by an angle of 90 deg., and vector IXc lags vector IR, also by an angle of 90 deg. Since IR is in phase with I, this is just the same as saying that the current through the inductor will lag the voltage by 90 deg., and the current through the capacitor will lead the voltage by the same angle. Owing to this, the resultant reactive voltage is the difference between IXc and IXL, or whichever is the greater. In the case illustrated IXc is greater than IXL; capacitive reactance

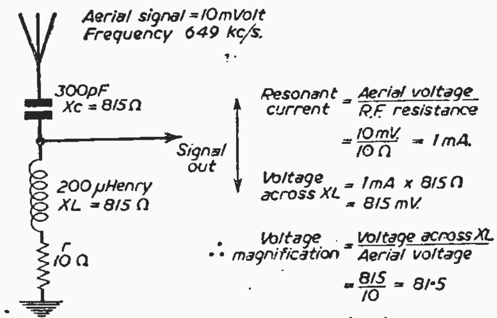



*Fig. 6.—The acceptor circuit.*

thus predominates, and the circuit is capacitive. Writing this as the impedance formula, we get: $Z=\sqrt{R^2+(X_c \backsim X_L)^2}$. The symbol $\backsim$ simply indicates, subtract the smaller from the greater.

**Resonance**

When discussing reactance it was shown that the value of Xc reduces as the frequency is increased, and, inversely, the value of XL increases with frequency. The two curves of Fig. 5 represent this function and it is, therefore, obvious that at one particular frequency (fo), XL equals Xc. At this frequency the two reactances cancel out and the impedance of the circuit consists only of the series resistance. This is what is meant by resonance, and the resonant frequency is the frequency at which the reactance of an inductor equals the reactance of a capacitor. The current through a series resonant circuit is always at a maximum, while the voltage across it is at a minimum and for this reason is termed the "acceptor circuit."

By combining the two reactance formulae a new equation is derived which enables the resonant frequency to be computed for any value of L and C, thus: At resonance: $2\pi fL=\frac{1}{2\pi fC}$. Now the value of f is the same for either reactance, therefore, by putting f (which will be the resonant frequency, or $f_0$) on the left-hand side and multiplying in the ordinary way, we get:

(*Continued on page* 541)

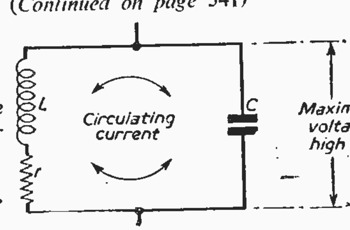



*Fig. 7.—The rejector circuit.*

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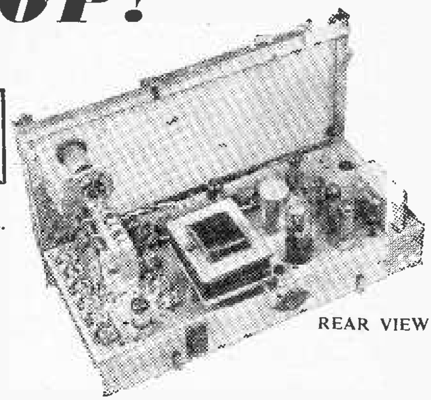

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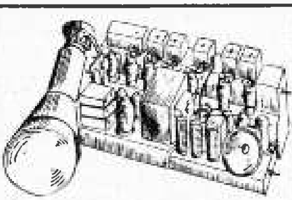

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(*Continued from page* 538.)

$$f_o^2=\frac{1}{2^2\pi^2LC}, \text{ or } f_o=\frac{1}{2\pi\sqrt{LC}},$$

where $f_o$ is in cycles per second, L in Henrys, and C in Farads. For normal use these values are too large, and therefore, by multiplying the top of the fraction by a million ($10^6$), L and C may be expressed in microhenrys and microfarads respectively. As an example, find the resonant frequency of a 200 microhenry coil, and a 0.0003 microfarad capacitor:

$$f_o=\frac{10^6}{2\times3.14\sqrt{200\times0.0003}} \text{ (taking } \pi \text{ as 3.14)}$$

$$=\frac{10^6}{6.28\times0.245}=649 \text{ Kc/s, approximately.}$$

This is the same as saying, at a frequency of 649 Kc/s a 0.0003 $\mu$F capacitor will have a reactance equal to that of a 200 microhenry coil, which may be proved by using the reactance formula, thus:

$$X_C=\frac{10^6}{2\pi fC}=\left(\frac{10^6}{6.28\times649\times10^3\times0.0003}\right)=$$

815 ohms approx.

$$X_L=2\pi fL=(6.28\times649\times103\times200\times10^{-6})$$

=815 ohms approx.

The frequency of 649 Kc/s was multiplied by $10^3$ to convert it into cycles per second, and in the second case the 200 microhenry coil was multiplied by $10^{-6}$, thereby expressing it as a fraction of a henry.

**The Magnification Factor**

The acceptor circuit of Fig. 6 may be the aerial input arrangement of a standard broadcast receiver tuned for medium wave reception. The value of L and C being the same as those in the previous illustration. Included in series with the tuned circuit is a resistor which represents the total resistive loss of the combination. This is contributed not only by the D.C. resistance of the coil and capacitor leakage, but also by the R.F. skin effect, created owing to the fact that radio frequency current tends to travel along the surface of a conductor. This factor is termed the R.F. resistance, or r of the coil, and its value may be much higher than its D.C. resistance. Further, it will not remain constant throughout the wave-band, but will increase with frequency. A reduction of R.F. resistance may be attained by enlarging the diameter of the coil wire, although it should be noted that dielectric losses will have the effect of increasing it, especially as the tuned frequency rises. A typical value for r at 649 Kc/s may be 10 ohms, but at television frequencies it will be much greater.

Consider a 649 Kc/s signal of 10 mV. arriving at the aerial (Fig. 6). By using Ohm's law formula to find the resonant current we get:

$$\frac{10 \text{ mV.}}{10 \text{ ohms,}}$$

or 1 mA. of R.F. current. Then by applying Ohm's law formula across each element in turn the potential across each may be easily computed. The resistor shows a potential of 10 mV., while across each reactive element a potential of 815 mV. is developed. This is a phenomenal instance where the part may be more than the whole; it happens in all resonant circuits and may be easily proved. The secret, of course, is the two reactive voltages being anti-phase cancel out; however, in practice only one of them is applied as output voltage to the next stage.

In this way a resonant circuit produces a voltage magnification which is usually notated by the capital letter Q. Obviously, then, the Q of a tuned circuit depends on two factors; the inductive or capacitive reactance and the R.F. resistance. The value of Q may therefore be expressed as $\frac{X_L}{r}$ or $\frac{X_C}{r}$, since at resonance $X_L=X_C$. Increasing the value of L and reducing C for a certain value of $f_o$ produces a high Q circuit, since in so doing the value of $X_C$ and $X_L$ are increased, but they still remain equal. In practice considerable benefit is acquired from such a procedure, since the selectivity of the circuit is enhanced, and for wave traps and similar devices this is a very desirable feature. In wide band amplifiers, such as those employed for television, however, the value of Q is purposely reduced in order to maintain the requisite wide band-width, by shunting the tuned circuits with a resistor of low value.

**The Rejector Circuit**

So far we have only considered the series, or "acceptor circuit." Still equally important, in radio design, is the parallel or "rejector circuit" (Fig. 7). The function of this circuit differs from that of the "acceptor circuit" inasmuch that at resonance it has maximum impedance, or dynamic resistance, therefore the voltage across it will be at a maximum while current at a minimum. The Q of the circuit is dependent on the same factors as the "acceptor circuit," so also are the conditions for resonance. The criterion of such a circuit is at resonance, its dynamic resistance (Rd) can rise to a very high figure, which may be calculated by the formula $Rd=\frac{L}{Cr}$, L and C are in microhenrys and microfarads, and r, of course, being the R.F. resistance of the coil as previously defined. Although when at resonance the "rejector circuit" passes minimum R.F. current, the current circulating between the capacitor and inductor is much larger.

What happens is, the capacitor discharges through

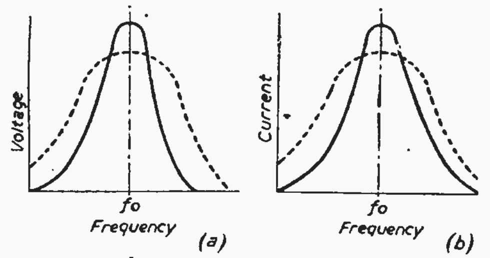


*Fig. 8.—(a) Response curve of the rejector circuit, and (b) response curve of the acceptor circuit.*

the inductor and, as is well known, a magnetic field is created. After the charge in the capacitor has been exhausted in driving current through the circuit in one direction, the inductive field decays. This will result in a back-E.M.F. across the inductor driving the current through the circuit in the opposite direction, thus the capacitor is recharged, and the cycle recommences. Therefore, the small current given by the external circuit is only needed to make up the resistive losses incurred by the oscillatory current. The coils should be designed to have a low R.F. resistance, which will result in the circuit having a desirable high Rd.

# News from the Trade

## Halifax Mullard Valve Service Depot

A MULLARD Valve Service Depot, to serve radio retailers and service engineers in the North of England, has now been opened at Berry Lane, Halifax (Telephone: Halifax 5722). This depot, which is situated near the Halifax main-line station, works in close co-operation with the main Mullard Valve Service Department at Waddon, Surrey.

Like the Mullard Service Department already established at 108, Dale End, Birmingham, the new depot provides immediate service on valves and television picture tubes for any dealers who may like to call.

## New Ekco Auto-radiogram

E. K. COLE, LTD., announce the introduction of a new auto-change radiogram, the ARG168, with separate lightweight high-fidelity pick-up heads for long-playing and normal type records, and a seven-valve circuit giving all-wave reception with push-pull output of 8 watts on a high-fidelity 10in. speaker.

There are independent bass and treble tone-controls.

The gramophone side is equipped with interchangeable heads, one taking a replaceable sapphire-tipped stylus for long-playing records and the other taking miniature steel needles for standard discs. The auto-changer will play up to eight 10in. or 12in. records at all three speeds, and 7in. records may be played singly.

A three-position switch connects the internal speaker only, internal and extension speakers, or extension speaker only. The set is housed in an attractive walnut veneer cabinet with storage space for all types of records.

The price will be announced later.—**E. K. Cole, Ltd., Southend-on-Sea, Essex.**

## Tyana Soldering Irons

TYANA soldering irons, which are made in voltage ranges from 100/110, 200/220 and 230/250 (other ratings available on request) have been specially produced for the radio trade and for radio constructors. They are not only cheap in price (16s. 9d. each) but they are backed by a service of replacement parts. Under test we have found them to be efficient and, an important point, the handle is cool when in use.. It is intended for neat and intricate work, has an adjustable bit which, together with the element, can be speedily interchanged. It takes approximately three minutes to heat up, weighs four ounces and consumes 40 watts. It is marketed by Kenroy, Ltd., 152/297 Upper Street, London, N.1. We have had one in use in the PRACTICAL WIRELESS laboratory for some time.

## E.M.I. Introduce L.P.R.

THE E.M.I. record companies introduced in October under various trademarks ("His Master's Voice," Columbia, Parlophone, M.G.M.) two new types of gramophone records, in addition to their standard 78 r.p.m. records—33⅓ r.p.m. 10in. and 12in. long play records with playing times of up to 35 and 50 minutes respectively, and 45 r.p.m. 7in. records with a playing time equivalent to standard 78 r.p.m. records.

Both the long play 33⅓ r.p.m. and 7in. 45 r.p.m. records have approximately 250 grooves to the inch as against approximately 100 grooves to the inch on standard 78 r.p.m. records. They are played with featherweight pick-ups using a semi-permanent type of stylus especially shaped to fit the narrower grooves.

Both types of record are made from a new all British plastic which is the outcome of a close co-operation between E.M.I. scientists and the British chemical industry.

Apart from the higher standard of reproduction they provide, the entry of the E.M.I. record companies into the L.P.R. field will furnish the public for the first time with long play recordings of the world's greatest artists, conductors and orchestras.

The 7in. 45 r.p.m. record is new to the British market. It is non-breakable, light, flexible and extremely handy, and the quality of reproduction and silent surface of these records are outstanding. A foot of shelf space will accommodate more than 120 45 r.p.m. records.

These new long play 33⅓ and 7in. 45 r.p.m. records will create a considerable new British export trade for E.M.I.

The E.M.I. record companies will continue to publish regularly standard 78 r.p.m. recordings for playing on the millions of standard instruments in use at Home and Overseas.

"His Master's Voice," Marconiphone and Columbia are now producing radio-gramophones and record players to play the new types of records. These instruments were seen for the first time at the National Radio Show at Earls Court.

## Trade Literature

*Copies of catalogues and lists mentioned below are available from the addresses given free of charge.*

THE Dubilier Condenser Co., Ltd., Ducon Works, Victoria Road, North Acton, W.3, have just published their leaflets No. GC852, which contain details of their latest developments in capacitors. These leaflets will be of particular interest not only to trade and service engineers, but to all concerned with radio, television and electronic engineering.

Standard Telephones and Cables, Ltd., Rectifier Division, Warwick Road, Boreham Wood, Herts, have now issued their leaflet F/SRL11 (second edition), dealing with their low current tubular rectifiers, marketed under the name of SenTerCel. The recent development of these rectifiers with their special plates enables less plates to be used for a given voltage. They are marketed in two types the "K" and "N."

The Telegraph Condenser Co., Radio Division, North Acton, W.3, have issued technical bulletin No. 26, series two, dealing with their Hi-Load Ceramic Transmitter Condensers. These specially-designed condensers are intended for use in R.F. heater equipment and transmitters of medium and high power. Their high stability and high K.V.A. rating make them suitable for tank surface and for blocking and coupling positions.


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**Radio Interference Suppression,** by G. L. Stephens. Price **10s. 6d.,** postage 6d.

**The Radio Amateur's Handbook,** by A.R.R.L. Price **30s. 0d.,** postage 1s. 0d.

**Sound Recording and Reproduction,** by J. W. Godfrey and S. W. Amos. Price **30s. 0d.,** postage 9d.

**TV Fault Finding,** compiled by *Radio Constructor*. Price **5s. 0d.,** postage 3d.

**Telephony,** by J. Atkinson. Vol. One, **35s. 0d.,** postage 9d.; Vol. Two, **55s. 0d.,** postage 9d.

**Practical Wireless Encyclopaedia,** by F. J. Camm. Price **21s. 0d.,** postage 9d.

**Radio Servicing Equipment,** by E. Lewis. Price **25s. 0d.,** postage 9d.

**Radio Engineering,** by F. E. Terman. Price **50s. 0d.,** postage 1s. 0d.

**A Handbook of Telecommunication,** by B. Cohen. Price **30s. 0d.,** postage 9d.

**Practical Wireless Service Manual,** by F. J. Camm. Price **8s. 6d.,** postage 6d.

**Marine Radio Officers,** by Dowsett and Walker. Price **60s. 0d.,** postage 1s. 0d.

**Radio Valve Data,** compiled by *Wireless World*. Price **3s. 6d.,** postage 3d.

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**THE "TWIN" ONE-VALVE POCKET RECEIVER.**—This interesting circuit is designed around the famous "twin" valve now available as a British all-dry midget type. The set gives powerful headphone reception on the medium waveband, and it can be adapted for the long waves. It requires no aerial or earth and is small enough to fit in the pocket. Design, 3/6, post free.

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The "Bosun" represents my Latest Design in my noted all-dry battery Series. It has been tried under the most difficult conditions in Dorset, and has passed tests for Range, Selectivity, Power and Quality with flying colours.

For a 3-Valve "Straight" design, covering Ship-to-Shore Transmissions and Medium- and Long-wave broadcasting, performance is of a very high order, while Selectivity is amazing for a single tuned circuit. **CONSTRUCTING THE "BOSUN."** My Data Sheet No. LO/34 covers, in every detail, the building and wiring of this design. Price 3/2½ Post Paid.

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**Decca XMS** P/UP. **£7**, plus **1/-.** Connoisseur STD P/UP, **£4.11.8**, plus 1/-. S/Light weight, one head, **£6.9.0.** LP Head. **71/8.** Trans., **15/-.** Fibre P/UP, **£4.3.2.** Trans., **25/-** Chancery XTAL P/UP, **54/-**, plus **1/-.** LP Insert, **31/6.** Collaro AC514 Player Unit MAG Head, **£6.10.5**, plus **2/-.**

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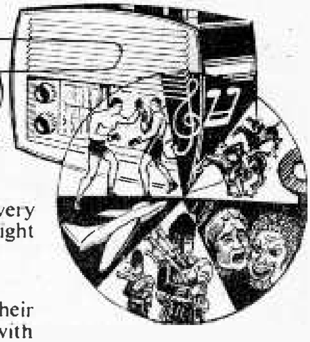

By MAURICE REEVE

### Talks

THE series of six talks on "The Pennine Way," given by Colin Wills, were very good. The Pennine Way is to be the longest of half a dozen or more "ways," or "walks," to be constructed by the Ministry of Town and Country Planning, in conjunction with various other bodies, through the loveliest parts of Great Britain. They will incorporate many historic lanes and paths and, where necessary, new ones will be constructed linking these together. As the talks revealed, some will be precipitous and mountainous, and when completed should prove veritable "shop windows" for showing off our beautiful country to its best advantage.

"The Critics," discussing themselves, were amusing and instructive. Much was made of the non-expert butting in to things he doesn't really understand, and I'm not quite sure whether all will be in agreement with their reasons for the non-inclusion of music among the subjects they discuss.

The suggestion that the non-expert should set the ball rolling might have amusing results if not tried too often. But those who put these and similar views forward miss the chief charm of the programme, which is the discussion, *by people of intelligence and perception*, of subjects nearly related to their own, and the ventilation by them of new angles of approach and points of view.

After all said and done, we don't disqualify ourselves in our private lives from talking on subjects other than those we happen to be engaged in professionally! On the contrary, after listening to many of the opinions bandied about these days on almost any and every topic, we are justified in feeling we know more about it than the expert.

### Plays

"Meet Under the Clock" was a sort of memorial programme to the Dieppe raid of 1942 with, of all people, Bernard Braden in the role of a newspaper correspondent who receives his instructions under the clock at Victoria Station and has to report back there on the completion of the mission 48 hours or so later. Quite good. Like the raid itself, we were given no hint of the subject of the programme.

One statement of fact in the course of the script was so erroneous and absurdly incorrect that it calls for special exposure. At the height of the engagement the correspondent, in my words, cables home in his dispatch "such casualties in one day's fighting have never been seen before in the whole history of war." This, of course, is arrant nonsense. The casualties, including prisoners, at Dieppe were less than one-tenth of what the British Army alone suffered in the one day's fighting on July 1st, 1916, which is the actual all-time record. Many single days of both world wars as well as others produced far heavier slaughter than Dieppe. But perhaps the script did not set out to be historically accurate. Mr. Braden was very effective in a straight part.

### Parlour Games

For those who like their entertainment laced with some intelligence, I can recommend "Say the Word" every Monday evening. One of the BBC's Parlour Games series, though better than some inasmuch as our brains are allowed to function without any impairment of our evening's light-hearted relaxation.

### Censor Wanted

Before proceeding with the past month's programmes, and in case the point gets overlooked, I would like to make an earnest appeal for the complete excision from all scripts of that ever more frequently used and filthily suggestive adjective "flipping." Perhaps, if left to itself, it will die a natural death. But an unnatural one would be more appropriate.

A new World Theatre series started with Shaw's political extravaganza on conditions in Great Britain as he conceived they might likely be in the not too distant future—to wit, The Apple Cart. Not one of the late author's best works—the feminine element is far too sparse for one thing—it nevertheless contains brilliant satire, a king of unusual prescience—who, from a position of apparently immediate departure for the Riviera or some other of deposed Royalty's playgrounds, outwits all and sundry—and a preview of future Anglo-American relations which bear a remarkable resemblance to what they are to-day.

The work was given a slap-up performance, as most of Shaw's things are on the wireless. Peter Coke was suave and much too clever for his political opponents as King Magnus; Frank Pettingell was his rumbustuous northern self as the Labour leader Bill Boanerges, whilst Marjorie Westbury and Susan Richmond as the Postmistress and Power-mistress-General showed how powerful and shrewd women can be in a Cabinet. Martin C. Webster effectively produced.

### The Festival

As usual, more good things come over the air from the Edinburgh Festival than is possible to listen to, two or more of them sometimes being simultaneous. I chose the concerts of the Festival Piano Quartet, founded for the first festival in 1947 by the late Artur Schnabel. His place is now taken by his pupil, Clifford Curzon, with the other members, Szigeti, Fournier, and Primrose, still there. With other artists assisting as demanded by the works played, we were given some magnificent performances of chamber music masterpieces.

Eric Parkin played very well John Ireland's only piano sonata, and made it seem a much neglected work in this dreadfully repetitious age.

# OPEN TO DISCUSSION

The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

## Balanced Speakers

SIR,—Our friends, G. Hurrell (N.W.9) and R. H. Cowtan, are on the wrong track, I think.

Good reproduction is possible with one speaker only, and I would like them to try my tone control circuit (PRACTICAL WIRELESS, December, 1951, page 569).

If they still want to use balanced speakers with a cross-over network, a pressure unit is a *must* for the highs.

Nearly all the cinema sound systems use pressure units as tweeters, because of their high efficiency.—A. WATERWORTH (Burnley).

*Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of cover.*

SIR,—I read the letter from your correspondent, R. H. Cowtan, with considerable interest.

It is a view I have recently taken and I couldn't agree with him more. It is not reasonable to expect one speaker to reproduce all frequencies faithfully. It may be capable of doing so electrically, but it is the mechanics of the speaker which fail.

Three circuits handling the frequencies for which they are specially designed, the outputs of which drive three L.S. with diaphragm and suspensions best suited to reproduce those frequencies, would be the ideal.

Otherwise one might as well expect a percussion instrument such as cymbals to be capable of reproducing the sound of the oboe.—SIDNEY E. V. POOLE (Rickmansworth).

## Cycle Radio

SIR,—In reference to the article on "Cycle Radio," by R. Alexander, in the September issue, it may be of interest to Mr. Alexander, and any other aspiring "Cycle Radio" fans, to know that it is quite possible to obtain all the H.T. required from a cycle dynamo.

Two years ago I conducted such an experiment using the receiver portion of the surplus army walkie-talkie set No. 38, Mk. II.

I used a spare output transformer and rewound the secondary to suit the 6 volt A.C. input from the cycle dynamo.

The output from the transformer was then rectified by selenium rectifiers in "bridge" formation to obtain full wave rectification. The smoothing was accomplished by two 8 $\mu$F electrolytic capacitors and a midget choke.

I was surprised and pleased to find that by this means I could obtain 125 volts of H.T. under load, at a speed of 7-8 m.p.h.—ALLAN LANE (Cheshire).

## Musical Frequencies

SIR,—A sentence on page 414 of September's P.W. in my opinion conveys the idea that there is no mathematical relationship between the notes of the musical scale. This is a pity, for the mathematics of the scale and of the equally-tempered keyboard instrument are very interesting to many people. I offer the following brief notes on the subject in the belief that they will be of interest to those who intend building the Electronic Organ.

It is the ratios of frequencies in the scale that matter (subtracting one frequency from another gets one nowhere). Here is a table of ratios for an ordinary major scale when played or sung perfectly in tune in any key :—

| | doh | ray | me | fah | soh | lah | te | doh |
|---|---|---|---|---|---|---|---|---|
| Ratio of frequency with that of doh ... | 1 | $\frac{9}{8}$ | $\frac{5}{4}$ | $\frac{4}{3}$ | $\frac{3}{2}$ | $\frac{5}{3}$ | $\frac{15}{8}$ | 2 |
| Ratio of adjacent notes ... ... | $\frac{9}{8}$ | $\frac{10}{9}$ | $\frac{16}{15}$ | $\frac{9}{8}$ | $\frac{10}{9}$ | $\frac{9}{8}$ | $\frac{16}{15}$ | |

That such an odd series of intervals should be our musical "foot-rule" is rather remarkable, but with the exception of ray and te (neither of which sounds pleasantly when played simultaneously with doh) the notes are, in fact, closely related to doh through their harmonics—e.g., doh's third harmonic is soh's second.

Keyboard instruments are not tuned to the above table, however. A little arithmetic will show why. Call doh C at 264 c.p.s. and we have—

| C | D | E | F | G | A | B | C |
|---|---|---|---|---|---|---|---|
| 264 | 297 | 330 | 352 | 396 | 440 | 495 | 528 |

Now let us try making another scale on, say, G, and we find our new "ray" is $396 \times \frac{9}{8} = 445\frac{1}{2}$ which is out of tune with A. Other discrepancies show themselves as other scales are constructed.

A system of tuning known as equal temperament is the answer to these discrepancies. The scale, consisting of 12 semitones (seven white and five black notes on a keyboard), is divided into 12 equal steps logarithmically. To raise a note one octave the frequency is doubled so each step is one-twelfth the doubling process, i.e., the ratio between adjacent semitones is $1 : \sqrt[12]{2}$ ($2^{1/12}$). The table of ratios with doh becomes :—

(*Continued on page* 549.)

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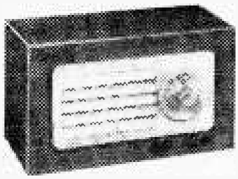

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| | with trans. | less trans. |
|---|---|---|
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| 3½in. ... ... ... | | 13/6 |
| 5in. ... ... ... | 16/6 | 12/6 |
| 6½in. ... ... ... | 16/6 | 12/6 |
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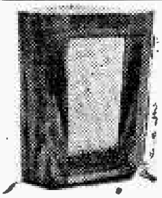

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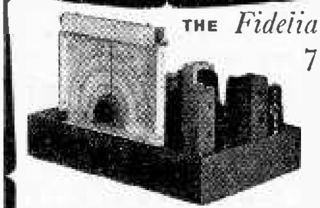

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(*Continued from page* 546.)

doh ray me fah soh lah te doh

$1,\ \sqrt[12]{2^2},\ \sqrt[22]{2^4},\ \sqrt[12]{2^5},\ \sqrt[12]{2^7},\ \sqrt[12]{2^9},\ \sqrt[12]{2^{11}},\ 2$

It is interesting to reflect that the piano tuner uses his skill to put pianos out of tune to a very exact degree and that to do this he listens for beats between two close frequencies much in the same way as an I.F. transformer " listens " to the difference between the signal and oscillator frequencies. Example: the third harmonic of C at 264=792, compared with G's second harmonic at $2 \times \sqrt[12]{2^7} \times 264$ = nearly 791, gives one beat per second. The interval doh to soh, known as a fifth, together with the octave interval (the only accurate interval in a well-tuned piano or organ) can be used to lay the complete scale, e.g., C to G, G to D, D down to D, D to A, etc.

Although a departure from the usual run of topics " Open to Discussion " I hope those not already aware of them will find these facts of interest.—R. STONE (S.E.25).

### Installations for Yemen

SIR,—I feel that your September " Round the World of Wireless " comments may lead readers to imagine that the marvels of radio are now only just reaching the Yemen States.

May I quote a report by Dr. Harry Hoogstraal of the Naval Medical Research Unit No. 3 (U.S.) who toured a large area of the Yemen some two years ago? He states that at Ta'izz he observed messages being received from all parts by wireless "over as swift and efficient a system as we have ever seen."

This from a man conversant with American standards of radio communication!—FRANK H. COWLES (Southall).

### Condenser Testing

SIR,—My letter printed in the issue for July was not intended to suggest that the addition of a potentiometer as suggested by Mr. Coombs would serve no purpose, but to correct what seemed to me to be a misleading statement and to make the point that there are better ways of making improvements to the basic circuit. How I think that these modifications should be made will be clear from the design now appearing in PRACTICAL WIRELESS.

I would like to underline my chief criticism of Mr. Coombs' previous letter in which it was claimed that the use of the potentiometer would permit quicker results on larger condensers. This statement would seem definitely misleading. A smaller voltage certainly helps in the case of small condensers, with the proviso that, if it is desired to be able to form a reliable estimate of capacitance, the voltage should not be reduced so far that the charging curve (i.e., up to the striking voltage of the neon) runs beyond the " substantially straight " part of the exponential curve. The words within the quotation marks are those used in my previous letter. I know quite well the shape of an exponential charging curve and hence I avoided the mention of the " straight part of the charging curve," that Mr. Coombs appears to have read between the lines of my letter. I am quite sure, however, that Mr. Coombs, with his apparent ability to appreciate the mathematical formula involved knows quite well which part of the curve was referred to as " substantially linear."

One gets the impression, at times, that it is not necessary to travel to South Africa to find condensers that rapidly deteriorate from the point of view of leakage and it is for this reason that the suggested test is applied as much as to test capacitance, but in all parts of the world it is necessary to avoid the use of leaky condensers in such positions as couplings between valves.

Neons are not always marked when they have a resistance in the base, but I think that it will generally be found that the absence of such a resistance is noted on the lamp. The neon specified in the Power Pack article is particularly suitable, however, and is easily obtainable.—R. HINDLE (Wallasey).

### Amateur v. Professional

SIR,—Replying to the letter of Mr. K. G. Harvey, N.13, I am of the opinion that Mr. Harvey has misunderstood the meaning of radio amateur, as mentioned in the August issue. It was not intended to be used in a disparaging manner because, as we all know, the amateur plays and always has played an important part in national security and industry.

I fail to see, however, where any question of ability or knowledge was mentioned and, furthermore, Mr. Harvey seems to think that the professional engineer is one that either owns a shop or is a service engineer.

Surely a professional engineer is one that has passed his examinations and obtained his degrees and thereby earns his living in that capacity.

For example, a medical doctor is a professional man, but it could not be said to apply to a male nurse. Similarly, a service engineer does not fall into this category unless he is technically qualified and a member of one of the learned institutions. An electrician is not a professional, whereas a chartered electrical engineer is, and both earn their living doing their particular job.

Nevertheless, the professional is really an amateur at heart; this can be appreciated when one realises that a large number of highly qualified research, development and design engineers engaged in industry or Government research are also members of the amateur movement, whether members of the R.S.G.B. or affiliated societies.

I refer Mr. Harvey to the publications issued by learned societies wherein such valves as those listed are always appearing in new circuit techniques and electronic developments. The amateur and professional alike are to-day getting more electronically minded and both are interested in applying valves to new uses other than radio.—E. G. BULLEY (N.14).

(This correspondence is now closed.—ED.)

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PRACTICAL WIRELESS, Nov., 1952

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Range 0/750 V. 200 ohms per V. each ... 22/6
Range 0/1,500 V. 250 ohms per V. each ... 22/6
Range 0/3,000 V. 200 ohms per V. each ... 25/-
0-1 m/a 2½in. scale desk type ... 32/6

**WEARITE**:

705 Coil Pack 3 wave band ... 37/10
400B Min. I.F.T. 465 kc/s pair ... 15/-
501 and 502, 465 kc/s pair ... 14/-
800s pair ... 15/-

**CONDENSERS.**—1 mfd. 2,500 v.w., metal, 2/6. Electrolytics, 8 mfd. 450 v.w., 2/6. 8 x 8 mfd., 4/-; 16 mfd. 450 v.w., 3/6; 16 x 16 mfd. 450 v.w., 5/-. All midget Tubular Cans, cardboard sleeves. 20 mfd. x 40 mfd. 350 v.w., size 4½in. x 1in., 7/6. Bias Condensers, 65 x 25 mfd., 50 x 12, 12 x 50, 1/6; 50 x 50, 2/-. All new stocks—NOT surplus.

**STROBE UNITS.**—Brand New, in sealed cartons these contain 6 EF50s, 5 EA50s, 1 SP61, a host of condensers, resistors, transformers, chokes, relays, switches, 7 pots and 5 smoothing condensers. Size 18in. x 8½in. x 7½in. Only 67/6, plus 5/- carriage.

**L.T. RECT'S.**

12 V. 2½ A. Westinghouse ... 12/6
12 V. 4 A. S.T.C. ... 17/6
12 V. 8 A. S.T.C. ... 32/6

**S.T.C. RECT'S, E.H.T.**

K3/25 650 V. 1 mA. ... 4/7
K3/40 1,000 V. 1 mA. ... 6/-
K3/100 8,500 1 mA. ... 14/8
K3/200 10,500 V. 1 mA. ... 26/-

**H.T. RECT'S.**

S.T.C., 300 V. 75 mA. ... 6/-
S.T.C., 150 V. 120 mA. ... 4/6
S.T.C., 250 V. 250 mA. ... 18/-
G.E.C., 1 mA. Meter Rect. ... 11/6

**THE " MINI-FOUR."**—4 Station midget portable as specified in PRACTICAL WIRELESS. 14 suitable condensers (incl. 8 mfd.); 11 suitable resistors; 4 B7G V/Holders; 1 pair Wearite " 800 " I.F.T.'s; 1 Elac 3½in. P.M. Speaker; 1 Speaker Transformer; 1.5 Vc. with D/P switch; 4 valves, IR5, IS5, IT4 and 3S4. All above new and unused. Offered at £4/12/6, carriage paid.

Over 10,000 ex-Govt. Valves in stock at competitive prices.

**5 HARROW ROAD, EDGWARE ROAD, W.2. TEL: PADDINGTON 1008/9, 0401.**

## COPPER INSTRUMENT WIRE (ex-stock)

| | | ENAMELLED | | TINNED | | COTTON COVERED | | SILK COVERED | |
|---|---|---|---|---|---|---|---|---|---|
| SWG | Inch | 2 ozs. | 4 ozs. | 2 ozs. | 4 ozs. | 2 ozs. | 4 ozs. | 2 ozs. | 4 ozs. |
| 16 | .064 | 1/4 | 2/- | 1/4 | 2/- | 1/4 | 2/- | 1/4 | 2/- |
| 17 | .056 | 1/4 | 2/1 | 1/4 | 2/1 | 1/4 | 2/1 | 1/4 | 2/1 |
| 18 | .048 | 1/4 | 2/2 | 1/4 | 2/2 | 1/4 | 2/2 | 1/4 | 2/2 |
| 19 | .040 | 1/4 | 2/3 | — | — | 1/5 | 2/3 | 1/6 | 2/5 |
| 20 | .036 | 1/5 | 2/4 | 1/5 | 2/4 | 1/5 | 2/4 | 1/7 | 2/8 |
| 21 | .032 | 1/5 | 2/5 | — | — | 1/5 | 2/5 | 1/8 | 2/10 |
| 22 | .028 | 1/6 | 2/6 | 1/6 | 2/6 | 1/6 | 2/6 | 1/9 | 3/4 |
| 23 | .024 | 1/7 | 2/7 | 1/7 | 2/7 | 1/7 | 2/7 | 1/10 | 3/2 |
| 24 | .022 | 1/7 | 2/8 | 1/7 | 2/8 | 1/7 | 2/8 | 1/10 | 3/2 |
| 25 | .020 | 1/8 | 2/9 | 1/8 | 2/9 | 1/8 | 2/9 | 1/11 | 3/4 |
| 26 | .018 | 1/8 | 2/10 | 1/8 | 2/10 | 1/9 | 2/11 | 2/- | 3/6 |
| 27 | .0164 | 1/9 | 2/11 | 1/9 | 2/11 | 1/10 | 3/1 | 2/1 | 3/8 |
| 28 | .0148 | 1/9 | 3/- | 1/9 | 3/- | 1/10 | 3/2 | 2/2 | 3/10 |
| 29 | .0136 | 1/10 | 3/1 | 1/10 | 3/1 | 1/11 | 3/4 | 2/3 | 4/- |
| 30 | .0124 | 1/10 | 3/2 | 1/11 | 3/5 | 2/- | 3/6 | 2/4 | 4/2 |
| 31 | .0116 | 1/11 | 3/3 | 2/- | 3/6 | 2/1 | 3/7 | 2/5 | 4/4 |
| 32 | .0108 | 1/11 | 3/4 | 2/1 | 3/8 | 2/1 | 3/8 | 2/7 | 4/8 |
| 33 | .010 | 2/- | 3/5 | 2/2 | 3/10 | 2/3 | 3/11 | 2/10 | 5/2 |
| 34 | .0092 | 2/- | 3/6 | 2/3 | 4/- | 2/4 | 4/2 | 2/11 | 5/4 |
| 35 | .0084 | 2/1 | 3/7 | 2/4 | 4/2 | 2/6 | 4/5 | 3/1 | 5/8 |
| 36 | .0076 | 2/1 | 3/8 | 2/6 | 4/5 | 2/7 | 4/8 | 3/3 | 6/0 |
| 37 | .0068 | 2/2 | 3/10 | 2/7 | 4/8 | 3/- | 5/6 | 3/5 | 6/4 |
| 38 | .006 | 2/3 | 4/- | 2/9 | 4/11 | 3/4 | 6/2 | 3/7 | 6/8 |
| 39 | .0052 | 2/4 | 4/2 | 2/10 | 5/2 | — | — | 3/10 | 7/2 |
| 40 | .0048 | 2/5 | 4/4 | 3/- | 5/6 | 4/7 | 8/2 | 4/1 | 7/8 |
| 41 | .0044 | 1/6 per oz. | | 1/9 per oz. | | | | 2/3 per oz | |
| 42 | .004 | 1/9 „ „ | | 2/- „ „ | | | | 2/6 „ „ | |
| 43 | .0036 | 2/3 „ „ | | 2/6 „ „ | | | | 3/- „ „ | |
| 44 | .0032 | 3/- „ „ | | — | | | | 4/- „ „ | |
| 45 | .0028 | 4/- „ „ | | — | | | | 5/6 „ „ | |
| 46 | .0024 | 5/- „ „ | | 5/- „ „ | | | | 7/6 „ „ | |

47 and 48 swg Enam. and 47 swg E.S.S.C. wires in stock. State needs.

All above postage extra. *POST ORDERS ONLY PLEASE.* Send stamp for comprehensive lists.

## EUREKA & CONSTANTAN RESISTANCE WIRES

PRICES PER OUNCE

| SWG | Enam. | D.R.C. |
|---|---|---|
| 16 | 1/6 | 1/6 |
| 17 | 1/6 | 1/6 |
| 18 | 1/6 | 1/6 |
| 19 | 1/6 | 1/6 |
| 20 | 1/6 | 1/6 |
| 21 | 1/6 | 1/6 |
| 22 | 1/6 | 1/8 |
| 23 | 1/6 | 1/10 |
| 24 | 1/8 | 2/- |
| 25 | 1/10 | 2/2 |
| 26 | 2/- | 2/4 |
| 27 | 2/- | 2/4 |
| 28 | 2/- | 2/6 |
| 29 | 2/2 | 2/6 |
| 30 | 2/2 | 2/6 |
| 31 | 2/3 | 2/8 |
| 32 | 2/3 | 2/9 |
| 33 | 2/4 | 3/- |
| 34 | 2/6 | 3/- |
| 35 | 2/8 | 3/3 |
| 36 | 2/9 | 3/6 |
| 37 | 3/- | 3/9 |
| 38 | 3/3 | 4/3 |
| 40 bare 3/- | | 4/9 |

Up to 48 swg stocked.

LITZ WIRES also available.

Large stocks of B.A. SCREWS, NUTS, WASHERS, SOLDERING TAGS & EYELETS; Paxolin type TUBING; Laminated Bakelite and Ebonite PANELS; TUFNOL and EBONITE TUBES and ROD; ERIE and DUBILIER RESISTORS; GERMANIUM AND SILICON DIODES.

Trade supplied.

# POST RADIO SUPPLIES

**33 BOURNE GARDENS, LONDON, E.4 TEL: CLISSOLD 4688 & 2021**