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Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

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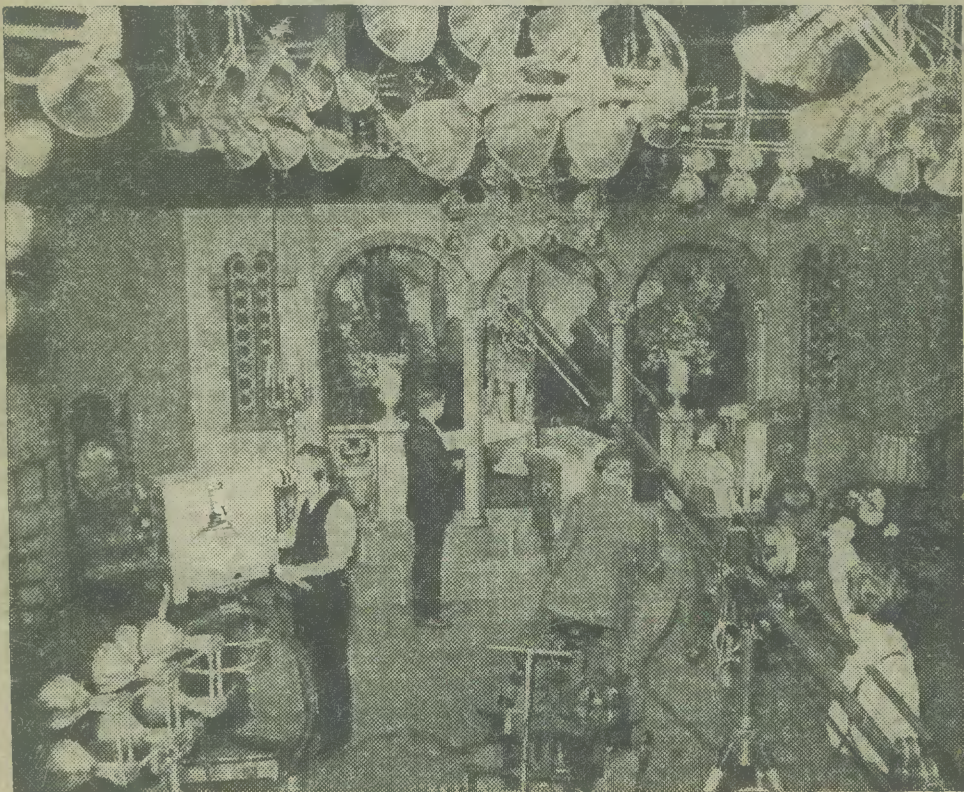

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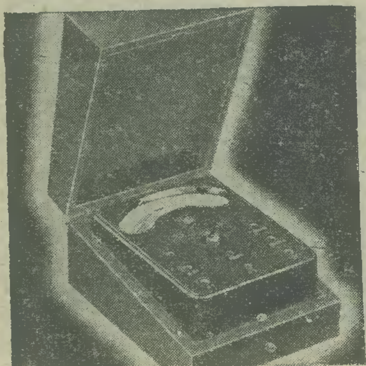

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Practical Wireless

and PRACTICAL TELEVISION

13th YEAR OF ISSUE

EVERY MONTH.
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Editor F. J. CAMM

COMMENTS OF THE MONTH — BY THE EDITOR

Television — How Soon?

AT the time of going to press Lord Hankey's Television Committee has not published its report to Mr. Attlee (Lord President of the Council), but it is likely to be published some time during March or April. Naturally there has been a lot of speculation as to its contents, especially among those who already possess television receivers, and are wondering whether those sets will be rendered obsolete by any new plans recommended in the report. It must be remembered, however, that reports are often issued, but not always acted upon in their entirety, and we have no doubt that the existence of a few hundred television receivers in the London area has not escaped the attention and consideration of the Committee.

National Basis

AT the same time, television now has to be considered on a national and not on a local basis. The tail must not wag the dog. For television to attain a national basis the pre-war style of programme would not do.

In 1939 television was still in the experimental stage, and the programmes were designed to suit the limitations of the system then in use. Neither the B.B.C. nor the public were taking television very seriously in that year. The war clouds were looming, and it was a service designed to cover a very limited area—a part of the London area. Such a limited market could not provide the demand which is necessary to encourage manufacturers and financiers. As with so many other things, the war has developed television to an extent which it would have taken 20 years of private endeavour to do, and it has been brought to this state of perfection at public expense. The public is therefore entitled to expect television to be launched after the war in such a form that it is national in its appeal.

Entertainment Value

IT must have real entertainment value, and not be regarded purely as a scientific wonder, and a basis for experiment by keen amateurs. The public would not tolerate the 1939 style of programme. The Alexandra Palace Station has been kept in working condition during the war, but we do not think any television programme will be put out until the whole country can be covered. London should not be considered as a favoured county.

Some of the speculation suggests that we shall not return to the 405-line system, which was admittedly not good enough. Some of the prophets have suggested 1,200-line transmissions. Others stress the need for a closer link between the television engineers of this country and those of America, where it seems likely that 660-line transmissions will be standardised.

The Report will undoubtedly deal with these matters as well as the range of the video signals. Even if fundamental changes are not made in the 1939 system, great improvements in the quality of the pictures are possible. It is well known that few existing television receivers are capable of translating intelligibly more than about 300 lines of the 525 transmitted.

The flickerless frequency varies from 60 to 48 per second, with an intensity of 70 to 12 ft. lamberts, and thus by comparison with films television has a much greater advantage.

Large Screen Television

WITH a 35 mm. film there are about half a million picture elements, while with the 525-line television there are only half that number, although it is realised that full advantage of improved definition can only be achieved with the large screen television suitable for cinemas. Some of the improvements which will give us better television are the new flat-faced cathode-ray tubes, and the tubes with black screens which considerably reduce halo effect. The size of these tubes will be about 20 in. maximum.

Whether the constructor will be catered for by a supply of suitable components is still a matter of doubt and speculation. Television differs from radio in that much higher voltages are necessary, and it is thought that this fact alone may prevent it from becoming popular with amateurs.

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ROUND THE WORLD OF WIRELESS

London-Athens Radio Circuit

CABLE AND WIRELESS, LTD., announce that the London-Athens wireless circuit was re-opened on January 29th for Press traffic only. The circuit, which had been closed since the transmitting station was attacked and immobilised on December 30th, has now been opened with temporary apparatus.

In the initial stages the circuit will be capable of carrying only a limited volume of Press traffic.

Direct wireless communication between London and Athens was established by Cable and Wireless, Ltd., in 1940. The circuit was closed from April, 1941, when Greece was occupied, until the liberation in October, 1944.

B.I.R.E. Meeting

AT a meeting of the British Institution of Radio Engineers (North-Eastern Section), to be held at the Neville Hall, Westgate Road, Newcastle-on-Tyne, on April 18th, a paper on "Dielectric Heating by the Radio Frequency Method," will be read by L. Grinstead, M.I.E.E. (Member).

The operator, attached to a British Military Mission camped among the mountains somewhere in occupied Europe, gets to work on his suitcase wireless set.

The Harbour Called Mulberry

ON D-day, June 6th, 1944, the prefabricated harbours Mulberry A and Mulberry B sailed from the south coast of England, but the story of their devising and manufacture begins very much earlier in the war—begins, in fact, immediately after our troops landed back here from Dunkirk. From that moment we began to plan a method of getting back into occupied Europe, and although the idea of a prefabricated harbour was not evolved until two years later, the germ of it began in the early raids on the French coast.

The broadcast feature, on March 5th, "The Harbour Called Mulberry," told the dramatised story of this gigantic military and industrial achievement in three phases. Phase one covered the tactical inception of the harbour from 1940 to the Quebec Conference in 1943. Phase two described in dramatic outline the making of the ports, perhaps the biggest achievement in the history of British industry. Phase three dealt with the installation and the running of the ports.

Better Scottish Broadcasting

ACCORDING to a recent statement by Melville Dinwiddie, B.B.C. Scottish Director, Scotland can look forward to making a bigger and better contribution to broadcasting after the war.

The B.B.C. plans for the future would encourage Scottish broadcasting to maintain and improve its standards of quality, with the result that there would be no limit to the programmes they could produce for listeners at home and overseas.

British Military Mission's Mountain-top Radio

MANY British Military Missions, sent into countries occupied by the Germans, equip, feed and organise bands of partisans to harry the enemy lines of communication. These missions live primitively, often moving to avoid German searches. They organise landing strips for 'planes to carry in food, guns and ammunition, and then arrange for the supplies to be distributed to the partisans. One mission has a camp in a valley among mountains some 4,000 ft. above sea level. Their camp is guarded against surprise attack by the enemy, and a wireless operator accompanies the mission every time they go out on reconnaissance.

Philco Post-war Plans

THE Philco Group of Companies held a two-day meeting in London recently with the pre-war wholesalers and distributors of the Philco Radio and Television Corporation, Ltd. Post-war production plans and marketing methods for the products of the Company members of the Group were discussed.

Mr. L. D. Bennett, chairman and managing director of the group of companies, announced that there would be no change from pre-war methods of distribution of the domestic radio and television receivers. Car radio, however, is to be a complete unit of the Group. In addition to manufacturing sets for the British market at Perivale, Philco will also maintain their own car radio sales organisation.

The Philco car radio sales organisation will deal directly with the motor-car manufacturers for the installation of Philco sets as standard or optional equipment at the factories.

Car radio sets will also be made available through wholesalers, installation and service depots, and retailers for owners of private cars, for installation in cars not previously equipped with radio. Philco also announce the continuation of their pre-war policy of producing special models for charabancs, buses, coaches, yachts, and other water craft.

"High-brows" Appreciate Jazz

FOR some time there has been a tendency for devotees of both Jazz and "classical" music to look more tolerantly on each other's musical tastes—and, indeed, to share them.

Radio programme compilers are finding it difficult to keep pace with changing outlooks, finding, as they do, an increasing demand for classical music from those they had planned to placate with Swing—while, on the other hand, world-famous exponents of serious music are openly expressing their delight in Jazz.

"New York Times" music critic, Howard Taubman, would like to see the word "classical," as applied to music, abolished for ever. Each composition should be listened to and judged on its merits, he argues, and not compared to those of the great masters.

"Music is no sacred thing," he says, "emanating from a handful of inspired mortals, but a vital force whose appeal . . . should be directed towards the greatest number."

Middle East Broadcasting

IN the Middle East, the Forces Broadcasting Service has given a great deal of thought to this aspect of music, closely in touch, as it is, with the desires of vast numbers of average British men and women temporarily in uniform.

On the whole, no revolutionary change has yet been made in its presentation of musical works. There are programmes of Swing, for example, in which every artist is a virtuoso; in which directors are as meticulous in their compilations as any compiler of symphonic music—and hold equally strong opinions regarding range, tone, balance and harmony.

Popular Music

ONE programme of "serious" music in Forces radio gave the Forces Broadcasting Service a few headaches to begin with. Aware of the growing demand for this kind of entertainment amongst Services personnel, yet abhorring the title "classical," they called it "Popular Music," and made it a one-hour feature every afternoon. And, realising that Service conditions make intensive listening difficult, they gave this programme a "semi-classical" flavour, by the introduction of the more tuneful works of famous composers—the waltzes of Johann Strauss, the lighter works of Mozart, Brahms and Schubert.

Unexpectedly came requests from the rank and file of the Services for the finest and most intricate symphonic works, both old and contemporary. Result was that, on two days a week, the programme in question was lengthened to an hour and a half, renamed "Services Concert Hall," and now broadcasts anything up to a full-length symphony concert.

U.S. Listeners to B.B.C.

NEARLY 10 million Americans hear one or more British programmes in the course of a week. This is shown by a national survey made last September amongst a cross-section of the adult population of the extent of listening and the reactions to six B.B.C. programmes which are picked up by American stations.

The programmes are "Radio Newsreel," "Transatlantic Call," "London Column," "American Eagle in Britain," "Transatlantic Quiz" and "Atlantic Spotlight." One or more of these, the survey revealed, were listened to during the week in question by about 14 per cent. of the estimated 71 million adults in the U.S.A. who own radio sets.

Radar to Beat Icebergs

RADIO-LOCATION is likely to be used after the war to save lives at sea, by detecting icebergs, or reefs, in the path of ocean-going vessels.

At the reception held before the Radio Industries Club's recent luncheon. (Above, left to right), Group Captain Nelson, Deputy Director of Technical Training in the R.A.F.; Mr. E. E. Rosen, Chairman of Ultra Electric, Ltd.; and Mr. Alex. Moody, Exhibition Organiser of the R.M.A.

(Right) Mr. De A. Donisthorpe, of the G.E.C., and Chairman of the Radio Industries Club, Tommy Handley, Fred Yule, Francis Worsley, and Ted Kavanagh.

Television Broadcasting Practice in America—1927 to 1944

A Paper Read Before the Institution of Electrical Engineers by DONALD G. FINK

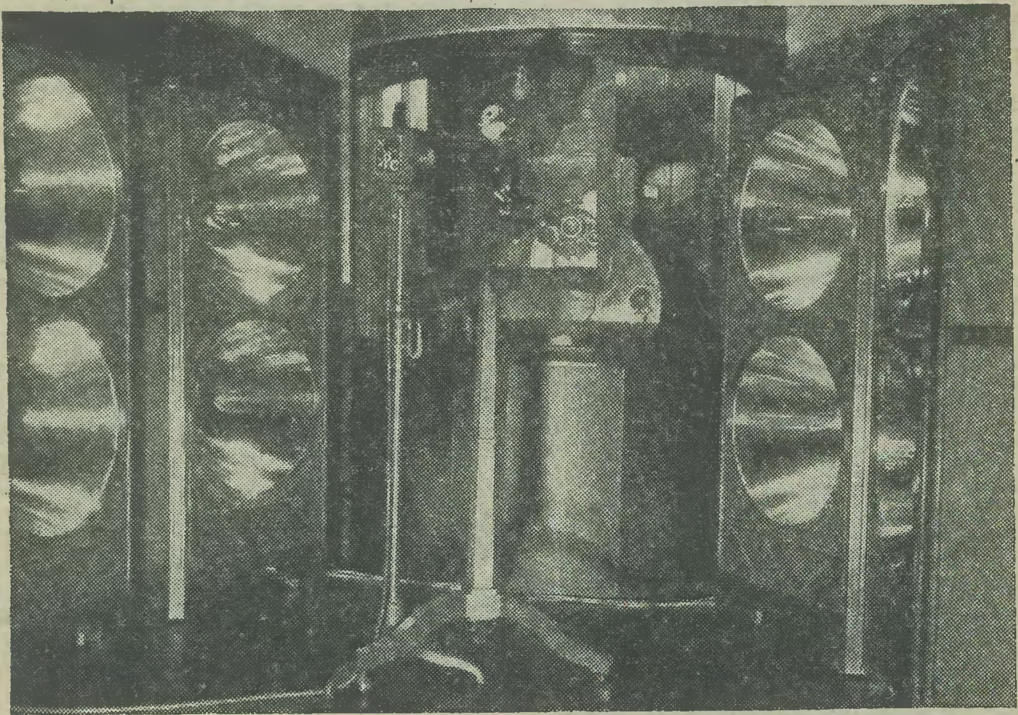


Fig. 2.—Early low-definition installation of the National Broadcasting Company. Notice the figure of "Felix the Cat" suspended before the flying-spot scanner and the photocells.

SUMMARY

THIS paper reviews the history of television broadcasting in America from 1927 to the present, with particular emphasis on current practice. Section 1, the historical survey, traces the evolution of standards of transmission, frequency allocations, and broadcasting practice. Noteworthy programmes are recalled. Section 2, on present practice, gives a detailed account of the standards of transmission governing public broadcasting under the current regulations of the Federal Communications Commission. The stations currently operating are listed. Typical equipment used in these stations is described in four categories: studio equipment, transmitters, radiators, and mobile pick-up equipment. The design of current (i.e. immediately pre-war) receiving equipment is described. The paper concludes with a digest of post-war prospects.

DEFINITIONS OF AMERICAN TELEVISION TERMS

Antenna Field Gain.—The ratio of the effective free-space field intensity produced at 1 mile in the horizontal plane from the antenna, expressed in millivolts per metre for 1 kW antenna input power, to 137.6.

Aspect Ratio.—The numerical ratio of the frame width to frame height, as transmitted.

Black Level.—The amplitude of the modulating signal

Fig. 3A.—The progress of definition, 1929 to the present: 60-line image.

corresponding to the scanning of a black area in the transmitted picture.

Field Frequency.—The number of times per second the frame area is fractionally scanned in interlaced scanning.

Frame.—One complete picture.

Frame Frequency.—The number of times per second the picture area is completely scanned.

Frequency Modulation.—A system of modulation of a radio signal in which the frequency of the carrier wave is varied in accordance with the signal to be transmitted, while the amplitude of the carrier remains constant.

Interlaced Scanning.—A scanning process in which successively scanned lines are spaced an integral number of line widths, and in which the adjacent lines are scanned during successive cycles of the field-frequency scanning.

Negative Transmission.—Applied to a system in which a decrease in initial light intensity causes an increase in the transmitted power.

Scanning.—The process of analysing successively, according to a predetermined method, the light values of picture elements constituting the total picture area.

Scanning Line.—A single, continuous, narrow strip, containing high lights, shadows, and half-tones, which is determined by the process of scanning.

Vestigial Sideband Transmission.—A system of transmission wherein one of the generated sidebands is partially attenuated at the transmitter and radiated only in part.

(1) HISTORICAL SURVEY

Television broadcasting in America began in 1927, when the Federal Radio Commission issued the first television licence to Mr. Charles F. Jenkins, authorising broadcast transmissions from a station in the suburbs of Washington, D.C. Prior to that time, development of television techniques was not open to public participation. V. K. Zworykin applied for a patent on his iconoscope (emitron), which may fairly be called the cornerstone of modern television, in 1925. In 1923, Jenkins in America and John Baird in England, had demonstrated the transmission of crude images over wires. Early in 1927 the Bell Telephone Laboratories demonstrated a low-definition picture over wire circuits, between New York and Washington. But the concept of providing broadcast emissions, available to experimenters, not otherwise connected with the transmitting organisation, did not gain wide currency in America until 1929. In that year some 22 stations were authorised by the Federal Radio Commission to broadcast visual images. In the 15 intervening years, construction permits and licences have been granted to no fewer than 104 stations. Of these, 21 never got beyond the construction permit stage, 48 were licensed but later ceased transmission, and 35 remain in operation to-day. Of the latter, nine stations are licensed for regular transmissions to the public, and may accept programmes from commercial

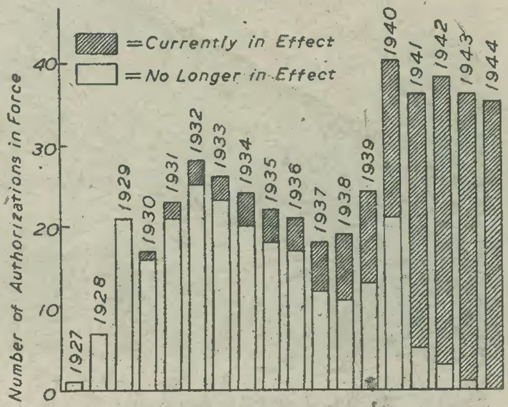


Fig. 1.—The trend of American television activity from 1927 to the present, as indicated by the number of broadcasting station authorisations (licences and construction permits) in force each year.

sponsors. The remainder are experimental stations, many of which render occasional public service. Fig. 1 shows the trend of activity, as judged by the number of stations authorised each year from 1927 to the present.

During this period there has occurred a definite evolution of standards of transmission and frequency assignments. The earliest stations had wide latitude

Fig. 3B.—120-line image.

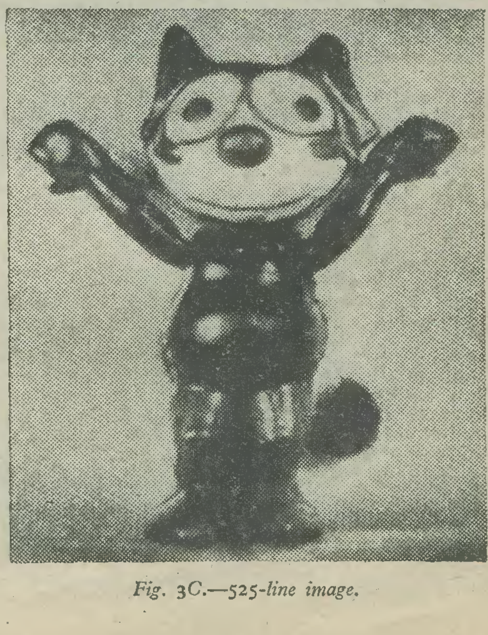


Fig. 3C.—525-line image.

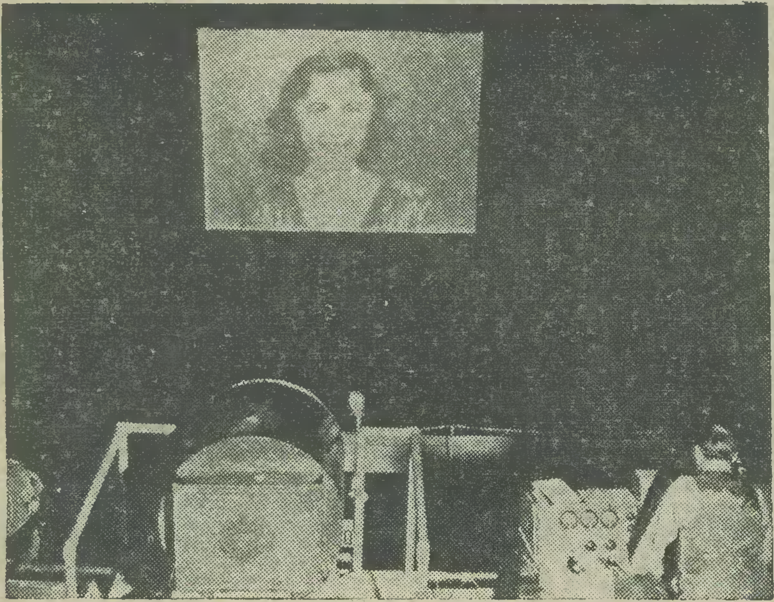


Fig. 4.—Theatre television: An image of Miss Lucy Monroe singing in the N.B.C. television studios and reproduced on a 15ft. by 20ft. screen in a nearby theatre. The projector employs a Schmitt optical system, 60ft. from the screen.

in choice of frequency, almost any frequency above 1,500 kc/s being permitted if no interference was caused to other services. But this latitude was soon withdrawn, as the short-wave region became crowded with other, more vital services. In 1929, emissions were limited to a band-width of 100 kc/s, within the regions 2,000–2,100, 2,100–2,200, 2,200–2,300, 2,750–2,850, and 2,850–2,950 kc/s. The powers employed varied from 100 W. to 20 kW., the majority of stations operating at 5 kW.

The quality of the early images was primitive, judged by any standard. The pictures were commonly transmitted at a rate of 20 per second. At this rate the number of picture elements capable of being transmitted by double sidebands in a 100-kc/s band is limited to 5,000. This number of elements provides sufficient resolution to distinguish the features of a man's face, not much more. Equal resolution in vertical and horizontal dimensions was achieved within the band limits by employing a square image of about 70 lines, but the preferred figure was 60 lines.

Many different types of scanning were employed during this period. The most popular was the flying-spot method. In this system (see Fig. 2) the subject remained in partial darkness before a bank of eight (or more) stationary photocells, while a narrow, intense beam of light scanned the scene.

The typical experimental receiver, which persisted in use up to 1932, consisted of a scanning disc, from 2 to 4ft. in diameter, through the perforations of which was viewed the surface of a flat electrode enclosed in a gas filled lamp. Synchronisation, when achieved, was by virtue of the power-line connection. Three or more stages or resistance-capacitance-coupled amplification were customarily used to produce the signal to actuate the gas-filled lamp.

Many of the major American television stations of the present day can trace their origin to this early period The National Broadcasting Company's station in New York was first licensed as W2XBS in July, 1928, and has since evolved from the 2,000-2,100 kc/s band to the 50–56 mc/s band, from 60-line pictures to 525-line pictures. In 1942 the call letters W2XBS were withdrawn in favour of the "commercial" call letters WNBT. Similarly, the Columbia Broadcasting System station in New York, now WCBW, started in July, 1931, as W2XAX. This station operated with 60-line pictures, 20 per sec., for a total of 2,500 hours in the period ending February 1933. The General Electric station in Schenectady operated on similar standards, with 20 kW power from 1929 to 1932.

The programmes of the day were suited to the capabilities of the system. A toy doll in the form of "Felix the Cat," was a familiar test subject in the early days of the N.B.C. transmitter (see Fig. 3).

One of the early stations in Boston, W1XAV, was a favourite of engineering students at the Massachusetts Institute of Technology, several of whom possessed scanning-disc receivers. The subject-matter often consisted of a small group of students who went to the studio to be scanned by the flying-spot, while another group, viewing a receiver nearby, endeavoured to recognise the first. Facial recognition was not always possible, although such simple acts as exhaling the smoke from a cigarette were usually evident enough. The elementary nature of the technique may be judged from the synchronisation method employed by the author, while a student during this period. The scanning-disc motor, of the non-synchronous variety, was driven above synchronous speed. A rubber eraser, held against the edge of the disc, provided sufficient friction to bring the disc into synchronism.

In 1931 it was evident that progress could not be made on the restricted channels of the 2-mc/s band, and the trend toward higher frequencies began. One of the earliest to apply for permission to use frequencies above 40mc/s was the Don Lee Broadcasting Sysyem in Los Angeles, California. In December, 1931, the licence of station W6XAO was granted to this organisation, authorising the use of the bands 43–46, 48.5–50.3 and 60–80 mc/s. In 1941 this station became a commercial station with the call letters KTSL, operating on 50–56 mc/s with a regular public programme service. The Don Lee station has, throughout its 13 years of operation, offered a regular and consistent high-definition programme service, a fact which makes it pre-eminent among American television stations.

Permission to use the 43–80 mc/s bands was granted to several other stations, including N.B.C.'s W2XF and W2XBT in New York, Jenkins's W3XC in Wheaton, Maryland, W1XG in Boston, and W8XF in Pontiac, Michigan. In 1933 and 1934 several additional v.h.f. stations were licensed to use the bands 42–56 and 60–86 mc/s. In 1936, all activity in the 2-mc/s band ceased and all v.h.f. stations were placed in the bands 42–56 and 60–86 mc/s.

In 1937, the frequency allocation was set up for the first time on the basis of channels 6 mc/s wide. Nineteen such channels were set up between 44 and 294 mc/s. The channel from 44 to 56 mc/s was transferred in 1940 to frequency-modulation (sound-broadcasting) stations and replaced by an additional channel from 60 to 66 mc/s and the channel from 156 to 162 mc/s deleted. The present allocation comprises 18 channels, each 6 mc/s wide, from 50 to 294 m/s.

(1.1) Evolution of High-definition Standards

Shortly after permission to operate in the v.h.f. bands was given, attention was focused on purely electronic methods of scanning and cathode-ray tubes for reproduction. Dr. Zworykin had demonstrated a cathode-ray receiver before the Institute of Radio Engineers in Rochester, New York, in November, 1929. In 1932, an "all-electronic" system was demonstrated by R.C.A., transmitting 240-line images from New York to Camden, near Philadelphia, over an air-line distance of about 80 miles, with one intermediate relay point at Arney's Mount, New Jersey. This was one of the earliest demonstrations of cathode-ray equipment, but the term "all-electronic" was something of a misnomer, since no satisfactory electronic synchronising circuits had been developed, and the synchronising pulses were derived by passing light to a photocell through apertures in a whirling disc.

In 1934, the march toward higher definition got properly under way. Each transmitter was free to employ any scanning method, but between 1932 and 1934 agreement was reached that interlaced transmission, based on the "odd-line" principle, was the simplest and most satisfactory method of avoiding flicker in the reproduced images. The first "odd-line" value chosen was 343, an odd number composed of odd factors ($343=7\times7\times7$). From this root sprang many other choices, all tending toward greater definition in the pictures, all odd numbers, composed of odd factors. The list of scanning specifications, in approximately chronological order, is given in Table 1. It will be seen that the progress toward higher numbers of lines was not steady, indicating that there were differences of opinion. The majority opinion was that no more than 441 lines could be accommodated in a picture sent by double-sideband methods within the limits of a 6-mc/s channel. The dissenting opinion was that it would be better to err on the high side in the number of lines, with consequent excessive definition in the vertical dimension, in the hope that better utilisation of band-width would be possible as time went on. This dissenting opinion was, in fact, justified in 1939, when vestigial-sideband transmission was proved feasible and adopted as standard. The 441-line figure then proved too small for a 6-mc/s channel, and the standard was eventually changed (in 1941) to 525 lines, the present value specified in the F.C.C. regulations.

Fig. 6.—A British evacuee child, listening to his parents in England while being televised in the N.B.C. studios.

Table 1—SCANNING SPECIFICATIONS

Date	Organisation	Number of lines	Frame rate per second
1934	R.C.A.	343 ($7\times7\times7$)	24 and 30
1937	Philco	441 ($3\times7\times3\times7$)	24
1938	Philco	525 ($3\times5\times5\times7$)	30
1939	Philco	605 ($5\times11\times11$)	24
1939	R.M.A.	441 ($3\times7\times7\times3$)	30
1940	R.C.A.	507 ($3\times13\times13$)	30
1941	N.T.S.C.	525 ($3\times5\times5\times7$)	30

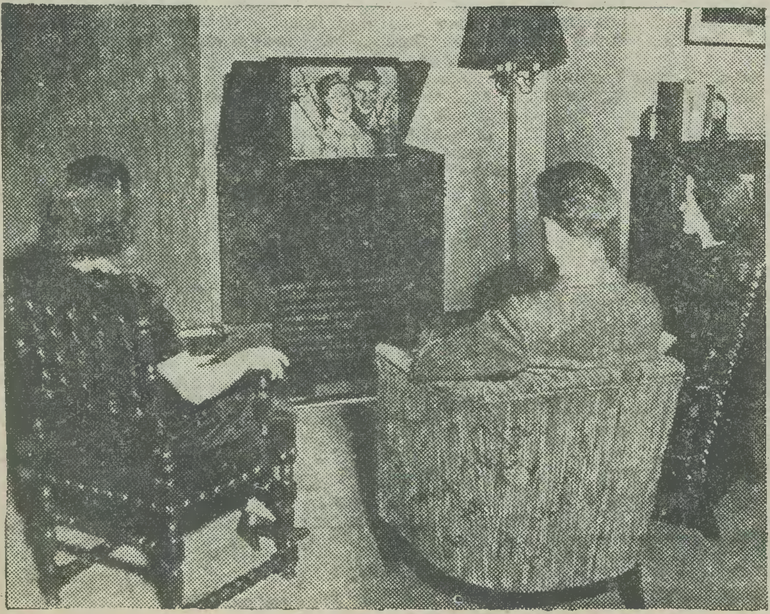


Fig. 5.—A 1941 model of the R.C.A. projection receiver for home use. The image is 13½in. by 18in. projected on a translucent, retractable screen.

The decision concerning the rate at which the pictures were to be transmitted centred about the two values indicated in Table 1, 24 frames per sec. and 30 frames per sec. The figure of 24 frames per sec. was highly attractive from two points of view. In the first place it coincides with the previously established standard frame rate for motion pictures, which constitute a more-than-appreciable fraction of the television programme material. In the second place, the 24-per-sec. rate admitted 25 per cent. more detail in the picture than did the 30-per-sec. rate, all other factors considered equal. But when an attempt was made to operate at 24 frames per sec. with a 60-c/s source of alternating current (mains power), economic factors began to obtrude because the 24-per-sec. rate is not simply commensurate with 60-per-sec. Very complete shielding of the cathode-ray tube and expensive altering of the d.c. supply, especially in the

Fig. 7.—Typical war time programme material: air-raid instruction for the benefit of A.R.P. workers viewing the images at precinct police stations. The camera is of the orthicon variety.

scanning circuits, was found necessary to avoid deterioration of the scanning pattern caused by the resulting vertical and horizontal shifts of the scanning lines from their proper positions.

Argument proceeded for some time on the question whether the added cost incident to reducing this effect was justified by the increase in detail possible with the 24-per-sec. rate. Finally the economic factors won the day. The value of 30 frames per sec. was standardised in 1936, and has not been seriously questioned since that time.

This left unsettled the question of operating motion-picture film, recorded at 24 frames per sec., on a television system operating at 30 frames per sec. Running the film at 30 frames per sec. would involve 25 per cent. excess speed of motion, and corresponding increase in the pitch of the associated sound reproduction. It was soon found that these effects could not be tolerated, so it was necessary to find means of preserving an *average* frame rate of 24 per sec., while scanning each frame at an "instantaneous" rate of 30 per sec. The means was found in the fortunate fact that the fraction 1/24 is the average of two other fractions, 2/60 and 3/60. The television system scans the frame twice in two interlaced fields in 1/30 sec., i.e., the scanning of a single interlaced field occupies 1/60 sec. Thus, if one frame is held stationary in the projector for 2/60 sec., and the next frame is held stationary for 3/60 sec., synchronism with the field scanning rate is maintained, while the average rate of passing the frames through the projector is maintained at 24 per sec. This system works surprisingly well. It is necessary only to devise an intermittent pull-down mechanism which allows the film to "dwell" for unequal lengths of time (2/60 and 3/60 sec.) on alternate frames. To ensure equal exposures of each frame, it is customary to expose the film during the vertical retrace time, between field scansions, and to count on the storage property of the iconoscope mosaic to preserve the charge configuration throughout the subsequent field scansion. This procedure also provides plenty of time in which to move the film between frames. Continuous-motion projectors have also been devised in which a moving lens system counteracts the motion of the film, and a shutter system divides the exposures into the required unequal intervals.

It is safe to say that if this problem had not been so satisfactorily solved, the cost of television receivers to the American public would be substantially increased.

(*To be continued*)

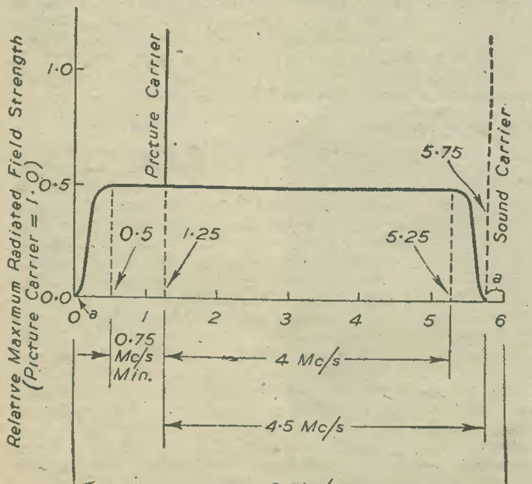


Fig. 8.—Idealised picture transmission amplitude characteristic.

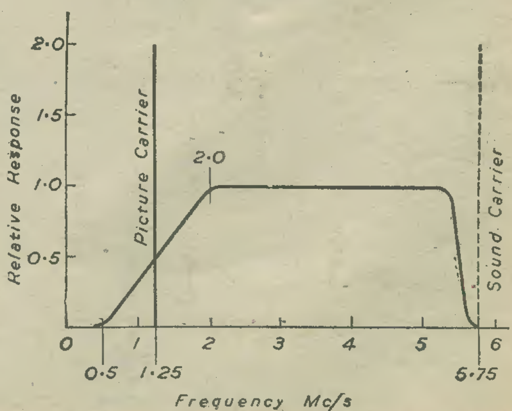


Fig. 9.—Receiver response characteristic for use with the emission characteristic shown in Fig. 8.

Improving Pick-up Reproduction

Some Notes on Methods of Volume and Tone Control, the Use of Scratch Filters, and on Pick-up Repair and Maintenance

PROBABLY because it is easy to connect a gramophone pick-up to almost any type of receiver or amplifier, it may be overlooked that the quality of reproduction sometimes leaves much to be desired. Naturally, in order to obtain reproduction approaching "B.B.C." quality—where record reproduction is concerned—it is necessary to have a much better amplifier and speaker than those in general use for home radio entertainment. But there is no reason why the quality obtained from gramophone records should not be very nearly as good as that from a broadcast programme, if suitable steps are taken to compensate for the shortcomings of the records and of the more "popular" types of pick-up.

Screened Leads

One of the most important points to remember is that the lead from the pick-up to the receiver or amplifier should be as short as convenient, and should consist of screened wire, the screening being effectively earthed; a metal pick-up arm should also be earthed. It is equally important that the alignment of the needle in relation to the record should be correct. Instructions with regard to the mounting of the pick-up arm are generally given by the makers, but in the absence of these it is generally correct to have the needle at an angle of about 75 deg. to the record face. In the case of most pick-ups, this setting will be given automatically if the pick-up is fitted into the tone arm of a "mechanical" gramophone, or if a pick-up supplied complete with its own arm is mounted in accordance with the makers' instructions.

When there is any doubt about the correct mounting of a pick-up arm it should be positioned so that the upper face of the arm is horizontal when the needle is resting on the record surface. Should the record turntable be higher or lower than normal, in respect to the level of the motor board, it may be necessary to raise or sink the mounting base of the arm. It is necessary that the needle should track across an approximate radius of the record; this means that the arm should be so mounted that the needle passes over the centre of the turntable spindle.

In mounting the pick-up arm, ensure that it can rotate with complete freedom. Any stiffness in movement will result in undue record wear, and also in distorted reproduction.

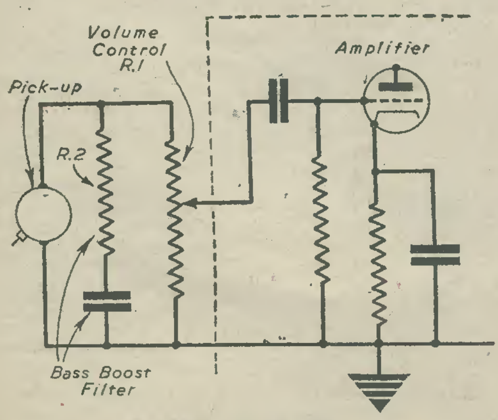


Fig. 1.—Connection for a pick-up volume control and of a resistor-condenser filter employed to improve bass output.

Volume-Control Connections

Volume control is a simple enough matter, and the connections to the control potentiometer are the same as those for most forms of audio volume control, as shown in Fig. 1. The value of the potentiometer is important; if the resistance is too low, pick-up output will be reduced and reproduction will probably be rather "woolly"; if the resistance is too high reproduction will have a tendency to "shrillness" and instability will probably result. The correct value is that stated by the makers, and depends upon the design of the particular pick-up. In the absence of information on this point it will generally be found that a suitable value for a magnetic pick-up is 50,000 ohms—but it might be as high as 250,000 ohms, and tests may be necessary. In the case of a crystal pick-up the correct value for the volume control is more likely to lie between 0.5 and 1.0 megohm.

The leads to the volume control from the pick-up, as well as those from the control to the set, should be screened, especially if the control is not placed within a few inches of the pick-up. Any lack of attention in this direction will result in "howling," distortion, or both. When distortion occurs due to this cause, it is because of instability, or to audio oscillation at a frequency outside the audio range. A volume control of the carbon-tack type is often to be preferred on the grounds of silent operation, but a good-class wire-wound component should be perfectly satisfactory.

Graded Potentiometer

In either case the control should be of the graded type, connected so that there is a reasonably uniform change of volume for any given amount of rotation of the knob at any point within its range. A potentiometer of the linear-resistance type will have little effect for a fairly wide range of rotation near the "full-volume" end of the scale, and there will be a sudden reduction and very sharp variation of volume for a small movement of the knob near the "minimum volume" position. This will be even more marked when using a graded volume control connected wrong way round. When using a volume control of unknown type, therefore, it may be found desirable to try the effect of reversing the connections to the two outside terminals.

Boosting the Bass

Due to the method of making gramophone records, the volume on bass notes is less than that on treble. This is due to the fact that much greater amplitude is required to produce the same volume at the bass end of the scale than at the other end, and to the fact that amplitude has to be curtailed due to the permissible width of the grooves. To overcome this disadvantage, most pick-ups are designed to have a rising sensitivity characteristic from frequencies of about 300 c/s downward. But even this may not provide sufficient compensation, and the addition of some sort of "bass boost" filter is often desirable. The simplest form of a filter of this kind is shown in Fig. 1, where it will be seen to consist of a fixed resistor and fixed condenser in series across the pick-up terminals. The value of these components depends to a certain extent upon that of the volume control, and the resistance of the volume control should be increased when using this parallel circuit so that the overall resistance of the volume control and tone compensating filters is equal to the optimum value of volume control resistance specified by the makers of the pick-up. In practice, this cannot be provided for in a very satisfactory manner, due to the fact that the tone compensating resistance has to be made unduly high.

Improved Tone Compensation

A better method is to use the arrangement shown in Fig. 2. Here it will be seen that a series resistor is used in addition to the parallel tone compensator and the volume control. By following this system the

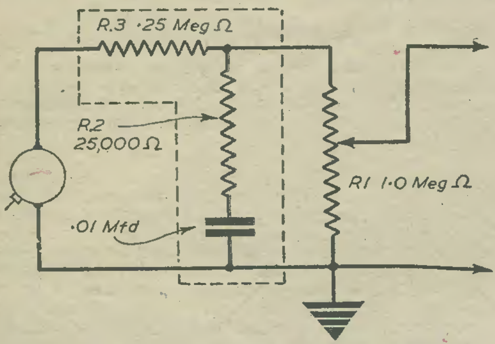


Fig. 2.—A system of tone compensation which is much better than that shown in Fig. 1. The tone-compensator, or bass-boost filter, is enclosed within a broken line. Component values shown are those which apply when a total pick-up load of approximately 250,000 ohms is required.

tone compensator can have a relative low value without the pick-up being too heavily loaded. Here again, however, the overall value of the series-parallel resistor combination should be equivalent to the required load. This means that the load (the correct value of volume control resistance) specified by the makers should be equal to:—

$$R_3 + \frac{R_1 R_2}{R_1 + R_2}$$

By way of example, it may be stated that when the total load required is 250,000 ohms, values of 1.0 megohm, 25,000 ohms and .25 megohm are approximately correct for R1, R2 and R3 respectively.

It will be evident that there must be a certain overall loss of volume when employing this form of tone compensation, for the simple reason that R3 forms one arm of a fixed potentiometer, and therefore the full pick-up output can never be applied to the amplifier. Despite this, the available input to the amplifier is likely to be greater than could be obtained by using the arrangement shown in Fig. 1 if the value of R2 were sufficiently low to produce the required results.

Suppressing Needle Scratch

The arrangement for providing bass boost tends automatically to reduce the effect of needle scratch, since the scratch is at a high audio frequency—4,000 to 6,000 c/s. A better method of eliminating scratch, however, is by using a filter consisting of an iron-core choke and fixed condenser, as shown in Fig. 3. From this it will be seen that, for all practical purposes, the choke replaces the tone-compensating resistor shown in Fig. 1. Unlike the resistor, however, the reactance of the choke varies according to the audio frequency applied to it. And if the values of the choke inductance and condenser capacity are suitably chosen the choke-condenser filter will resonate at the scratch frequency, or thereabouts. It will be remembered that the impedance of a series resonant circuit (an acceptor circuit) is zero at resonance; this means that the scratch frequencies would be by-passed, or shunted out.

A suitable value for the choke is 3 henries when using a fixed condenser of .001 mfd. If the choke is provided with tappings, so much the better, for the most suitable value can then be determined by trial. For those who may wish to make their own choke, about 4,000 turns of 36-gauge enamelled wire may be wound on a spool fitting on a standard transformer core having a winding arm of ½in. by ½in. cross section. Tappings should be provided at each 500 turns from 2,500. To give even greater latitude the fixed condenser may be replaced by a .002 mfd. pre-set component. It is a good plan to mount the choke and condenser in a metal box, which can be earthed.

It is worth noting that scratch filters were readily available before the war at very low prices, and it may still be possible to find one by hunting round the radio stores. The filters are generally mounted in a bakelite case provided with two terminals, and the filter is simply wired in parallel with the pick-up terminals.

Pick-Up Faults

There are not many possible faults in a pick-up in addition to those already mentioned, but there is one which is not uncommon with a unit which is becoming old. It is due to stiffness of the needle holder which prevents free pivoting as the needle traverses the record groove. This fault is normally due to perishing or hardening of the small rubber buffers usually fitted one on each side of the holder inside the pick-up case. When the fault is present, distortion will occur, especially at high frequencies.

A rough check can be made by lightly "flicking" the needle with the finger tip; the needle should "give" slightly, but there should not be a large amount of play, as there would be if the rubber had shrunk or come adrift. Replacement can be carried out if the case is carefully opened and new strips of soft, pliable rubber cut with a razor blade and inserted in place of the old ones. The work calls for a fair amount of care and

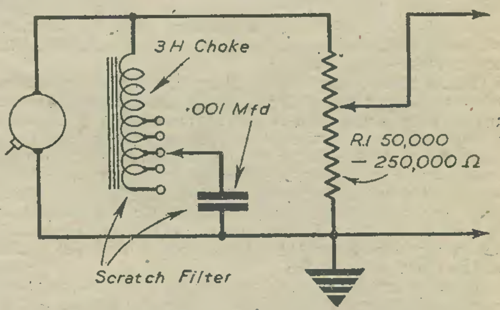


Fig. 3.—One form of scratch filter consisting of a tapped iron-core choke and fixed condenser, which form an acceptor circuit. Details for making the choke are given in the text.

patience, and should be attempted only when it has been verified that the pick-up is definitely faulty. Take care that the needle holder, or stylus, is accurately centred after fitting the new buffers, and that it has not been strained in the process of carrying out the repair.

Other minor faults are looseness of the screws which hold together the pick-up case and looseness of the stylus on its pivot. The method of remedying the first fault (which gives rise to resonances and vibration on certain notes) is obvious. The method of curing the second fault can be decided only as a result of studying the form of construction used in the particular pick-up under consideration.

A.C.-operated Power Packs

Circuit Details of Power Units for Use with Different Types of Battery Receivers

DESPITE the general convenience and portability of battery-operated receivers, there is no doubt that they are relatively expensive to run. In addition, suitable batteries are not always easy to obtain nowadays. And when batteries are employed, power output is of necessity limited; even with class B and other push-pull output circuits output can seldom exceed one watt, and is often considerably less.

In pre-war days many amateurs were able to rebuild their battery receivers for mains operation, but to-day it is often difficult to obtain components for a complete rebuild. The components required for a mains unit, on the other hand, are in fairly good supply.

The solution to the question of building a mains power pack is largely dependent upon the type of battery set with which it is to be used. Quite apart from the current consumption of the receiver consideration must be given to portable sets of the type using an H.T. battery and accumulator, as well as to the "all-dry" set; car-radio sets also come into the picture, because there are many owners of these receivers who wish to retain them, but who are not able to use them in the car.

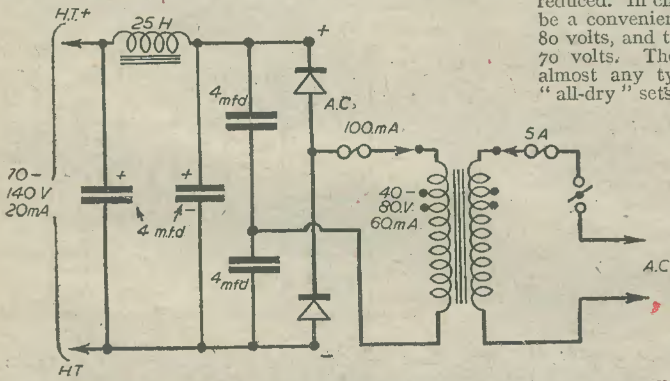


Fig. 1.—Circuit of an H.T. eliminator suitable for most small battery sets. A type H.T.14 Westinghouse metal rectifier is used. The 80-volt secondary winding of the mains transformer is tapped at 40, 50, 60 and 70 volts.

An Eliminator for "All-Dry" Sets

A portable set for battery operation can well be fed from a mains unit when it is used in the home, while still being suitable for use elsewhere from batteries, when a mains supply is not available. We might first consider the "all-dry" type of set, which is very popular and for which the necessary special H.T./L.T. batteries do not appear to be very plentiful. In view of the extremely small L.T. consumption of this type of set, it is scarcely worth while to provide an L.T. supply from the mains. Instead, a fairly large 1.5-volt cell (such as a so-called "bell battery") can be used for L.T., and an eliminator made for the H.T. current supply. For the H.T. mains unit, a circuit such as that shown in Fig. 1 is suitable; this circuit is, in fact, convenient for use in connection with almost any type of small battery-operated receiver. Use is made of a Westinghouse metal-oxide rectifier, type H.T.14, which has a rated maximum output, before smoothing, of 140 volts, at 20 mA.

Range of Output Voltages

That output is given when the rectifier is operated as a voltage-doubler, as shown, and connected to a transformer having a secondary winding rated at 80 volts, 60 mA. As, however, the maximum H.T. voltage of "all-dry" valves is 90, the secondary should give not more than 50 volts, 60 mA, if the receiver takes 12-15 mA, or 40 volts, if the receiver takes 10 mA or less. These figures are arrived at after making allowance for a small voltage drop across the smoothing choke and speaker transformer, and allowing for the fact that the rectified voltage output rises as the current load is reduced. In choosing or winding a transformer, it would be a convenience to have a secondary rated at the full 80 volts, and to provide tappings at, say, 40, 50, 60 and 70 volts. The eliminator would then be suitable for almost any type of small battery receiver, including "all-dry" sets.

Smoothing Circuits

From Fig. 1, it will be seen that two 4-mfd. "paper" type condensers are wired in series across the rectifier for voltage-doubling, and that two 4-mfd. electrolytic condensers are employed for smoothing. The voltage-doubling condensers should have a working voltage of not less than 200, whilst the electrolytics should be rated at not less than 350 volts working; these voltages allow a safety factor in case of the eliminator being switched on without load.

The smoothing choke is shown as 25 henries. This value is by no means critical, and an inductance between 15 and 30 henries is suitable, the main proviso being that it should be capable of carrying the maximum load of 20 mA.

It will be seen that two fuses are fitted in the circuit; that marked 100 mA is to protect the rectifier in the event of D.C. overload, and the .5 amp. fuse safeguards against blowing the mains supply fuse should a short-circuit occur in the transformer primary circuit.

When using an eliminator of the kind described it is necessary that the valve anode circuits in the receiver

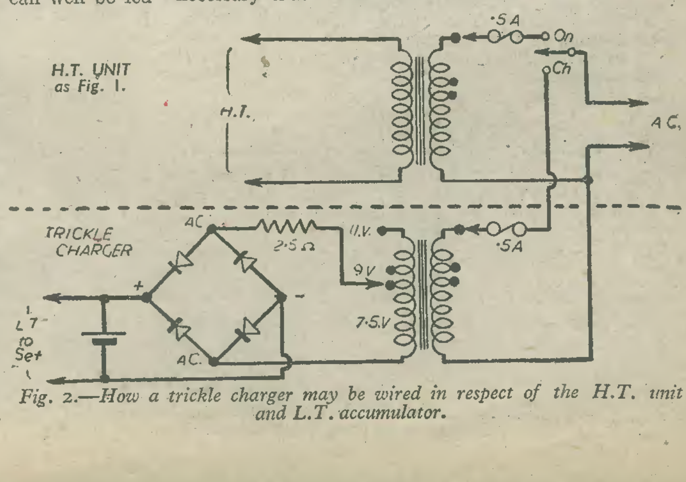


Fig. 2.—How a trickle charger may be wired in respect of the H.T. unit and L.T. accumulator.

should be de-coupled in the usual manner. If de-coupling is not already provided, it should be arranged in the set itself, as that is generally more convenient and satisfactory than the provision of de-coupling circuits in the eliminator. Precautions to be taken in the event of mains hum being in evidence after connecting an eliminator will be referred to later in this article.

The 2-volt L.T. Supply

If an eliminator of the type described, but having a maximum output of 140 volts, is required for use with a battery set operating from a 2-volt L.T. accumulator, it will be desirable to make provision for trickle-charging the accumulator. This is in nearly every case far better than making provision for a 2-volt D.C. supply direct from the eliminator itself—although that is possible. The method of providing trickle-charging facilities is shown in Fig. 2. It will be seen that an additional transformer, fuse, rectifier and resistance are used, while the single-way on-off switch (which must be of the Q.M.B. type) shown in Fig. 1, is replaced by a double-throw switch of the same type. When the switch is in the position marked "On" the H.T. eliminator is in use and the set may be operated. By throwing the switch to the position marked "Ch" (charge), the H.T. eliminator is disconnected and the 2-volt accumulator is put on trickle-charge. Details given in Fig. 2 assume that the rectifier is of the bridge type (Westinghouse type L.T.2, for example), and that a standard transformer having a secondary giving a maximum output of 11 volts at about 2 amps. is used. The secondary should be tapped at 9 and 7.5 volts; it is the last-mentioned tapping which is required to charge a 2-volt accumulator at .5 amp. when using the type of rectifier referred to above. Four-volt and 6-volt batteries can be charged, also at .5 amp., by using the 9-volt and 11-volt terminals respectively.

The 2.5-ohm regulating resistance shown is an essential item. Use can be made of an old rheostat, or a resistor can be made by winding 50in. of 24-gauge Eureka resistance wire on a strip of paxolin; it is best to use bare wire, spacing the turns slightly. Alternatively, it may be possible to buy a ready-made resistor of suitable value.

Higher Output

When a much higher H.T. output is required, an eliminator may be made, using the circuit shown in Fig. 3. This is suitable for a receiver having mains-type valves, whether it be one primarily designed as a mains set, or a battery set which has been modified for use with indirectly-heated valves. This time use is made of a valve rectifier in a full-wave circuit. The valve may be one of the standard 350-volt 120 mA types shown in the lists of most British valve manufacturers; examples are the Cossor 442 B.U., Mazda UU4, Mullard DW4/350 and Osram U12/14; the last-mentioned valve has a maximum anode voltage of 500, but can well be used on 350 volts input. The mains transformer has one secondary for rectifier heating, with an output of 4 volts at 2 to 3 amp., and another giving 350 volts on each side of the centre tapping. Smoothing is again by means of a 25 henry choke and two 4 mfd. electrolytic condensers. It may be stated in passing, however, that "paper" condensers can be used when electrolytics are not available, for both this and the previous circuit. In the present case the condensers should have a working voltage of at least 500; it is better to use condensers rated at 750 volts, which would easily be reached if the eliminator were switched on without load.

In buying the smoothing choke it should be remembered that the component chosen should be designed to carry not less than 120 mA, and, in view of the high current, it should have a D.C. resistance of not more than 300 ohms. In general, it is better to use a 15 henry choke with a D.C. resistance of, say, 250 ohms, than a 30 henry one with a resistance of 500 ohms. In either case there will be a voltage drop across the choke, and this must be allowed for in estimating the actual voltage available in the form of smoothed H.T. at the output terminals.

H.T. Voltage Tappings

An eliminator of the kind shown in Fig. 3 is convenient for general experimental use. In that case,

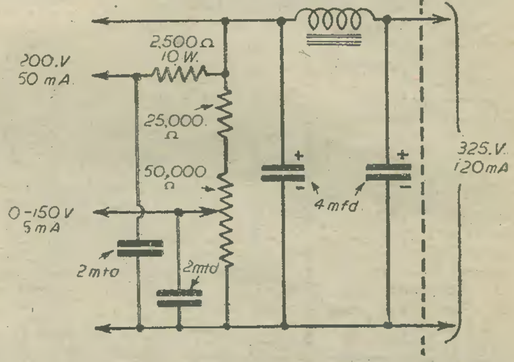


Fig. 4.—A modification of that part of the circuit to the left of the broken line in Fig. 3. The purpose of the resistor-condenser network is to provide additional outputs of the approximate values indicated.

however, it would be an advantage if different output voltages were readily available. This can be arranged by modifying the output circuit as shown in Fig. 4. Here it will be seen that a fixed-voltage tapping of 200 volts, 50 mA is provided, as well as a variable tapping which gives 0-150 volts at 5 mA. Other outputs can be provided by employing different resistor networks, and those shown are detailed only to illustrate the principles.

Combined Eliminator and Output Stage

For experimental purposes it is often convenient to have a power unit and power-output stage combined. A circuit for such a unit is given in Fig. 5, where use is made of a P.X.4 triode. The rectifier and smoothing circuits are the same as those shown in Fig. 3. In addition, there is a voltage-dropping resistor in the main H.T.-positive output lead to limit the output to about 140 volts at 20 mA. This supply is adequate for a fairly large battery-operated receiver.

The input lead to the grid of the power triode would be taken to the anode terminal of the receiver output valve, leaving the speaker transformer in the receiver to act as an output choke. If the power unit and output stage were to be used regularly the speaker transformer could be removed from the receiver and replaced by an L.F. choke.

A few words of explanation may be

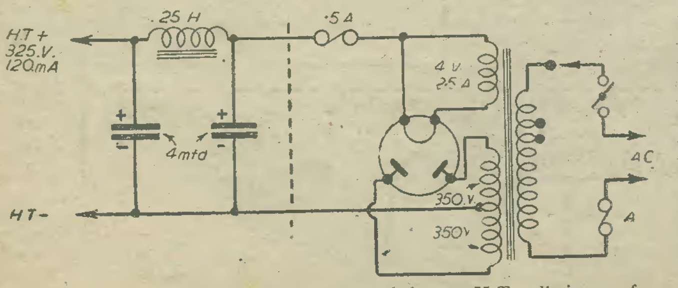


Fig. 3.—A full-wave rectifying valve used in an H.T. eliminator for outputs up to 350 volts, 120 mA.

required in connection with the output stage built into the power pack. The valve suggested has a directly-heated filament, and therefore the "earth return" is made through a 50 ohm "humdinger" and the 1,000 ohm bias resistor. The mains transformer has a separate 4-volt winding rated at 1 to 3 amp. for feeding the filament of the triode, which takes 1 amp. A 100-ohm resistor is connected in the anode circuit of the triode to prevent parasitic oscillation and generally to "calm" the amplifier.

Hum Suppression

It is sometimes found that a battery set operated from a mains unit is inclined to suffer from mains hum. In many cases this merely indicates that the decoupling provided is insufficient when the valves are working at higher efficiency due to the somewhat increased anode voltage. The remedy is, clearly, to check over the decoupling, and, if necessary, to increase the value of decoupling resistors, particularly in the detector anode circuit. A poor earth connection may also tend to emphasise hum; the cure is obvious. With a sensitive receiver, and particularly one working on short waves, hum can often be eliminated by connecting two .001 mfd. condensers in series between the filament terminals of the H.F., frequency-changer and detector valves, and earthing the centre point of the condensers.

It is sometimes found that distortion occurs when using an eliminator, although reproduction was good when the receiver was operated from batteries. This is usually due to the fact that the H.T. voltage is higher than before, with the result that some valves are being overloaded. The cure is to increase the bias voltages, or, better still, to change to automatic bias, which is always to be preferred.

"Special" Cases

No reference has been made in this article to the operation of class B and Q.P.P. receivers from an eliminator. This does present special problems due to the wide variation between minimum and maximum current load. Probably the best method of countering this difficulty is by using a rectifier capable of giving at least 50 mA output and using a neon stabiliser, as explained in a recent article in PRACTICAL WIRELESS entitled "Current and Voltage Regulation."

Many efforts have been made to produce an H.T.–L.T. eliminator for use with a car-radio set, but in general these efforts have not been successful. In consequence, the only satisfactory method of using a car-radio in the home is by using the car battery and putting this on trickle-charge when the set is not in use. A trickle-charger circuit similar to that shown in Fig. 3 is generally satisfactory. The components must be appropriate to the battery voltage, and a maximum output of 1 amp. for a 12-volt battery or 2 amps. for a 6-volt battery is desirable.

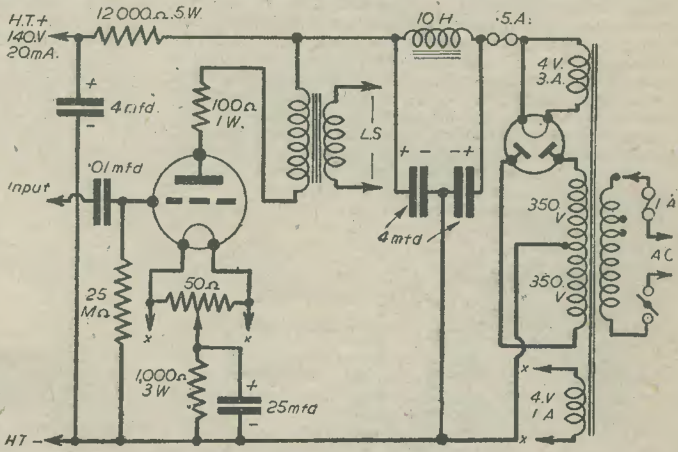


Fig. 5.—A combined H.T. eliminator for a battery receiver with single output valve and super-power amplifier.

Radio in America

ACCORDING to our American contemporary "Radio Craft," radio-equipped homes have increased by 3,700,000 since April, 1940, according to a survey issued by Columbia Broadcasting System. Research department of CBS explains the increase in the face of the 1940 "freeze" on set production. Thirteen million radio sets, they state, were manufactured in 1941, and some thousands of sets which had been secondary receivers in homes with two or more receivers changed hands. Many of these became primary sets in new radio homes.

The survey "U.S. Radio Ownership," which was released for the benefit of persons interested in the radio market, gives detailed information on population, families and radio ownership in each of the States, with totals for several geographic areas. "(Radio Craft," December.)

A television controlled machine-gun has now been proposed. All the technical means to accomplish it are already in our hands. The *modus operandi* of the new weapon is as follows:

The ordinary machine-gun must first be converted into an automatic gun. The ammunition is contained in cases built around it and the firing as well as the aiming is done by electrical means at a distance. In order to aim the machine-gun at the correct angle a small electrical motor is used which moves the gun barrel into any desired position. The firing is done by means of a simple electro-magnetic control.

The television transmitter, heavily camouflaged, is set up right behind the machine-gun. Thus the transmitter will "view" or scan the field immediately in the front and to the sides of it. Somewhere in the rear will be the television receiver, and the electric power unit with its generator which supplies the necessary current for the television transmitter and receiver, as well as the power for remote control of the machine-gun.

At the receiver an operator continuously watches the television screen for any suspicious motion. If the enemy approaches he immediately starts firing merely by pressing a hand control button. The operator, manipulating a small wheel in front of the control board, gives the motion to the machine-gun, so that it can be pointed either to the right or left, up or down. By watching the television screen, which also shows the distant machine-gun, he can see exactly into what angle he must point it so its fire will cover the approaching enemy. A machine-gun "defence in depth" is created with a relay of several machine-guns and several television transmitters, all connected to the same cables.

Valve Replacement

A Word of Caution Regarding the Fitting of New Rectifiers, and Some General Notes on International Octal Nomenclature

THE recent experience of a keen, but not very experienced radio mechanic brings out a number of points of interest and importance. This mechanic was asked to repair a small universal mains receiver which had failed in service, and was practically "dead." In fact, the principal sign of "life" was that the valves appeared to run very brightly.

He tested the line cord, and, although it was rather hot, the resistance was correct at 600-odd ohms; that is, the value was correct in that it would drop the mains voltage to the correct figure for the valve heaters in series, provided that they were passing the correct current of .3 amp. As there was no sound from the speaker—not even mains hum—he thought it probable that the rectifier was at fault. The rectifier was removed

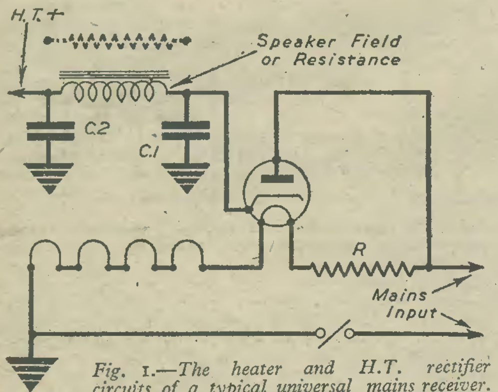


Fig. 1.—The heater and H.T. rectifier circuits of a typical universal mains receiver. The L.T. voltage dropper is marked R; the electrolytic smoothing condensers are marked C.1 and C.2.

and tested for heater resistance without any fault being found. In the course of the tests, however, it was found that there was very low resistance—no more than 20 ohms—between the heater and the cathode.

At this stage he fitted a new rectifier, thinking that that should set matters straight. To his discomfiture, the valve at once showed signs of distress; there were showers of sparks inside the glass bulb, and a marked blue glow could be distinguished through one of the gaps in the internal blackening. The set was quickly switched off and the valve tried in another receiver. It did work, but it was found that the rectifier output was below normal.

Rectifier Overload

Being at a loss to explain the behaviour of the valve he called in the assistance of a colleague, who at once asked if the smoothing condensers in the original receiver had been tested before the initial valve was replaced. Of course they had not; and it did not take long to find that the condenser connected directly between the cathode (H.T. positive) of the rectifier and chassis earth was internally short-circuited. Unfortunately, this is not an altogether rare fault with small electrolytic condensers as used in many of the miniature universal mains sets. The second electrolytic, between the "smooth" side of the speaker field winding and the chassis, was quite sound, and showed a resistance of almost infinity.

Upon replacement of the defective condenser and of the second valve, after making sure that the cathode-heater resistance had not been previously affected, the receiver worked passably well.

The Cause of Trouble

The lesser-experienced mechanic was still at a loss to understand what had happened to cause the peculiar behaviour which he had previously observed. In order to explain, his colleague drew a diagram as shown in Fig. 1. This shows the valve heater and rectifier circuits of the set which had been defective. It will be seen that the voltage-dropping resistance is included in the heater circuit only, and that the full mains voltage is used for H.T. supply by connecting one side of the mains directly to the anode of the rectifier.

He explained that the short-circuit across C.1 had put such a heavy load on the rectifier that the cathode had partially disintegrated. The excessive load also brought about the blue glow. In addition to this, the gross maltreatment had overheated the cathode and brought about the short-circuit between it and the heater.

To simplify the explanation, the circuit shown in Fig. 2 was drawn. An arrow indicates the short-circuit across C.1, and a cross is used to indicate the failure of the insulation between cathode and heater. Because of this short, and because the valve (almost amazingly) continued to conduct between cathode and anode, the effect of connecting a resistance in parallel with the normal voltage dropper was produced. Due to the two resistances being in parallel, the over-all heater-circuit resistance was reduced, and an excessive current was passed through all the heaters. Fortunately, this occurred for such a short time that the heaters were not destroyed, although no doubt weakened.

It is rather difficult to explain how the rectifier continued not only to rectify, but to pass a relatively high current. The reason may be that marked ionisation occurred, and that the heater as well as the cathode acted as an emitter. No doubt the heater would have become open-circuited had the set been left switched on for any appreciable time. The new rectifier would also have been damaged had not the set been switched off very quickly.

Caution

The experience described should be a sufficient reminder that smoothing condensers should always be carefully tested before replacing a rectifier. This applies

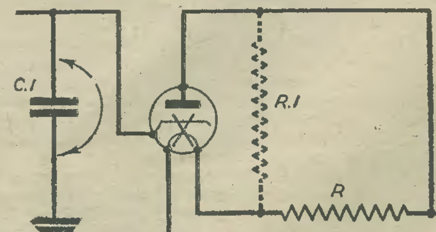


Fig. 2.—When an internal short-circuit occurred in C.1, an insulation breakdown developed between the cathode and heater. The result was a "phantom" resistance in parallel with R. This caused a rise in heater current in all the valves.

to all types of receiver, but more particularly to a universal set in which the rectifier anode is connected more or less directly to the mains supply. The phrase "more or less directly" is used purposely, because in some cases it is connected to a tapping on the voltage dropper. This is done when the H.T. voltage required is less than the mains voltage, or when the rectifier employed has an anode voltage rating of something less than 200. For example, several types of half-wave rectifier have a maximum rated plate voltage of 125. In some such cases it may well be that the total heater voltage is equal to the required rectifier anode voltage; the rectifier plate supply might then be taken from the heater of the rectifier valve. When this is possible it confers an advantage in that the heater and cathode voltages are not so greatly different.

In a case of that kind, particular care is necessary in determining the correct resistance for the line cord or other form of voltage-dropping resistor, due to the fact that the resistor carries not only the L.T. current, but the H.T. current as well. When the valves are

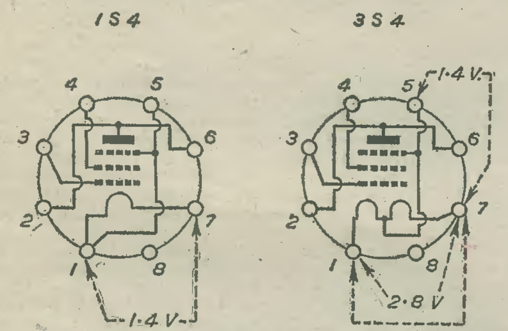


Fig. 3.—Two similar types of pentode. The 3S4 can be operated from either a 1.4 or 2.8 volt L.T. supply, whereas the 1S4 is suitable for operation from 1.4 volts only.

of the type rated at .15 amp. and the H.T. current is in the region of 100 mA., it is clear that the total current passed by the resistor may be nearly doubled, which means that the ohmic vaule may be halved, and that the resistor must be capable of passing about .3 amp., instead of .15.

Alternative Rectifiers

When replacing rectifiers it should be remembered that it is often possible to use an alternative type, if the precise replacement is not available. For example, a half-wave rectifier can often be replaced by a so-called voltage-doubler, which has twin anodes and twin cathodes, by bridging together the two anodes, and also the two cathodes. It is clearly important that the new valve should have the same heater-current rating as the other valves in the set; it would be dangerous to put a .3 amp. valve in a holder intended for a valve rated at .15 amp., because its resistance would be lower than that of the correct valve. As a result, the current passed through the other heaters would be excessive. In any case, the rectifier would not work, because its heater current would be too low. If a .3 amp. rectifier were replaced by one rated at .15 amp., the rectifier itself would probably suffer damage because the voltage applied to it would be too high. As a last resort it may be feasible to use an incorrect valve in this way, provided that its heater were shunted by a resistor equal in value to the resistance of the rectifier heater. For example, it would be correct to connect a 350 ohm, 10 watt resistor in parallel with the rectifier rated at 50 volts, .15 amp., when using it in a set with valves having .3 amp. heaters.

Valve Nomenclature

It will be understood that in doing this it would also be necessary to alter the value of the dropping resistor, because it would no doubt have been set for a rectifier with a 25-volt heater. At this point it may be stated that, in general, .15 amp. valves can be recognised by the prefix "35" or "50," which is the heater voltage, in the type reference. Examples are the 35Z4-GT and the 50L6-GT. On the other hand .3 amp. valves generally have type references prefixed by the figure "6" or "25"; for example, the 6A8-G and 25A6-G. Unfortunately, perhaps the prefix "12" is used for valves having both .15 and .3 amp. heaters. The figure indicates the approximate heater or filament voltage.

Another point in connection with type recognition which is not always recognised is that different letters have been fairly well standardised for different functions. Thus, "A7" and "A8" generally indicate a frequency changer, "J5" a triode, "SG" and "SH" an H.F. pentode, "Q7" a double-diode triode, "L" or "A" an output pentode or tetrode, and "Z" a rectifier. It must be realised that the above statement is rather in the nature of a generalisation, applicable to American or International Octal type valves, and is intended as a rough guide only.

To make another generalisation, it may be stated that valves with the type prefixes "6" and "12" are normally intended for use in stages other than the output and rectifier, while those prefixed by the numbers "25," "35," "50" and "70" are normally output valves and rectifiers. Incidentally, the 707L-G or 70L7-GT (GT indicates a smaller glass bulb) is a combined beam power amplifier and half-wave rectifier.

"Double-Voltage" Filaments

Another interesting point in connection with valve replacement concerns a few valves of the "all-dry" type with filaments rated at 1.4 volts. Some of these have centre-tapped filament, so that they can be operated from either a 2.8 or a 1.4 volt supply. For example, the 1S4 and the 3S4 are both output pentodes with similar characteristics. But whereas the former has a single filament for direct operation from a 1.4 volt supply at .1 amp., the latter has a centre-tapped filament which can be fed from either a 1.4 volt supply, when the current consumption is .1 amp., or from a 2.8 volt supply, when the current consumption if halved to .05 amp. Details of the two-valve types are shown in Fig. 3. It will be seen that to operate the 3S4 from a 1.4 volt supply, the two ends of the filament should be connected together (terminals 1 and 7) and the junction of the two and the centre tap (terminal 5). For 2.8 volt operation, no connection is made to the centre tap, while the ends of the filament are taken to the supply terminals.

It is recommended that reference should be made to the appropriate PRACTICAL WIRELESS Valve Data Sheets while reading the above notes. After a little study of these Data Sheets it will be found that many of the details can readily be memorised.

Negative Feedback

Its Operation in Battery Receivers.

By S. O. MAWS

SO much has been written about the subject of negative feedback in A.F. amplifier design that it would be pointless to delve deeply into the theory of it here. It is convenient, however, to preface this article with a short recapitulation of the chief advantages derived from the application of negative voltage feedback. These are, a reduction in all forms of distortion (frequency, amplitude and phase), and a reduction in the effective anode A.C. impedance of the final valve of the amplifier with a consequent increase in the damping it imposes on the output load, whatever that is. The amount of distortion with feedback is $\frac{1}{1+M\beta}$ times the amount of distortion without feedback, where M is the amplification of that section of the amplifier over which feedback was applied without feedback and β is the fraction of the output voltage which is fed back. There is only one disadvantage associated with the use of negative voltage feedback and it is that the voltage amplification of the amplifier is reduced by applying it. Again, this reduction occurs in this same ratio. There is, however, one aspect of negative feedback which has not been stressed in the literature on the subject and it is a point worth noting. It is this: That the efficiency of an amplifier which we may take to be the value of the fraction

$$\frac{\text{power output for a given amount of total distortion}}{\text{total power consumption of the entire amplifier}}$$

is improved by the application of negative feedback. For example, a normal domestic receiver consuming 40 watts and using a conventional output pentode will probably give 3.5 watts of audio-frequency power with 5 per cent. total distortion. This represents an efficiency of 8.75 per cent. By the use of feedback the distortion could be reduced, say, to 2 per cent. for the same power output or, putting this another way, we could get a greater output, perhaps 4.5 watts, for 5 per cent. distortion, and this power output represents 11 per cent. efficiency. This is not a vast improvement in efficiency, and in mains-driven equipment, for which electrical power is so cheap, is hardly worth bothering about. But in battery-driven receivers and amplifiers where power is so dear the increase in efficiency brought about by the use of negative feedback is of very great value. One of the chief obstacles in the design of battery-driven equipment is that the acoustic power output is limited by the current which may be economically taken from the H.T. battery, and so any device which improves the overall efficiency of the equipment is clearly a very good thing.

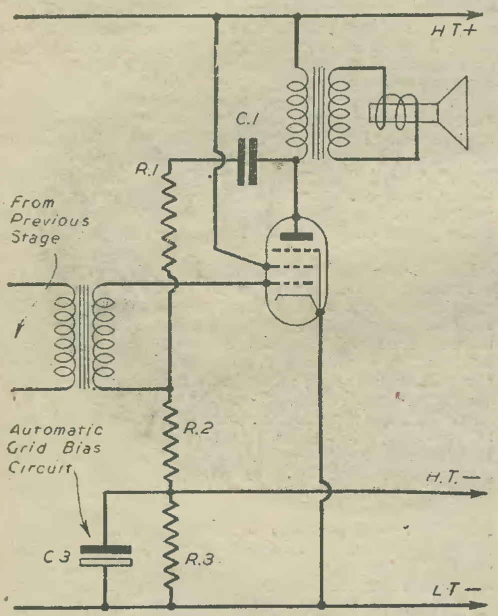


Fig. 1.—A method of applying negative feedback to an output pentode.

Application to A.F. Section

Let us consider, then, ways in which negative feedback may be applied to the A.F. section of battery receivers. The quality of a triode output stage is generally considered to be very good, so it is pointless to apply negative feedback to it. Moreover, the necessary sacrifice in gain cannot be tolerated. It is, however, worthwhile to apply negative feedback to a pentode and two methods of doing so are illustrated in Figs. 1 and 2. In Fig. 1 a potentiometer composed of R1, R2 and C1 is connected between anode and filament of the output pentode and the voltage developed by this across R2, which will be $\frac{R2}{R1+R2}$ of the output voltage of the valve is connected in series with the P.D. developed by the secondary of the intervalve transformer. If C1 is so large that its reactance, even at the lowest frequencies in which we are interested, is small compared with R1+R2, then the feedback voltage will be independent

(*Continued on page* 195)

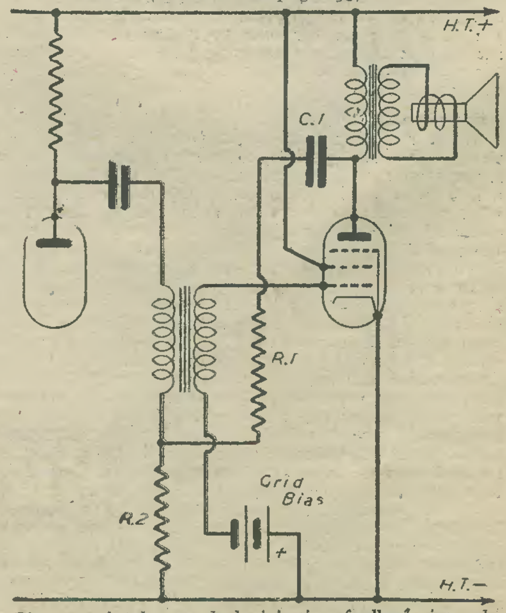


Fig. 2.—Another method, injecting feedback into the primary of an inter-valve transformer.

of frequency and will therefore tend to give a straight line frequency response to the amplifier. If, however, a bass lift is wanted, then C1 can be made smaller. The values of R1 and R2 to use will depend on the degree of feedback wanted; in any case their sum must be large, at least several times the optimum load of the valve, or else they will absorb an appreciable fraction of the output power of the valve. Suppose we decide that we can afford to reduce the amplification of the pentode, normally 25 times, to 10 times. Then

$$\frac{1}{1+25\beta} = \frac{10}{25}$$

giving β as $\frac{3}{50}$

Thus $\frac{R_2}{R_1+R_2}$ must equal $\frac{3}{50}$. Suitable values will be R_1=50,000 ohms and R_2=3,000 ohms. For straight line frequency response C_1 can equal 0.25 μF, and for a bass lift of a few decibels its value can be reduced to 0.05 μF. The RC combination R_3C_3 is for the provision of automatic grid bias.

Inter-valve Transformers

It is also possible to inject the feedback voltage into the primary circuit of the inter-valve transformer, assuming this component is parallel-fed as shown in Fig. 2. Battery bias is indicated here. In this circuit instability may result due to a possible change of phase occurring in the transformer, which effectively turns the negative feedback into positive feedback, which may be great enough to cause oscillation at an audible or supersonic frequency. Should this occur, a reversal of the leads to the primary or the secondary winding will put matters right. There is, however, quite a strong possibility of meeting trouble with this circuit, due to the phase shifts occurring in the transformers. Generally speaking, it is a very good plan in negative feedback chains to have as few transformers as possible between the point at which the feedback voltage is taken and the point at which it is re-introduced into the amplifying chain. This is a particularly annoying conclusion to reach, for the idea of including transformers within the feedback chain is an attractive one in that it would enable the frequency distortion which they usually introduce to be reduced considerably. Due to the inclusion of the A.F. transformer within the feedback loop in Fig. 2, a smaller degree of feedback need be used to give the same reduction in distortion and voltage gain as before. Suppose the transformer gives a voltage step-up of 1 : 3. The amplification without feedback is thus 25×3=75, and the feedback fraction necessary to reduce this in the same ratio $\frac{10}{25}$ quoted before is

$$\frac{1}{1+75\beta} = \frac{10}{25}$$

$$\therefore \beta = \frac{3}{50}$$

Suitable values for R_1 and R_2 now are R_1=150,000 ohms and R_2=3,000 ohms. C_1 can be 0.05 μF for a level frequency response and 0.01 μF for a bass emphasis if wanted.

In order to get the necessary attenuation for the feedback voltage we can use the step-down ratio of the output transformer instead of a potentiometer. Fig. 3 shows how this may be done. This scheme is an attractive one in view of the fact that no extra components are required, but in practice is frequently troublesome owing to the inevitable phase shifts which occur in output transformers. The distortion and voltage gain are reduced in the ratio

$$\frac{1}{1+\frac{25}{K}}$$

if the feedback voltage is injected into the secondary lead of the intervalve transformer, and

$$\frac{1}{1+\frac{25K'}{K}}$$

if it is injected into the primary of the intervalve transformer, in which the ratio of the output transformer is K : 1 and the ratio of the intervalve component is taken at 1 : K'. Taking K as 50, and K' as 3, both typical values, we have that this reduction factor is given by

$$\frac{1}{1+\frac{25\times3}{50\times2}} = \frac{2}{5}$$

so that distortion and voltage gain are both reduced to 40 per cent. of their previous value.

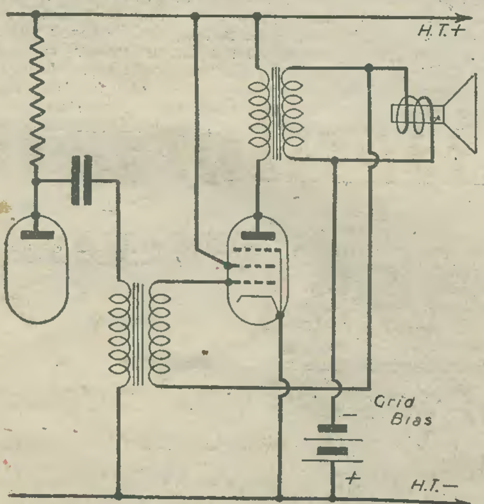


Fig. 3.—Feedback voltages may also be taken from the secondary of the output transformer.

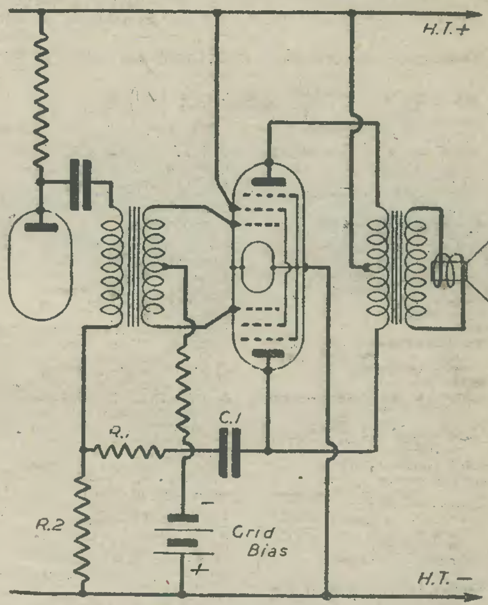


Fig. 4.—Applying negative feedback to a Q.P.P. stage.

Push-Pull Output Systems

We will turn now to the problem of applying negative feedback to push-pull output systems and we will deal first with the QPP system, in which two similar output pentodes (sometimes in one bulb, sometimes in separate bulbs) are used. If the two valves are accurately matched there is little likelihood of second (and even order harmonics generally) being present in the output, but there will certainly be some third and odd order harmonics. If the two valves are used in Class A conditions the odd harmonic content will be small; if they are biassed back almost to the point of anode current cut-off (as they usually are in QPP systems to keep the mean D.C. H.T. current low), the percentage will be considerable. The presence of these harmonics is most undesirable; they give an artificial brilliance to the reproduced sound which can only be described as "strident" or "brassy." It is, in fact, the presence of these odd harmonics in the acoustic output of such instruments as the trumpet and the trombone which gives them their characteristic sound. The application of negative feedback is, then, particularly desirable in QPP stages to keep this harmonic content at a low level. Circuits similar to those given for single-valve output stages may be used, but it is unavoidably necessary to apply the feedback voltage to the primary side of the intervalve transformer. A suitable circuit is given in Fig. 4 in which a double valve is indicated. To find out suitable values for R1, R2 and C1 we may proceed thus. Assuming the H.T. supply to be 120 volts when the valve is delivering its maximum output, its anode potential will be swinging from, say, 120−100=20 volts to 120+100=220 volts, representing a peak alternating component of 100 volts. Such valves usually require a grid bias potential of −9 volts, which means that a signal of 9 volts amplitude at the grid will fully load each valve. Now the intervalve transformer which feeds such QPP valves usually has a large step-up ratio. Suppose it is 1:7. Then the peak value of input signal at the primary required to load the valve fully is $\frac{9}{3.5}$ = 2.5 volts, giving the overall amplification, from primary of intervalve transformer to one anode as $\frac{100}{2.5}$ = 40 times. Suppose we decide to reduce distortion (and—unfortunately—the amplification) to one-third of its previous value. We have that the necessary feedback fraction is given by

$$\frac{1}{1+40\beta}=\frac{1}{3}$$

so that

$$\beta=\frac{1}{20}$$

We can thus make R1=2,500 ohms and R2=50,000 ohms. C1 as in earlier examples may be 0.25 μF for a level frequency response and smaller if a bass lift is wanted. It will be necessary to determine by trial and error the correct valve anode to which the feedback potentiometer should be joined. If the wrong one is used, positive feedback and possible oscillation may result.

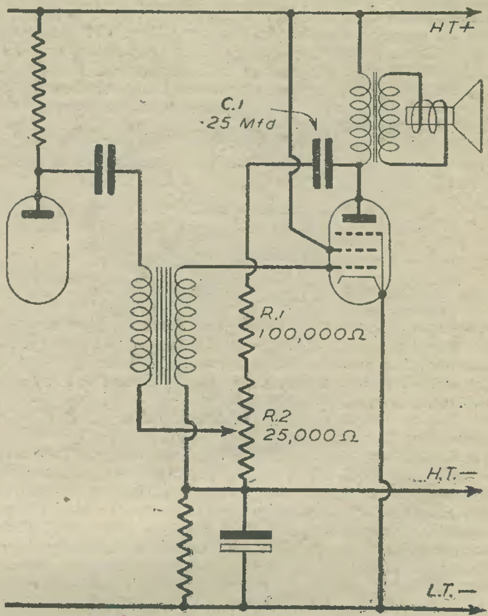


Fig. 5.—Volume control by means of negative feedback.

Feedback Control

It is a good scheme when designing feedback circuits to make the feedback fraction variable by means of a potentiometer as shown in Fig. 5, which is simply a reproduction of Fig. 1 in which R2 has been made into a potentiometer. This can be done with any of the resistances marked R2 in the diagrams of this article and it is best to use component values which give a very large degree of feedback when the potentiometer is set for maximum feedback. The component values indicated in Fig. 6 are suitable. The volume control in the circuit may then be neglected completely and the feed back potentiometer may be used for controlling volume. In this way one is always using the maximum degree of feedback possible for the output power given by the amplifier and hence the quality is always the best obtainable from the equipment. The only drawback to this circuit arrangement is that the feedback potentiometer will never reduce the output power from the amplifier to zero, but will only reduce it to a low level, depending on the values of circuit components used. It should be possible to reduce the volume to a low enough level for most purposes by a suitable choice of components.

"ALL-DRY" RECEIVERS

THE only fault of an unusual nature likely to be found in an "all-dry" receiver is one due to the valve filaments having lost some of their emission. They will glow normally (a very dull glow) but will not work at all, or produce only very faint signals. In the case of a superhet in particular, it may be found that signals are audible for a few seconds or even minutes when the set is first switched on, but then suddenly "die"; this happens because the oscillator ceases to oscillate. A test for the type of fault described can be made by trying a new 1½ volt L.T. cell. If that has no effect, it is justifiable to connect a 2 volt accumulator for a few seconds, especially if the valves are known to be old and to have had considerable use. Should it be definitely ascertained that the valves have lost a good deal of their emission they can often be retained in service for some little time by feeding them from a supply having a voltage up to about 2.2. This may be obtained from a 2 volt accumulator or from two 1½ volt cells in series, and in series with a wire-wound resistance of about 10 ohms. In any case, use the highest value of resistance which will just allow the set to operate. The lower the resistance—and therefore the higher the filament voltage—the shorter will be the remaining life of the valves.

Meter Range Multipliers

Extending the Range of Current and Voltage Reading Meters. Measuring Resistance. Multi-range Meters. By 2CHW

THE two types of meters most likely to be used by the amateur and average service engineer are those which depend on a "moving-iron" and a "moving-coil" movement for their operation.

The moving-iron meter is cheap, robust, and can be used on D.C. and A.C., provided the latter is of low frequency in the region of that of most A.C. supplies, and that the current consumed by the meter is not of serious consideration. When used on D.C. a very high degree of accuracy must not be expected, and it is always advisable to select a meter whose full-scale reading is approximately that of the voltages most frequently to be measured. This is advised to prevent errors likely to occur when reading off values at the bottom end of the scale, as the pointer or needle movement is roughly proportional to the square of the voltage or current flowing, and this results in the bottom end of the scale being badly cramped. The calibration marks get closer and closer together as zero setting is approached, thus

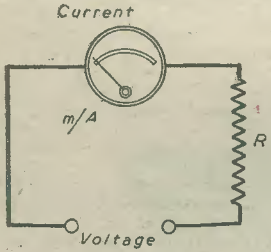


Fig. 1.—A voltmeter is simply a current meter with a suitable series resistor R.

making it rather difficult accurately to read off low values.

The moving-coil movement is by far the most reliable and widely used, but owing to its construction and accuracy it naturally costs more. It depends for its operation on the current flowing through a coil of wire which is pivoted in the magnetic field of a permanent magnet. The pointer is secured to the coil which is usually rectangular in shape, and its movement is proportional to the current flowing through it, therefore, unlike the moving-iron instrument, the meter scale can be marked off in even sections. This is a very desirable feature, as it allows accurate readings to be taken at any setting between zero and maximum. Unfortunately, a moving-coil meter cannot be used on A.C. supplies *unless* some form of rectifier is incorporated in its circuit, but, thanks to the development of the metal rectifier, it is possible to obtain very minute rectifiers, such as the Westinghouse, which will provide full-wave rectification so that the meters can be used on A.C. and still retain the good features of the original D.C. instrument.

Voltmeters

It will simplify matters if the readers not too familiar with meters and series and shunt multipliers think of a voltmeter as being nothing more than a *current* reading meter with a suitable resistance in series with it, for, in actual fact, that is all it is (Fig. 1). From Ohm's Law we know that a voltage applied to a circuit containing resistance will cause a certain current to flow, the value of which will depend on the value of the applied voltage and the value of the resistance. If, therefore, one considers a milliammeter, this type being taken as it is most widely used for radio work, having a F.S. (full-scale) or maximum reading of 1 mA., and if a resistor having a value of 1,000 ohms is connected in series with it and a voltage source of one volt, a F.S. reading will be obtained of 1 mA., but the scale marking could be changed to one volt, as it is actually indicating the value of the applied voltage under the conditions mentioned above. From Ohm's Law already mentioned, we know that one volt flowing through a resistance of 1 ohm will create a current of 1 ampere; similarly, if the resistance is increased to 1,000 ohms, the current will be reduced to 1/1,000th, or, in other words, 1 mA.

By applying Ohm's Law in this manner it is a simple matter to construct a multi-range voltmeter by utilising a good make of moving-coil meter having a F.S. of 1 mA. and a low internal resistance. The value of the F.S. reading is very important. A meter having, say, a full-scale reading of 5 or 10 mA.s would, obviously, require that current to flow in its circuit to produce a F.S. deflection, and if it was used as a voltmeter its current consumption imposed on the circuit under test could cause very misleading readings to be obtained. Supposing, for example, one wished to measure to voltage at the anode of a resistance capacity coupled valve, the anode load resistor of which would be several thousand ohms in value, as soon as the meter was connected between anode and common negative earth line an additional 5 or 10 mA.s would be caused to flow through the anode resistor, and this would create a serious voltage drop across it (Fig. 2), therefore, the voltage actually measured at the anode would not be the true value of that existing when the meter was not being used.

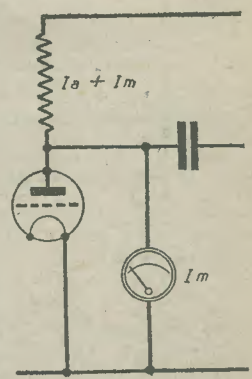


Fig. 2.—Showing that the current flowing through the anode resistor, when a v/meter is connected as shown, is equal to Ia plus Im.

It is, therefore, essential for the meter forming the heart of a multi-range meter to have (a) a full scale

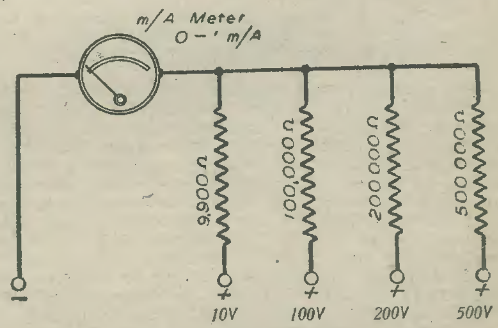


Fig. 3.—Series resistors for voltage reading, using an 0-1 mA. meter of 100 ohms resistance.

reading of 1 mA. or less; (b) low internal resistance; and (c) a reasonably large scale. Assuming a milliammeter having a F.S. of 1 mA. and an internal resistance of, say, 100 ohms is used, the circuit shown in Fig. 3 indicates how a multi-range voltmeter can be constructed, and the value of the necessary series resistors. It will be noted that the resistor for the 10-volt range is 9,900 ohms, i.e., 10,000 ohms the calculated value less 100 ohms which is the resistance of the meter. For the higher readings, the meter resistance need hardly be considered, as its value becomes increasingly smaller in proportion to the series resistor, though, strictly speaking, it ought to be allowed for.

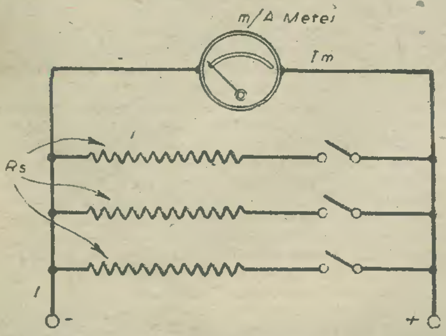


Fig. 4.—Increasing the current range of a milliammeter by means of shunts which by-pass the excess current.

For the 100-volt range, a 100,000 ohm resistor is used; for the 200-volt range, a 200,000 ohm, and so on, and this gives what is called a 1,000 ohm-per-volt rating for the meter. On a good voltmeter, this rating is always specified, and if one is concerned with measuring H.T. voltages, etc., the ohms-per-volt rating should always be as high as possible, and certainly not lower than that given above.

Multi-range Current Meter

With a current reading meter, we get back again to the fundamental meter movement, and if the F.S. reading is, say, 1 mA., it is obvious that a greater current cannot be passed through the meter without serious risk of damaging or burning out the winding. To enable the scale range to be increased, or, more accurately, to enable the meter to measure currents of greater value than that for which it is designed, it is necessary to by-pass the excessive current and this can be done by means of "shunts" or resistors connected in *parallel* with the meter. For the advice of those who possess high reading milliammeters, and who wish to make them low reading, it is not possible to reduce the F.S. value by any external means. To achieve this, it becomes a matter of rewinding the moving-coil, i.e., increasing the number of turns, a procedure which is not recommended so far as the average amateur is concerned.

The fundamental arrangement for the use of shunts is given in Fig. 4, the shunt resistors being Rs. The current flowing in the circuit under test is I, but this is split up between the meter and the shunt, and we will call these currents Im for the meter and Is for the shunt. Knowing that the meter can only handle a current equal to its F.S. rating, it becomes obvious that the additional or excess of current must flow through Rs, but this will only be true if Rs bears the correct relationship to the resistance of the meter (internal resistance). The current to be measured, I, will be equal to Im plus Is, and the value of the latter will depend on the value of Rs which can be determined from the simple formula

$$Rs = \frac{Rm}{(n-1)}$$

when Rm equals the internal resistance of the meter (usually specified by its makers), and n represents the number of times the full scale reading is to be multiplied. For example, if a meter has a F.S. reading of 1 mA. and its internal resistance is 100 ohms, and if it is required to measure 50 mA.s or fifty times its F.S. deflection, then

$$Rs = \frac{100}{(50-1)} = \frac{100}{49} = 2.04 \text{ ohms.}$$

Another method of finding the value of Rs is by the ratio of the currents flowing through the meter and the shunts, multiplied by the resistance of the meter.

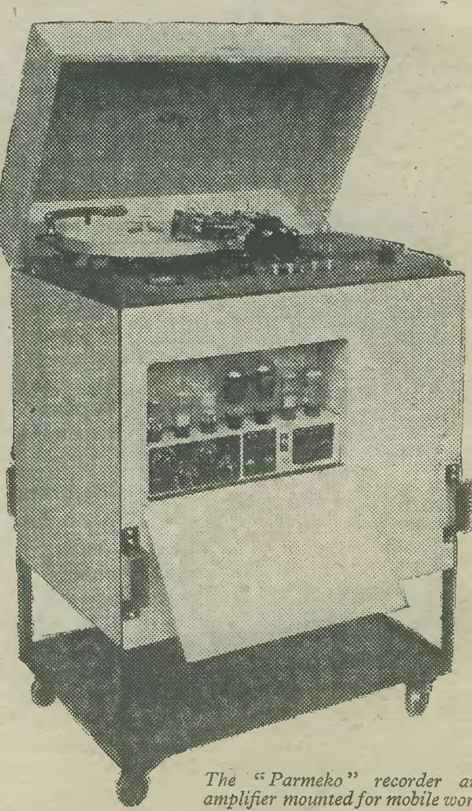
$$Rs = \frac{Im}{Is} \times Rm.$$

Applying this to the above case, the current Im will, of course, be 1 mA., while that flowing through the shunt Rs will be 50 − 1 or 49. The meter resistance is 100 ohms, so we get—

$$Rs = \frac{1}{49} \times 100 = 0.0204 \times 100 = 2.04 \text{ ohms.}$$

A simple method which will allow various shunts to be brought into circuit as required, so that the milliammeter will have several ranges, is shown in Fig. 3. The individual switches could be replaced by a rotary type having a suitable number of contacts, but it is important to see that whatever type of switch is used, its contacts are perfectly reliable and of negligible resistance, otherwise the resistance of the shunt circuits will be affected. The failure of a contact might easily mean the destruction of the moving coil; but more about that next month.

(To be continued.)



The "Parmeko" recorder and amplifier mounted for mobile work.

(See next month's instalment of Direct Disc Recording.)

Direct Disc Recording—6

The Cutter Head and Stylus

THE cutter head, with its associated stylus, is responsible for translating the sound energy received as a voltage from the amplifier into grooves on the blank. The cutter and the pick up are similar in function, although working in the opposite sense. Unfortunately many people, realising this, have tried to use an ordinary pick up as a cutter, even manufacturers have sold pick ups, more heavily damped than usual, as cutters. It cannot be too strongly emphasised that a cutter head must be designed as such if it is to fulfil its object satisfactorily.

It is therefore rather surprising to find how little attention has been paid in the past to this most important component. Indeed, many first-class equipments, with really good amplifiers and associated parts, have been put on the market with cutter heads which in no way were capable of even providing a reasonable response, let alone doing justice to the otherwise excellent equipment.

Cutter Heads

A lot of work has been carried out on cutter head design during the war, and the would-be enthusiast will have a number of really first-class types from which to choose when peace conditions permit. Even so, the cutter will still prove to be the weakest link in the chain in so far as anything but the most elaborate and costly equipments are concerned. Before the war there were only one or two makes in this country which could be even considered as useful instruments, although there were several to choose from the Continent and the U.S.A. The general tendency of all of them could be divided into two classes; those designed for "brute force" methods, and those designed of a "tricky type." The former relied on heavy damping to overcome nasty resonances and bad design of the moving system; this, of course, meant that several watts were required to drive them, even as much as 10 in some cases. The "tricky" types were often a genuine attempt to produce a good cutter which would work from the minimum power. This is an obvious desirability as normal amplifiers of the order of six to 12 watts could then be used, with economical results and freedom from overload on peaks. Unfortunately, this meant that tricky types of damping and suspension had to be resorted to in order to reduce peaks and resonances, with the results that these first attempts were very unstable over periods, and the ease in which they could be thrown out of adjustment, even during a recording, was disconcerting to say the least.

The more recent attempts have produced some very satisfactory results, even though by no means perfect, or, sad to say, as perfect as the many advertisers would have us believe. These cutters require in the order of 0.6 watts to fully modulate the groove.

Two types of cutter head are most used in direct recording, the electro-magnetic and the crystal. The moving coil type is usually found in the commercial recording studios, and is, of course, capable of very fine results, but it is a little more elaborate and expensive than would justify its general use for direct recording.

An electro-magnetic cutter is capable of giving very fine results if properly used, and the reader would do well to purchase the best type that he can afford, always bearing in mind, of course, that outside appearances do not count much, and should be no judge of the quality of the instrument, or of its price.

An e-m cutter, uncompensated, will cut a constant velocity pattern and an e-m pick-up will give a flat response from such a pattern. We must not forget, however, that as we have already seen (Article No. 3) our direct recordings, like the commercial type, must take a modified constant velocity form.

Cutters

Two main types of e-m cutters are in general use; the lower priced type with a pivoted and rubber damped armature and the higher priced type with a balanced armature. Unfortunately, the majority of the former types were never designed but "just happened" by hit and miss methods. In most cases they need a lot of power to operate them, due to the heavy damping introduced to cut down unwanted peaks and resonances. They usually have a trough, due to excessive damping, at about 2,500 c.p.s. and a resonance about 4,500 c.p.s., which, although it may be helpful in giving an "attack" to speech, can be very distressing in music, especially if it is a sharp peak. A cutter which has a gradual rise to a maximum at any frequency, of even several db, will not sound so distressing as one which has a sharp peak of even a few db. The latter will cause a nasty unnatural harsh sound in the top register. Figure 1a gives the rough layout of the lower priced type of cutter, this being the simplest construction. There are, of course, several methods of armature suspension and damping so that the diagram should be taken as a general indication rather than any one definite type. For instance, the armature damping could be in the form of a solid block of rubber, or, as is often found, small pieces of rubber held up against the armature by non-magnetic adjustable stops which make it more easy to adjust the centring.

In the diagram it will be seen that the cutter consists of the armature assembly with the bottom of the armature mounted on a rubber bearing so that it is free to swivel round this point; the top end being held between damping blocks which are adjustable between

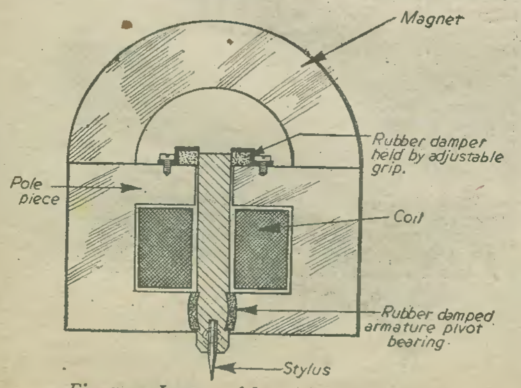


Fig. 1a.—Layout of low-price cutter.

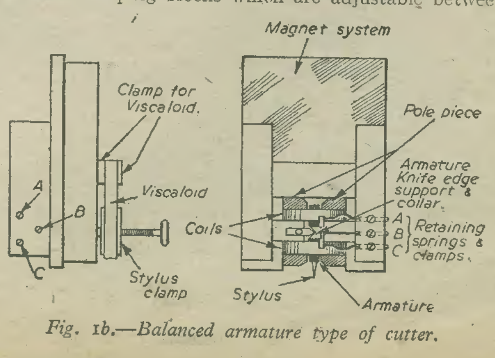


Fig. 1b.—Balanced armature type of cutter.

the faces of the pole piece. A horseshoe type magnet is used, whilst the coil is, of course, round the armature, the ends being brought out to suitable terminals. The cutting stylus is mounted in the same manner as a needle in a pick up at the end of the armature. Voltage variations in the field coil causes the armature to vibrate from side to side, thus causing the stylus to engrave the wave form of the frequency applied. The armature and stylus will have a natural period of vibration of their own, as also will other moving parts, so that the damping applied must be sufficient to keep these unwanted vibrations within certain limits. This is done by adjustment of the damping pads. If these are tightened up too much the sensitivity of the cutter will be considerably reduced, meaning that more power will be required to obtain a satisfactory cut. If more power is applied there will again come a point where unwanted vibrations will occur, so that this is not always the best method to adopt in designing a cutter head where a good free from resonance response is required, even if one has plenty of power in hand. This is rather the "lazy man's" way of designing a cutter, where he says proudly that his cutter will handle several watts, whereas, if he were honest he would say because it was badly designed he used heavy damping to overcome to some extent the results of his bad design. Another bad point about heavy damping is the quite serious falling off in the ability to respond to the higher frequencies, which is a great disadvantage in our case as direct recording is so well able to cater for the higher end of the scale due to the quiet background obtained with modern blanks.

The balanced armature type of cutter, if properly designed and carefully adjusted, is capable of giving first-class results with a very low input, but they must be treated carefully and kept in adjustment. Figure 1b gives a rough indication of the construction of this type, but here again it must be remembered that there are various designs of suspension and damping. The armature is pivoted in the centre by means of a V-bearing along its longitudinal axis, which is pivoted on a knife edge. Mounted on the armature is the armature saddle on which are three springs; one, the retaining spring, keeps the armature fast up against the knife edge whilst the other two are used to adjust the armature between the pole pieces. All three springs are adjustable, and when once correctly set can be locked into position. The top of the armature is let into a piece of rubber, or more usually a substance known as Viscoloid, which has the advantage of not being affected by age. The armature pivot block is also suspended in axial bearings of Viscoloid. The response of the cutter can be altered by cutting the Viscoloid to certain shapes and sizes, depending upon whether it is desired to alter the high, middle or low frequency response of the cutter. It must be stated, however, that Viscoloid is very responsive to changes in temperature so that it is necessary to keep the cutter at an even temperature when once adjusted; this is of no real objection in the home, or studio, but can be a disadvantage for outdoor and mobile work.

Matching the Cutter

It is very necessary that the cutter should be correctly matched to the output stage of the amplifier, even more so than when using a loudspeaker, because the results of bad matching will show up more on a record. The professional cutters and those used with most high class equipments can be obtained with either a 15 ohm or a 500 ohm winding. The cheaper types are usually higher, of the order of 1,000/2,000 ohms.

A 15 ohm cutter may easily be 175 ohms at 5,000 c.p.s. and only 2 ohms at 50 c.p.s. due to the magnetic cutter being a reactive load, inductive at all but the low frequencies where it is largely resistive. In terms of power this would mean that some 20db less would be required at 50 c.p.s. than at the frequency used for checking the head, usually 400 c.p.s., but that at 5,000 c.p.s. some 5db higher would be required. It will thus be seen how important it is that correct matching is obtained with a very much available higher power output than actually required for cutting, owing to the large load variations. This is one of the chief reasons for the use of power triodes in recording amplifiers rather than pentodes. The latter can, of course, be used, if plenty of negative feedback is applied. Even so, there is no doubt that the best results are to be obtained by the use of triodes for recording, with plenty of power to spare.

The actual amount of power required to cut by one of the better class cutters, such as the balanced armature one just described, will depend upon how well the moving parts are designed. The more carefully and delicately balanced is the armature bearing the less power will be required. The maximum power required, or rather used, will depend upon the level at which the magnetic saturation of the field occurs; if this occurs before the groove can be fully modulated the cutter is useless.

The Crystal Cutter

The crystal cutter has gained more favour in recent years, especially in America. It is used quite a lot in equipments using the embossing method of recording with good results.

A crystal cutter will cut a constant amplitude characteristic, which, if played back with a crystal pick up, will give perfect reproduction without equalisation. Those persons favouring constant amplitude recording can, therefore, use crystal cutters and pick ups, and forget all about equalisation. They cannot, of course, play back commercial pressings without equalisation.

The crystal cutter has no mechanical moving parts as we understand them in magnetic cutters. It is made up of several, two or four, Rochelle salt crystals clamped together at one end with the stylus at the free end. The crystals have a bending or twisting tendency when a voltage is applied to them which causes a mechanical deformation moving the stylus from side to side. It should be explained that the plates are cemented together so that their respective shearing or twisting tendencies are in opposite directions.

Crystal cutters require a voltage of the order of 75 to 120 across an impedance of anything from 50,000 to 100,000 ohms. They can also be used, with suitable correction circuits, for cutting a constant velocity characteristic. Temperature changes affect them, and they cannot be treated roughly; apart from breakage they are trouble free as regards adjustment, as this is carried out by the manufacturer, and the unit is then sealed up.

There have been, from time to time, several suggestions as to how best one can test a cutter head. Most of them will not bear close investigation, as they almost invariably bring into consideration other variables which give a wrong impression. Undoubtedly the best method is that known as the Buckmann-Meyer image which makes use of the "light-diffraction" pattern. This method shows up peaks, resonances and the general shape of the whole recorded pattern without the need of any expensive apparatus or expert knowledge, unless one desires to go into the why and the wherefore of the method, in which case he can read the very excellent paper published by these two workers. The method will be gone into in detail with suggestions and examples in a later article dealing with tests and the use of the complete recording equipment.

Aids to Hearing—2

Micro-telephones. Valve Amplifiers. Considerations Governing Designs.

By a Member of the Technical Staff

(*Continued from page 157, March issue*)

THE exact frequency range required from the hearing-aid for general use, i.e., speech and musical sounds, is a debatable point for, as we have already seen, it depends on the form of deafness, and whether an earpiece or bone conductor is to be used, and the desirability of keeping down extraneous noises and valve hiss, etc. Apart from working to a specified frequency response, provided after diagnosis of the source of trouble, the most satisfactory solution seems to be the fitting of an effective tone control in the hearing-aid amplifier, and in conjunction with this a satisfactory form of volume control.

The most simple aid to hearing is the now almost obsolescent ear trumpet, which was produced in many varied and weird forms. It had the advantages of being inexpensive, remarkably effective—bearing in mind its simplicity—over quite good distances, but it was rather embarrassing and clumsy in use. Some

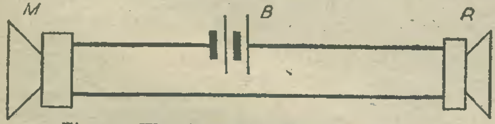


Fig. 1.—The circuit of a simple hearing aid.

of the latter designs, however, were quite compact and light in weight without losing efficiency. The actual amplification obtained, when thinking in terms of more modern equipment, was very small, but the mere cupping of the ear with the hand will show the effectiveness of improving or increasing the sound collector and directing the maximum sound directly into the channel leading to the tympanic membrane or ear drum. The development of the microphone, and, later still, the thermionic valve, has made it possible to achieve the same object without the use of a sound collecting device which did not fail to attract attention. It is strange, but in the opinion of the writer, the majority of persons suffering from deafness do not like to advertise the fact. This may be due to the play made on deafness by certain types of humorists or comedians, who, for some unknown reason, very rarely use poor eyesight to raise a laugh. This desire, therefore, on the part of the deaf person not to draw attention to his or her disability is a factor which must be given every consideration by the designers of hearing aids. Modern equipment is certainly progressing in the right direction, though there is still a great deal to be done with respect to better facilities for the provision of suitable hearing aids satisfying individual characteristics and bringing the cost of such equipment well within the reach of the masses. It is now possible—at least in more normal times—to purchase minute reproducers which fit into the ear, and which, when compared with the earlier type of headphone, are practically invisible. Through the introduction of midget components, batteries and valves, and the increase in efficiency of microphones, the dimensions of the amplifier, etc., are reduced considerably, but, even so, there is still room for improvement, and the ideal aid to hearing should be such that it can be carried on the person, leaving both hands completely free, with the minimum indication of its presence.

Micro-telephone Systems

The era of the ear trumpet came to an end, as regards popularity and efficiency, with the introduction of a simple sensitive microphone, which could be used in conjunction with a low-voltage dry battery and a suitable earphone. The various forms of apparatus coming within this class of hearing aids can be best classified under the heading of micro-telephones, to differentiate them from the more modern versions using thermionic valves.

The microphones used with these aids may be of different shape and size, but the majority are of the same fundamental design, commonly known as solid-back carbon microphones. Their output is high, but the quality of reproduction cannot be called good compared with more modern types. It is usually used in series with a small battery and a single earpiece, as shown in theoretical form in Fig. 1, in which M represents the microphone, B the battery, and R the reproducer or earphone. A cross-section of M (of the solid-back type) is given in Fig. 2, and this shows the fundamental assembly, of which, of course, there are many designs. The carbon back or cavity is indicated by A, and this is insulated from the carbon diaphragm C by felt or other suitable washers E. The area between C and A is practically filled with small carbon "shot," or balls, as shown by B. Over C is fixed a protecting cover or grille D. When sound waves strike the diaphragm, it vibrates in sympathy with the sound, and thus the electrical resistance between A and C varies, due to the variation in pressure or movement of the carbon "shot." Although this form of "mike" is quite sensitive to sounds, it is usually necessary for the distance between the person speaking and it to be fairly short for clear reproduction of speech. A certain amount of carbon hiss is present, and unwanted background noise can rise to objectional levels, depending, of course, on prevailing conditions. Some of the micro-telephone aids use two and even three microphones, but the majority use one which is generally designed to fix to the lapel of a coat or garment. The "mike" can be housed in the battery case, or the three items, namely, the battery, the earphone and the microphone, can be separate, the necessary circuit being completed by thin silk-covered twin flexible wire.

Transverse Current

Another form of carbon microphone which was very popular when the valve amplifiers were first introduced is that known as a transverse current instrument. This

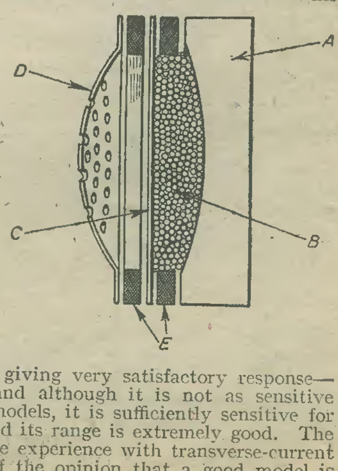


Fig. 2.—Fundamental construction of a solid back carbon "mike."

type is capable of giving very satisfactory response—if well designed—and although it is not as sensitive as the solid-back models, it is sufficiently sensitive for all general work and its range is extremely good. The writer has had wide experience with transverse-current "mikes," and is of the opinion that a good model is far better than a cheap version of, say, a crystal or a moving-coil instrument. Its cost is very much less; it can be quite small and of insignificant weight, and, generally speaking, it is more robust. This does not mean that the other types mentioned above are not good or worthy of their extra cost: they are, and they are capable of giving better response, but owing to their lower sensitivity it is usually necessary to employ an additional stage of L.F. amplification, thus making the amplifying unit a shade larger and slightly more complicated.

The transverse current microphone has a mica diaphragm and consists, as indicated by the cross-section, Fig. 3, of two carbon rods set in a container of insulating material, the space between them being filled with very fine carbon granules. The energising voltage is applied to the rods in series with the primary of a suitable transformer, and by virtue of the movement of the diaphragm and the granules the electrical resistance of the circuit varies in accordance with the sound waves impinging on the diaphragm.

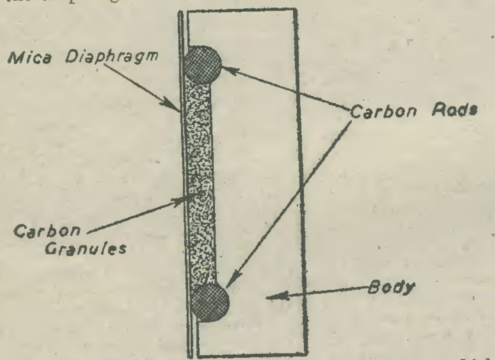


Fig. 3.—Transverse current type of microphone which gives better quality than that in Fig. 2.

A lapel type of microphone of this kind need be no larger than, say, $1\frac{1}{8}$in. in diameter by $\frac{3}{8}$in. thick, which means that it can be far from conspicuous.

Crystal microphones can be divided into two classes, namely, the diaphragm and the cell types. The former is the less costly but the more sensitive of the two, whereas the latter (cell type) is better from the point of view of reproduction. No energising current or transformer is required with crystal microphones, therefore, these space- and weight-saving considerations, plus their good quality output, have made them very suitable for use with hearing aid equipment of the valve type.

Amplifiers

It is highly probable that no two deaf persons will require the same intensity of sound for intelligible hearing; similarly, the sound reaching the microphone will vary widely according to the speaker, prevailing conditions and the pitch of the voice. It is, therefore, practically impossible to say what amount of amplification will be required for any one case. *unless* proper tests are carried out by a qualified person. This was stressed in the first article of this series, as it is of vital importance to know if one *may use* a hearing aid, etc.

The micro-telephone systems appear to be perfectly satisfactory in a high percentage of cases where the deafness is not acute. Where a more sensitive device is required, or if a bone conductor reproducer has to be used, then it becomes necessary to amplify the electrical equivalent of the sound picked up by the microphone.

At the present, it is not easy to secure all the necessary midget parts to make a unit as compact as one would wish, but the amplifier described has been kept well within reasonable dimensions. When designing the apparatus, the writer was faced with the alternatives of (a) having one container to house microphone, batteries and amplifier; (b) having battery and amplifier in one case and microphone separate, or (c) having individual cases for batteries and amplifier and microphone free. Each of these possible arrangements offer desirable features, and the problem of which to select can only satisfactorily be solved by knowing or deciding under what conditions the equipment will mostly be used. The final shape the apparatus takes must, therefore, rest with the user, and it is suggested that (a) is the most handy form for use in the home, etc., when one is sitting down; (b) is to be recommended for ladies, as the battery and amplifier case can take the form of a neat case which can hang from the shoulder; where complete freedom of movement is required (c) is the ideal arrangement especially for men, as the separate cases for the batteries and amplifier can be small enough to be carried in hip pockets.

H.T. and L.T. consumption is a matter of prime importance. To keep the size and weight of the apparatus down small batteries have to be used, and, naturally, it is not possible for them to have the same capacity as their standard counterparts. The question of cost of replacements must also be considered, and, during these days, the possibility of getting suitable batteries when required. The 1.4-volt valves used in the popular all-dry battery type of receivers offer some useful advantages during the shortage or absence of the true midget types.

(To be continued.)

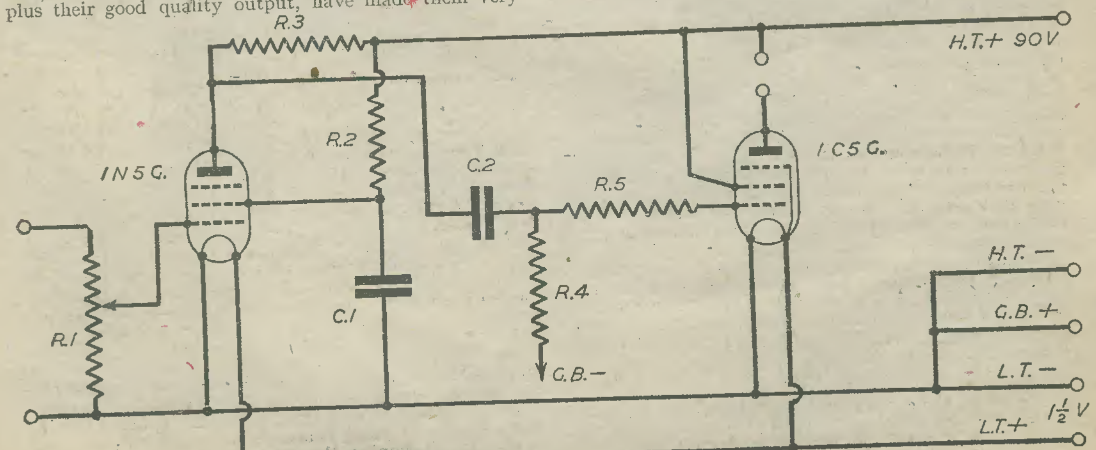


Fig. 4.—The basic circuit of a two-valve amplifier using 1.4 volt valves.

ON YOUR WAVELENGTH

By THERMION

A Lay Opinion

I WAS interested to read in a statistical paper the following opinion: "There are those who hold that television broadcasting will soon kill the aural brand, just as the talkies killed the silent films, and there are others who deny this on the ground that non-visual broadcasting can be listened to with half the attention, and will therefore always have a larger clientele than a variety that requires the complete attention of eye and ear."

This is not a very profound opinion for a paper which professes to teach economics. It is suggesting that aural broadcasting does not capture our whole attention, and that we like to do other things with a background of wireless noise in which we are not vitally interested as long as it is a noise. Perhaps that is why we have so much crooning and jazz, for it would naturally appeal to a large section of the generation which has sprung up in the last 10 years, and which is interested in nothing but "having a good time," "swigging cocktails," and relying upon social security to see them from the cradle to the grave at the expense of the few hard workers who may survive the present crippling system of taxing earned incomes.

It is my firm view that the responsibility for the disinterestedness in careers of modern youth belongs to the B.B.C. Children not out of their teens join political organisations, and want to reform the world before they have earned their right to live in it, or their right to the vote. They prefer to rely upon some powerful trade union, some half-baked political organisation, run by the guttersnipes and the have-nots, than to depend upon their own ability. That would require personal effort. Jazz lures them into a sense of false security.

However, here is a further quotation from this didactic paper on the staff of which is Miss B. Ward, who occasionally broadcasts: "Clearly television [*Is this intended as an unconscious joke? — Thermion.*] will have an enormous effect on techniques of presentation, and possibly on the social influence of radio."

This is another way of saying that television will have an influence on the influence of radio, or perhaps it is a piece of subtle hyperbole.

"But for the present the chief point to be noticed is that the influence of television will work in the same direction as the technical factors already mentioned—crowding of the ether, etc., that is, away from the large radius medium-wave station, and towards a much larger number of stations with a much smaller radius. If there is a case for frequency modulation on aural grounds, it is much stronger when television is added."

This is just a lot of words, a quagmire of tangled verbiage concatenated by confused thinking.

The Cambridge Wireless Society

I HAVE received one or two letters on university notepaper from those who claim to be members of the above society. Knowing that many of those who attend universities waste most of their time in thinking up leg-pulls, I always acknowledge such letters. Two recently acknowledged I observed were written in the same handwriting with an address at Christ College, Cambridge. The replies, as I expected, came back "not known." However, by this time I have no doubt that the two individuals concerned have had a somewhat painful interview with their tutors on the subject of waste time and misuse of College notepaper.

Frequency Allocation

THERE was a most interesting discussion at a recent meeting of the Radio Section of the Institution of Electrical Engineers on the subject of frequency allocation for long-distance communication channels (over 1,000 miles).

The discussion was opened by Mr. R. L. Smith-Rose, D.Sc., who stated that his remarks were confined to the radio-frequency embracing the 10 to 300 kc/s, and the 3 to 30 mc/s bands. While at specially favourable times or seasons, signals outside these bands are sometimes received at distances of over 1,000 miles, such conditions cannot be considered as suitable for the operation of a communication service at a useful high-low factor.

In particular the intermediate region from 300 to 3,000 kc/s is uneconomic for ranges exceeding 3,000 miles, since the attenuation of the ground wave and the absorption of the ionospheric waves preclude reliable communications over such distances.]

The justification for selecting the above frequency band is based upon the present state of our knowledge of the propagation of radio waves round the surface of the earth and through the ionosphere.

At the low-frequency end of the first band (10–300 kc/s), the experience gained in the operation of a station, such as Rugby, on a frequency of 16 kc/s, has shown that only by using a low frequency of this order can a virtually continuous telegraphic service, necessarily of a broadcast nature, be maintained with ships and other receiving stations in all parts of the world. Thus there is justification for continuing the use of the band 10 to 100 kc/s for those fixed stations erected for the purpose of maintaining communication in various directions at ranges from 1,000 miles upwards. The upper end of this band and continuing up to about 300 kc/s is usefully confined to those services operating entirely oversea, as from coastal stations to ships and aircraft, since in this way maximum use can be made of the reliable ground-wave range. While at least one radio-telephone service has been operated successfully on a carrier frequency near 60 kc/s, it is perhaps relevant to inquire whether the frequency band required for such a service could not be more usefully and economically employed for telegraphic purposes.

It is by no means so simple to suggest allocations in the frequency band 3 to 30 mc/s, but note should be taken of the conditions imposed by the ionosphere on the possibility or otherwise of maintaining virtually continuous communication conditions over the assigned path. The results obtained from studies of the reflection of waves from the ionosphere should assist in planning the allocation of frequencies for communication purposes. The highest frequency at which radio waves are reflected from the ionosphere over a particular path varies in a ratio of between two and three to one from day to night in the winter, and in a somewhat smaller ratio in the summer. The change in frequency from maximum to minimum of the sunspot cycle, some five to six years, is also about two to one, all other conditions remaining the same.

Apart from the fact that waves in this high-frequency

Our Roll of Merit

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D. Richards (W.O., R.A.F.).
G. Blatherwick (Pte., R.E.M.E.).
J. Ingram (L.A.C., R.A.F.).
S. Willmott (Sigmn., Royal Signals).
A. N. Hope (S/Lt., R.N.Z.N.V.R.).

band are transmitted efficiently through the ionosphere, the wavelengths involved (10 to 100 metres) are suitable for the use of highly-directive antenna array systems, which both reduce the signal interference conditions and improve the overall efficiency of the communication circuits.

For a given distance, geographical location and time of transmission, there is a maximum frequency above which it is, in general, not possible to sustain communication, however much power is available at the sending end. As the frequency is reduced below this maximum usable frequency, the absorption of waves by the ionised regions increases steadily so that, for a given transmitter power and receiver sensitivity, there is a lower limit to the frequency with which communication conditions can be maintained. Thus for any given projected circuit and terminal equipment, there is a band of frequencies, between the maximum usable and the lowest useful, which can be utilised. The upper limit is independent of transmitter power and receiver sensitivity conditions, while the lower limit depends upon both these quantities. It therefore seems logical to divide each of the given bands of available frequencies into two portions; the upper frequencies should be allocated to the circuits which require low power, omni- or partially-directional transmissions such as for fixed to mobile or mobile to mobile working; while the fixed point-to-point circuits, which have ample power available and can take full advantage of directional beam transmissions, can be accommodated in the lower-frequency portions of each band. The various conditions will, of course, have to take account of the changes brought about by time and season, and also, and by no means least important, of the value of the atmospheric noise level at the receiving end of the circuit.

One more general condition may be stipulated at the outset of any frequency-allocation scheme. In view of the great congestion in the high frequencies for all kinds of communication, it might be laid down that only in very exceptional circumstances, such as during a war, should any short-distance circuit use a frequency within the band of those specified for long-distance working. In conclusion, it is suggested that use should be made of our present scientific knowledge of radio-wave propagation as part of the foundation on which to base a revised scheme of frequency allocation for long-distance communication. This knowledge should be supplemented by the experience of those who are responsible for the practical design and operation of radio-communication circuits of the type under consideration.

British Short-wave League

MR. A. JOTCHAM, 119, Exeter Road, Dawlish, Devon, asks me to say that he is anxious to get into touch with all keen amateurs in Devon and Cornwall, with a view to expanding the activities of the British Short-wave League in those counties.

Short-wave Stations

I OFTEN receive requests for a reliable list of short-wave stations. This is given in "Newnes Short-Wave Manual" which costs 6s. 6d. by post from the offices of this journal. It is quite impossible during the war to publish a list of every short-wave station, since changes are frequent and any such list would be out of date by the time it saw print.

Our Present Size

I CONTINUE to receive letters of appreciation of the journal in its present size, and of approval of the present standard of contents. All readers ask that we do not go back to the larger format of pre-war days. Let us hope the time be not far distant when we shall revert to weekly publication, ampler space, and set construction.

Components

THE component shortage is still acute, and that is why we have refrained from publishing too many constructional articles. Quite often parts are available when the set appears in print, but the ready demand soon absorbs them. Such was the case with the one-valve midget we described some months ago, the valve for which is now quite unobtainable.

A Schoolboy Wants to Know

A SCHOOLBOY, signing himself M. Bamford, of Macclesfield, Cheshire, doesn't like my views of the Brains Trust. As a schoolboy he is, I suppose, greatly impressed with the air of erudition of some of its members.

We all presume when we are schoolboys that the schoolmaster is omniscient, but we learn better when we go out into the world. Master Bamford is at the stage when he thinks his schoolmaster, no doubt, a learned pedagogue, because he can detect a split infinitive, or knows the principle of Pythagoras. I can imagine Master Bamford listening in to Joad or Campbell with a look of rapt admiration on his face, and he is surprised that I do not share that admiration. The fact is I have grown up and learned better, as even schoolboys must do one of these days.

I was not, therefore, in the least surprised to learn that Master Bamford, the schoolboy, is an ardent Bing Crosby fan. He will grow out of it. It is one of those childish complaints, like measles.

HOW TO WRITE POEMS FOR BROADCASTING

[First choose your subject. Almost anything will serve. Then select a title, which need not necessarily have any relation to your subject. In fact, a certain amount of obscurity is desirable, as a proof of highbrow culture. Then give your fancy free play in the manner so much admired by the B.B.C. The following may give you a rough idea of what seems always very popular at Broadcasting House.

"SAND WORMS AND SEA BIRDS"

Wan-faced and wistful along the pebbled strand she paced,
Where ocean broke in tumult on the shifting sands,
Raising her tear-dimmed eyes to where the sea birds soared
In burnished reality above the heavenward reaching cliffs,
Then plunging downwards in the troubled waters, rose again
With fishy prey to fill their fledglings' maws,
And thus distraught, she paced the sun-kissed strand,
The wee sea-beasties slithering sideways from her path.
There to the keeping of the ozone-laden winds
Cast she her sorrow and her anguished voiced complaints

Why hast thou left me? Art thou for ever gone,
Thou false one? How can I, but lonely, roam alone
And voice my anguish to the all-unheeding skies?
Oh, not for this my mother gave me birth
And held me safely in the hollow of maternal arm.
O woe is me! And would that pale-cheeked Death
His scythe hadst sharpened and my infant life cut short
Ere thou, O faithless one, with honeyed blandishments
Had won my maiden heart and lured me, helpless victim, to this bitter fate.
Out, out upon thee, mocker of my maiden trust and innocence.
O woe is me! Ah, waley, waley woe!

Having worked this out of your system, persuade some B.B.C. elocutionist to declaim it into the mike as a bed-time uplift solace to the listeners-in. A few of the more ignorant and uncultured of them may remark, "Aw, hell. What's this one raving about? Switch off." But be consoled, you will not hear them. You have been "On the Air," and with a little further boosting by the B.B.C. you may yet be ranked amongst the Great Immortals.

P.S.—The operative words are "may be." "TORCH."

Commercial Receiver Design—2

A Layout for a High-fidelity Receiver

THE receiver shown in the schematic diagram (Fig. 3) is an expensive receiver, not the sort of receiver everyone is likely to buy, but it is a contrast to the receiver shown in Fig. 1 (March issue). The stages in the receiver of Fig. 3 not counting the rectifier—one stage of Radio Frequency, followed by a pentagrid converter, one stage of intermediate frequency amplification, diode detector and triode low-frequency voltage amplifier combined in one valve, a second L.F. voltage amplifier, and a pair of push-pull output valves; additional stages include three valves used in automatic frequency control system, and one a lamp for producing volume expansion.

Automatic volume control, manual volume control, with bass compensation, and tone control, all incorporated.

All this builds up to a really marvellous receiver. The A.F.C. would be in a class of its own with a receiver employing press-button tuning on motor driven condensers, the A.F.C. correcting drift which would later occur with these systems of tuning. Although this receiver would not be suitable for everyone, but improving the receiver in Fig. 1, or redesigning the old receiver to suit requirements, is something to be desired.

Redesigning the Old Receiver

Taking the R.F. tuned stage first. It is something not uncommon, but it is not a common thing found in commercial receivers of medium price; the practical man can build a good receiver suitable for his needs without going to a great expense, or buying a new receiver. The receiver owned by one can certainly be renovated and brought up to modern standards, with only adding an R.F. amplifier. There are many advantages in adding this R.F. amplifier:

(a) Increase of sensitivity.
(b) Decreased noise level.
(c) Image ratio reduced.

Fig. 4 shows the circuit of an R.F. amplifier, and Fig. 5 shows it added to a receiver. The most difficult part of the operation is adding the three-gang tuning condenser in place of the old two-gang used for tuning the frequency charger grid circuit and oscillator circuit. The valve used must be the suitable heater current and voltage to match the filament circuit of the receiver.

The coils will be dependent on the receiver's coil ranges, C, in the A.V.C. line, may not be required, as this will probably be included in the receiver's circuit.

The switching for the wave bands may be a rather complicated job, but this can be overcome by replacing the switching or if there are spare contacts on the present switching arrangements use them for the R.F. amplifier coil switching.

The bias of the R.F. valve with C, R, will depend on the circuit arrangement. This receiver in Fig. 5, the bias arrangement is dependent on R2 and R3, thereby making the chassis positive to a few volts with respect to earth, therefore R and C are not employed in the circuit.

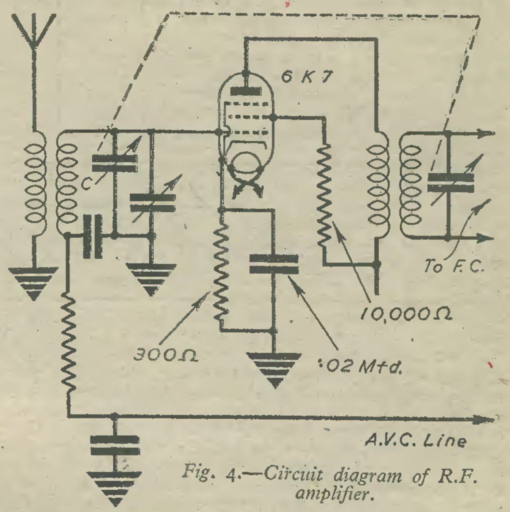


Fig. 4.—Circuit diagram of R.F. amplifier.

Automatic Frequency Control

Difficulty of accurately tuning a receiver having A.V.C. as well as troubles caused by drifts in frequency of the local oscillator when receiving short wave signals, are eliminated by a circuit arrangement that will automatically change the local oscillator frequency slightly so as to produce an I.F. frequency of exactly the proper value, provided the tuning is approximately correct. An A.F.C. circuit is shown in Fig. 6. In this circuit the A.V.C. and A.F.C. system are operated from a separate I.F. amplifier valve with a local impedance consisting of a tuned primary circuit coupled to a tuned secondary

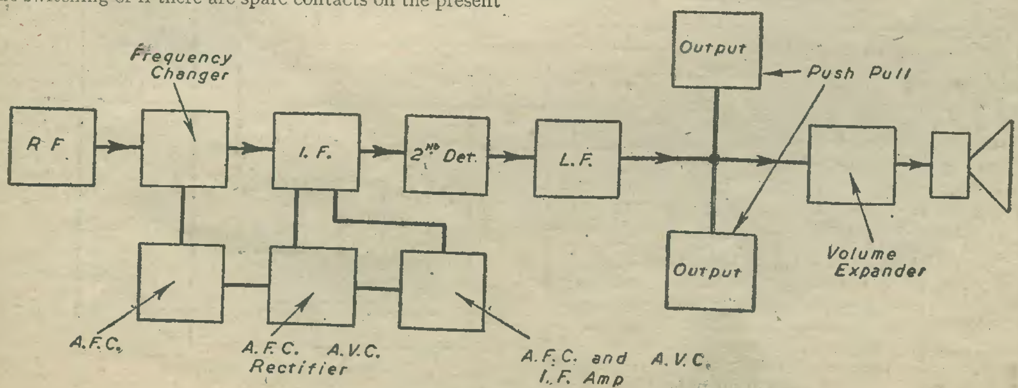


Fig. 3.—Schematic diagram for a high-fidelity receiver.

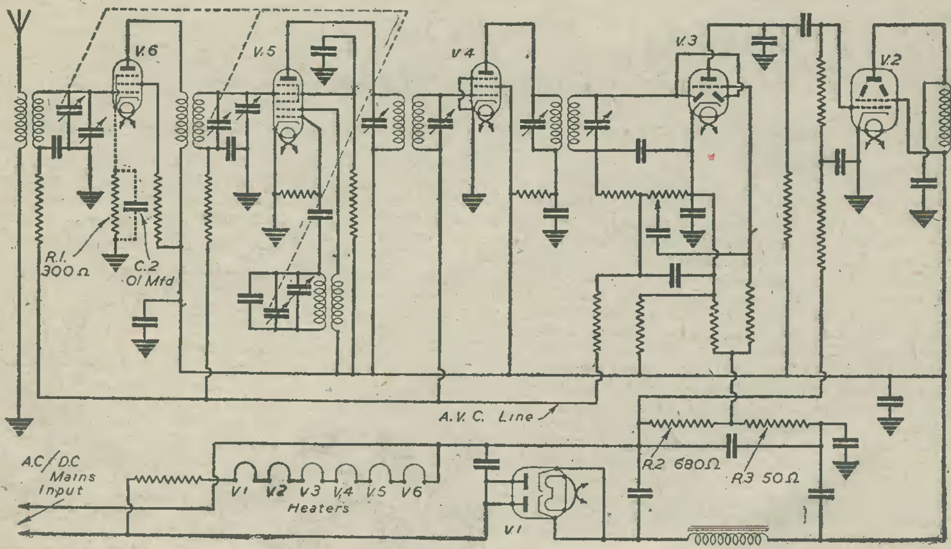


Fig. 5.—General circuit of commercial superhet receiver.

circuit. These are connected to a double diode valve (6H6), thereby the voltage applied to one diode is the vector sum of a component obtained from the primary circuit and obtained from the secondary circuit, and the voltage applied to the second diode is the vector difference of these two components. Two bias voltages are obtained with this arrangement of diodes, one proportional, the bias developed by one of the diodes and used for A.V.C., the other bias voltage is equal to the difference between the rectified voltages developed by these two diodes, and is used to control the oscillator frequency.

The circuit takes advantages of the fact that voltage component produced by the secondary circuit is in quadrature with the voltage component from the primary circuit, the frequency of the signal is exactly

(*Continued on page* 218)

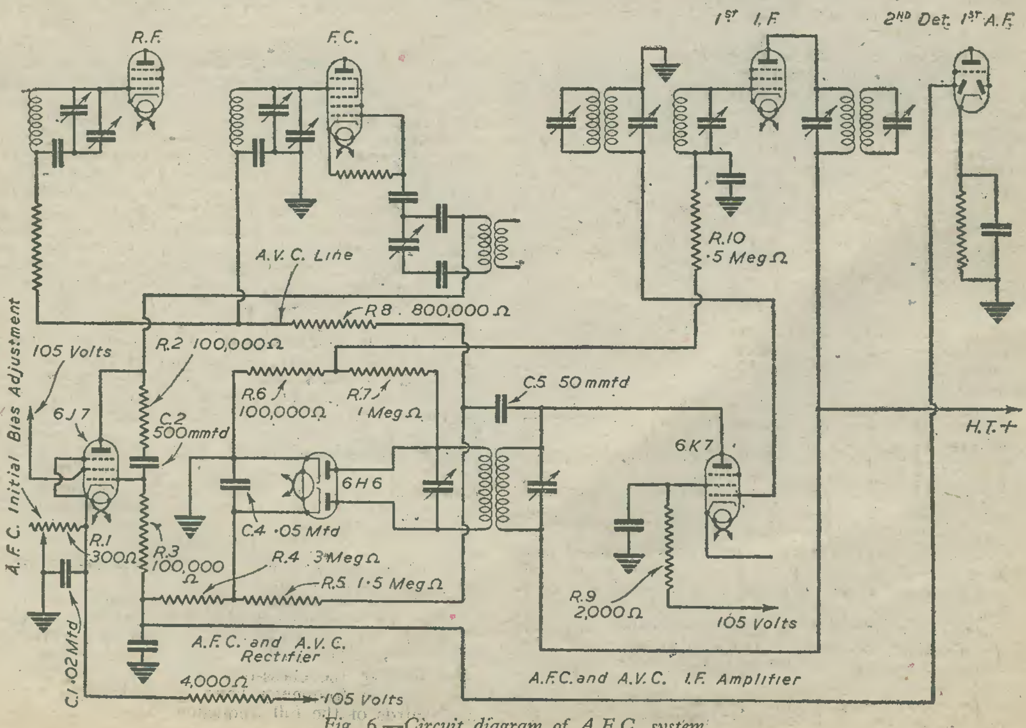


Fig. 6.—Circuit diagram of A.F.C. system.

Television Practice—4

Interlaced Scanning, Power Ripple, Frequency Bands and Typical Television Systems

Definition

DISTANCE leads enchantment to the view. This is particularly true in the case of the cinema and television. A seat close to the screen of either of these forms of entertainment reveals the grain and texture of the projected image and gives rise to what is known as poor definition. If a photograph is enlarged indefinitely a point is reached where clear cut features and definition of the more subtle shades becomes impossible, for graduations in the shading taking place in an area that is less in size than the grain formation of the emulsion is not reproduced. Similarly, the size of a television picture for good definition is determined by the number of scanning lines. Graduations in the light intensity of the image in the vertical direction will not be reproduced in a distance that is less than the width of any one horizontal line; therefore for good definition a large number of very narrow lines is the order of the day.

From 200 to 400 lines are required to reproduce a scene with any worth-while definition at all; any system employing 400 lines or more is considered as a really good one. Pre-war television employed a 405-line interlaced (see later) scanning, and under the correct viewing conditions gave a reproduction equal to a standard home cinematograph.

The best position for viewing a television image can be shown to be that at which the distance from centre to centre of two adjacent lines subtends an angle of about 1/30th degree, or 2 minutes of arc, at the eye. At this distance no line structure is seen and a uniform picture results. Any closer viewing brings into sight the line structure, while observation from farther away reduces the detail that can be perceived to something less than that actually present in the picture.

Power Ripple and Interlaced Scanning

In order to convey the impression of motion the television screen must be scanned a certain number of times every second. If the presentation of successive frames, i.e., the repetition of the image, is not sufficiently high, pronounced flicker will result, this trouble being noticeable even when the framing rate is sufficient to give the impression of movement.

The cinema projects approximately 24 frames per second on to the screen. By itself, considered as a simple series of presentations, even this rate is not sufficiently high to avoid flickering, and a shutter system is utilised not only to cut off the light between frames but to black-out the middle period of each frame itself. Thus there are two separate light projections for each frame, giving an effect equivalent to 48 frames per second. In this way flicker avoided through the repetition rate of 48 frames is considerably in excess of that required to create motion.

With television a repetition frequency of about 48 frames per second is also required to give flicker-free results, though not only is a comparatively high rate essential from the point of view of flicker elimination, but consideration of the stray fields set up by the power circuits of the receiver and associated lines brings up the question of frame ripple and the "pulling" effects between time base and power networks. This particular trouble is apt to appear if the frame frequency is not an exact sub-multiple of the mains frequently, and takes the form of disturbing ripples upon the reproduced image. By employing a frame frequency of, say, 25 on receivers designed for 50 cycle mains, this ripple, though not eliminated, at least is made stationary with respect to the picture and so has not such a disturbing effect.

Between 25 and 50 there are no sub-multiples of 50 and so on the usual 50 cycle power systems a picture frequency of at least 50 frames per second must be employed if flicker and mains ripple are to be avoided. This is a very high repetition rate and is not desirable since it calls for an extremely wide frequency band during transmission (see later). In order to overcome this difficulty and yet still retain the advantages of 50 frames per second with regard to flickerless results, a system of *interlaced* scanning is employed. In this technique the picture is scanned 50 times per second, but only *alternate* lines are traced per scanning period. Thus with a 400 line system, even-numbered lines would be scanned during the first 1/50th second, and odd-numbered lines during the second 1/50th second. As with the cinema, flicker rate is therefore reckoned on the basis of 50 frames per second, twice the actual number of actually completed frames presented per second, while from the point of view of frequency band width, the band required is only that necessary for a 25 frames per second transmission. Interlaced scanning is apt, however, to suffer from a peculiar kind of distortion not present with simple systems, for when portraying very rapid motion, slight changes occur in the picture even between the period of the "half" frames, thus giving a slight "zig-zag" appearance to ordinarily vertical lines. The effect is not serious for normal motions of the picture and does not outweigh the advantages that interlacing gives in the flicker problem.

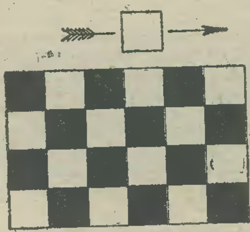


Fig. 17.—This sort of pattern demands the widest sideband frequencies when televised. From it may be deduced the formula giving the bandwidth required for any system.

Frequency Bands

A recent article covered the theory of carrier and sideband radiations. Television signals representing the equivalent of the picture being transmitted, are radiated in the customary manner by modulating a carrier wave with the video-frequencies, but the essential difference between picture transmission and ordinary sound transmission is that in order to send an image with a great amount of detail a very much wider band of frequencies is required than that necessary for the transmission of good quality sound. The greatest trouble arises when the image consists of a chess-board pattern with sudden changes from black to white, the width of the scanning line corresponding to the height of the squares (Fig. 17). As the scanning spot moves across such a pattern there are abrupt changes in the output current of the television camera which vary between a minimum and a maximum, *one cycle* of this current representing the scanning of *two* squares. From the figure we see that if the number of lines in the picture is L and the ratio of width to height, which is known as the aspect ratio of the picture, is R, then the total number of squares is given by

$$N = L^2R$$

so that for a repetition of n pictures per second the frequency band required will be

$$f = \tfrac{1}{2}L^2nR \text{ cycles per second.}$$

Working to this expression it is generally found that more detail is obtained in the horizontal direction than in the vertical, particularly in scenes where violent changes like the chess-board are not experienced. By making the frequency band approximately equal to two-thirds of the full frequency band, it is found that detail in both directions is made practically the same. Therefore the actual frequency band required for an aspect ratio of R

$$= 0.67 \cdot \tfrac{1}{2}L^2nR$$
$$= 0.34L^2nR \text{ cycles per second.}$$

Taking the case of a picture whose ratio of width to height is 5/4, with a definition of 400 lines at 25 frames per second, we get

$$\text{Frequency band required} = 0.34 \times 400^2 \times 25 \times \frac{5}{4} \text{ cycles.}$$
$$= 1{,}700{,}000 \text{ cycles per sec.}$$

which is considerable. Adding on 15 per cent. for the synchronising pulses, this figure begins to approach 2,000,000 cycles, giving, when used to modulate a carrier wave, a total sideband width of something not far short of 4,000,000 cycles. This immense coverage rules out completely any possibility of transmitting high definition television programmes on the medium wavelengths, or even on the "higher" short wavelengths for that matter.

The carrier frequency itself must be very high in order that the sideband width does not become a large percentage of it; the tuned circuits of the transmitter will then handle the modulated carrier without serious cutting of the outer sidebands. Pre-war television transmitted on a frequency of roughly 55 megacycles per second, which was quite a large percentage of the approximately 4 megacycles per second sideband frequency. On the ultra-short wavelengths there is a tremendous frequency band available, **thus making** them ideal for television transmission.

Transmitter and Receiver Systems

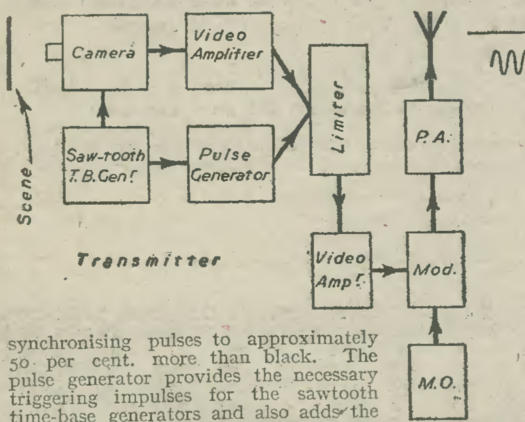
A typical television transmitter system is shown on the left-hand side of Fig. 18. The image is scanned by the television camera which produces a series of varying currents representing the changes in light intensity detected along each scanning line. These currents are fed to a video-frequency amplifier, so named to distinguish it from an audio- or radio-frequency amplifier, and the output of this passes on to a limiter and a pulse generating device. The limiter is designed to prevent the overloading of succeeding stages and limits the peak amplitude of the combined signal and synchronising pulses to approximately 50 per cent. more than black. The pulse generator provides the necessary triggering impulses for the sawtooth time-base generators and also adds the synchronising pulses to the signal currents emerging from the first video-amplifier. After the limiter stage further amplification takes place and the currents are then used to modulate the carrier wave generated by the master oscillators. A radio-frequency power amplifier passes the modulated carrier on to the aerial arrays and radiation takes place in the customary manner.

The whole system is quite conventional except for the scanning camera and its immediately associated circuits. The video-amplifiers call for careful design since they have to handle a very wide band of frequencies, and it is essential that their response should be substantially uniform throughout this range. The prevention of phase distortion, i.e. differences in the time taken for different frequencies to pass through the wiring of the amplifier, is particularly important, for if this occurs to any great extent certain frequencies representing certain components of the picture will be transmitted either too early or too late and correspondingly distort the reproduced image at the receiver. It will, of course, be appreciated that the above considerations must be borne in mind by the designer of video-amplifiers to be used in television receivers themselves. It is proposed to cover the theory and design of video-amplifiers in a later series of articles, since the whole aspect of the subject obviously cannot be dealt with here.

The right-hand side of Fig. 18 shows a typical receiver layout. The signals from the transmitter are picked up by the aerial system and passed through a series of radio-frequency stages, these stages being heavily damped in order to handle the requisite frequency band. Their output is mixed with the output of a local oscillator by conventional means and the intermediate frequency resulting is then amplified by a series of I.F. stages. The intermediate frequency is generally a high one, in the order of 8-10 mc/s, and the I.F. stages are usually stagger-tuned, i.e., each alternate stage is tuned a megacycle or so above and below the actual I.F. in order to obtain the necessary response over the wide range being handled. Detection then follows in the usual way, the resulting current passing on to a video-amplifier and the separating networks. The video-amplifier provides the amplification necessary for suitably controlling the intensity of the light spot on the screen of the cathode-ray tube, its output being applied to the tube's grid. The synchronising pulses present upon this current correspond, as we have seen, to the polarity of black and therefore cut the cathode beam to zero during the return periods of the scanning sequence.

The separating network is so arranged that only the large amplitude synchronising pulses are allowed to pass; this process was described in the previous article. The line and frame pulses, free of signal, then pass to a network which separates them by discriminating between their frequency and duration, and they then pass to their respective time-base generators where they act as triggering impulses to fire off the spot along each individual line and each individual frame.

(To be continued)



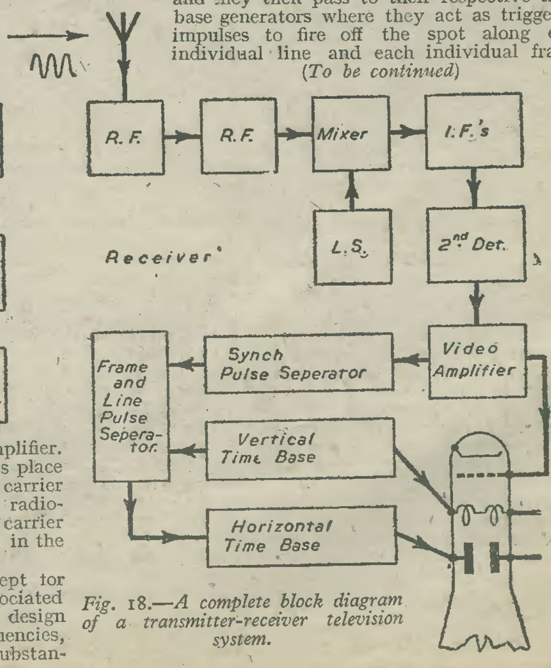


Fig. 18.—A complete block diagram of a transmitter-receiver television system.

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My fingers are frozen, bedad ! "
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We're soldering—not ski-ing, m'lad ! "

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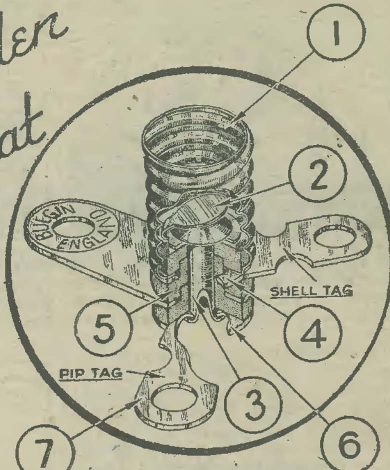

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1—Threaded shell with dimensions and details to B.S.98-10mm " MES " ; silver-plated finish.

2—Central " pip "-contact of spring phosphor-bronze to ensure good contact ; silver-plated.

3—Central rivet of solid steel ensuring permanently tight and positioned assembly.

4—Locking teeth on " shell "-contact solder-tag, ensuring contact and preventing unintended rotation.

5—Stepped insulant washers preventing short-circuit and permitting comparatively high-voltage working conditions.

6—Toothed solder-tag locks to rivet-turnover, fixing position and ensuring contact to " pip "-contact.

7—Dual-purpose soldering tags coated pure tin and accepting " threaded " or " wound " wiring ; fixing bracket, normally " dead," may contact with shell and replace the " shell-tag."

140 Types in Production

BULGIN

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BYE-PASS ROAD, BARKING, ESSEX.

RIPPLEWAY 3474 (5 lines)

(The Name "BULGIN" is a registered Trade Mark)

(See our Classified Advertisement on page 220).

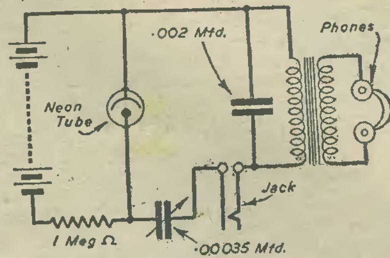
Practical Hints

Simple Oscillator Circuit

IN the June 1944 issue of "P. W." a description of a small oscillator was published, and I thought that the accompanying circuit of this unit which I have constructed might be of some use to any reader who requires a simpler set. All the components are of well-known make, with the exception of the neon tube, which was obtained from a disused electric oven.

COMPONENTS REQUIRED

Phones (S. G. Brown).
Morse key (Premier Radio Co.).
L.F. transformer 3 : 1 (Ferranti)
.002 tubular, .00035 variable condensers (Telsen).



Jack, and plug, and 1 meg. resistance (Cossor).
Ever Ready 45 volt H.T. battery.
Midget Radio chassis (6in. × 4in. × 2in.).
Neon tube (from disused oven or iron).

In use the oscillator is placed near the receiving set, and for code practice a key is connected to the jack.—T. B. NUTTALL (Astley).

Simple Test Board

THE accompanying diagrams show a simple test board which will enable tests to be carried out with any 7-pin valve whilst under working conditions. It successfully overcomes the inconvenience of shorting links and unsoldering wires, which are both cumbersome and dangerous.

A 7-pin valveholder and 15 sockets are mounted on the lid of a cigar box as shown in Fig. 1. Seven of these sockets are cut down until they are level with the top of the fixing nut, and are equipped with stout soldering tags. These sockets are the ones connected to the top cap lead, and sockets 1, 2, 3, 5, 6, 7 of the valve holder. The second set of sockets are equipped with long springy strips insulated at the tip by means of a piece of rubber tubing. When adjusted the insulated portion of the spring should be immediately above the corresponding socket in the first row, and the bare portion should maintain a firm contact with the soldering tag.

Connections may now be completed as in Fig. 2, care being taken that the second set of sockets are connected to the corresponding pins of the adaptor. It will be noticed that pin 4 is provided with only one socket, as it is one of the heater connections. Current readings need not be taken, as the lead to pin 5 is "split." If the contacts do not open when a plug is inserted the spring should be bent, and the soldering tag adjusted for the best position. For current readings the socket nearest the valve holder will generally be found to be negative, while for voltage readings either socket may be used. If desired, a 4-5 pin unit could be constructed.
D. TUDDENHAM (Longtown).

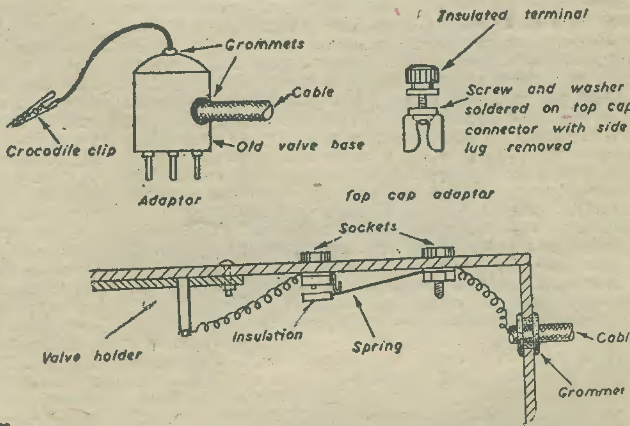


Fig. 2.—Socket connections and details of adaptors.

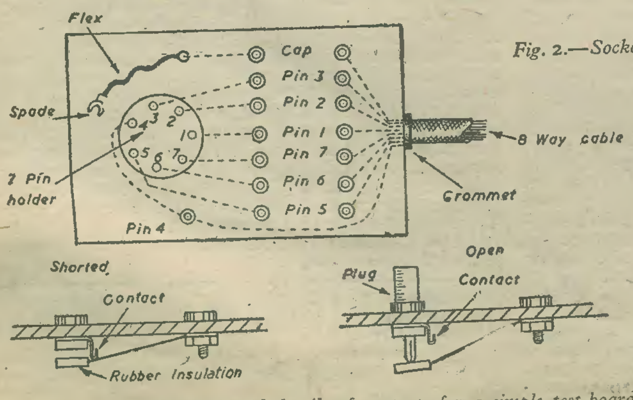


Fig. 1.—Plan of panel, and details of contacts for a simple test-board.

Gramophone Working

THE majority of listeners who use the gramophone section regularly will appreciate that a light so directed that it illuminates the edge of the turntable is a valuable accessory, as it ensures that the needle is correctly placed and also avoids damage to the record. Special small turntable illuminating lamps are available, but an economy may be effected by arranging that these are switched off when the gramophone lid is closed down. On most lids a self-supporting or similar stay is fitted, and usually two contacts may be mounted on this in such a manner that when the lid is lifted the light is in circuit and when the lid is lowered it is open-circuited.—R. J. OTTLEY (Leeds).

Interference Suppression After the War

MR. P. R. COURSEY, B.Sc., at an I.E.E. Meeting (Radio Section) said that the manner in which "interference," arising from irregular fluctuations of electric current, sparking contacts and the like in various electrical devices, can upset radio broadcast reception is too well known to need elaboration. How such sources of interference can also disturb radio apparatus other than that used for broadcast reception is not so widely recognised. It is not yet clear how far post-war suppression interference problems will differ from the post-war problems; but certain aspects of the general problem may usefully be discussed now so as to facilitate the handling of any future problem which may arise. Compared with pre-war conditions the main changes to be expected after the war concern the frequency range over which interference suppression is likely to be required; the types of apparatus that are likely to be in use as potential interference-generators; and the winder use of domestic electric equipment of generally well-known types.

For interference-suppression purposes the pre-war frequency range extended up to 1,500 kc/s so that only the broadcast sound frequency band was effectively covered. Such use as there was of television did not cover a wide enough area, nor were the users sufficiently numerous for their troubles to attract general attention. They were, therefore, forced to tolerate a certain amount of interference, varying according to the neighbourhood against which they had no remedy. Methods by which interference could be largely suppressed have been set out in a series of six British Standard Specifications, which were drawn up after much painstaking work by committees of technical representatives of the manufacturers and other interested bodies.

For post-war use it appears desirable to modify and improve these specifications in order to satisfy changed requirements. First, it will be necessary to extend the frequency range upward, a maximum in the region of 600 mc/s being at present envisaged. This increase in frequency range is required not only to cover the normal television transmissions and short-wave radio reception, but also to protect some of the newer radio and radar applications likely to be used as aids to navigation in civil aviation and on ships.

There is likely to be a considerable extension in the use of high-frequency equipment in many industrial electronic applications, apart altogether from a much wider use of electro-medical equipment, much of which is a source of interference. At present such apparatus, which frequently uses a high power and is troublesome in this respect, is prevented from doing any serious harm by the regulations requiring its complete screening, but other alternatives must be explored for the future.

Radiation from superheterodyne receivers can extend over a wide area, and it will almost certainly be essential for set manufacturers and designers to pay close attention to such potential source of trouble.

One aspect of interference suppression, which affected radio manufacturers only slightly in pre-war days, may become very important in the future, namely, the measures taken in other countries to suppress interference. It would seem that a high degree of uniformity is very desirable, not only to assist the manufacturer of apparatus for export, but also to protect the listener who may purchase imported radio receivers or other electrical apparatus.

In the discussion that followed there was almost unanimous agreement on the necessity for some kind of legal machinery for curbing electrical interference with radio reception, though there was some diversity of view as to the rigidity of the legal control that should be imposed. None of the speakers laid any great emphasis on the desirability of precise specification of legally permissible limits of interference, but many stressed the difficulties in the way of preparing such specifications. Suggestions for appropriate legal measures ranged from a plea for "enabling" legislation, which would permit a properly constituted authority to issue regulations, to a proposal that radio interference should be treated as a "nuisance" in common law. In support of the latter contention, it was pointed out that in legal actions to abate nuisances from acoustic noise there is no obligation to specify precisely the levels of the noise.

Doubts were expressed as to the extent to which a law on a rigid quantitative basis could be enforced, and there was also the problem of ensuring proper maintenance of interference-producing devices. Much could be done by the education both of those responsible for interfering apparatus and the users of radio receivers. Co-operation between the various interests concerned on both sides was considered to be vitally important.

The use of broadcast receiving aerials of greater effectiveness than those commonly installed was urged, as was the use of screened down-leads. The directional properties of aerials might be more generally employed in improving signal/noise ratio in UHF reception.

Though it was generally believed that interference would increase after the war unless effective steps were taken to check it, the general opinion was that the trouble was not likely to be particularly serious at ultra-high frequencies. The physical size of the majority of interfering devices is such that most of the radiation is below 10 mc/s. It was pointed out, however, that the radiation from ignition systems of motor vehicles covered a very wide frequency range. This was at present the most serious form of interference with UHF communication services, which often worked with low field strengths, and would need protection for frequencies at least up to 300 mc/s. It was stated that capacitors with properties suitable for interference suppression at frequencies above 50 mc/s would probably soon become generally available; existing designs were inadequate for this specialised purpose.

Some speakers thought that the newly developed technique of radio-frequency heating for industrial purposes would prove a serious source of interference in one case, interference from an eddy-current heater had been experienced at a distance of ½ mile from the source. Though it was agreed that the problem of suppressing radiation from equipment that might ultimately attain powers of the order of 1,000 kW and operate at frequencies up to 200 mc/s was a formidable one, the view was expressed that a solution would be found by adopting a combination of known methods. These would include screening, which was quite practicable for small or medium powered equipment, and also a limited allocation of exclusive frequency bands. Pleas were made for the exercise of reasonableness in approaching the problem, and to take local circumstances into account in estimating permissible radiated field strength. For example, there was no point in restricting radiation severely in circumstances where radiation at the particular frequency concerned could do no harm. Manufacturers of radio heating equipment should formulate their own code. A possible development of the future was for factories employing strongly interfering apparatus of any type to be built as screens.

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

THIS month brings the release of a very welcome addition to the H.M.V. Album series, in the form of four twelve-inch records in album of Beethoven's Concerto No. 3 in C Minor (Op. 37), played by Solomon, with cadenza by Clara Schumann—*DB*61969.

The work is in three movements, Allegro con brio, Largo and Allegro, and it was written during what must have been one of Beethoven's happiest years, 1800, a bare year before he experienced the first symptoms of the approaching deafness which caused him such acute distress. During 1800, however, Beethoven was enjoying well earned success; publishers were clamouring for his compositions, and, as he said in a letter to his friend Wegeler, " I have six or seven publishers for each of my works, and could have more if I chose. No more bargaining; I name my terms, and they pay."

The first movement commences with an unusually long orchestral *tutti* which announces its principal themes. The strings, wood wind and horns have some beautiful material in the first theme, which gives way to a graceful second theme by the clarinet and first violins. The soloist has a bold, flourishing entrance, and after dealing with the principal subject, has a delightful but brief dialogue with the orchestra, which leads to another melody in E flat minor, and on to the second theme.

The second movement is richly lyrical, giving the soloist some exquisite passages which, in the early part, are echoed by muted strings, who also provide a delicate pizzicato accompaniment to the pianoforte in the middle section. The Allegro is gay to the extent of irresponsible liveliness, the soloist leading the way right from the start, but the orchestra also has some brilliant work, and the movement as a whole is truly delightful, ending as it does in a joyous mood in the key of C major.

The whole performance is superb, and the soloist reveals his great understanding of Beethoven's work in a manner only surpassed by his technique.

Two more *H.M.V.* 12in. records, which need no words of mine to describe in detail, are *C*3420 and *C*3421. On these, the Boston Promenade Orchestra, conducted by Arthur Fielder, have recorded the famous " Ballet Suite," by Gluck, arr. Mottl. This is an exceptionally fine recording, and one which I feel sure will be appreciated by all. My selection of H.M.V. 10in. records is, indeed, on the short side this month, but, even so, I think it is very wonderful how we are still able to obtain fresh releases each month after nearly six years of war. If every record enthusiast made a point of returning his old unwanted records to his dealer (who will gladly pay for them), the record companies would have some of their production problems eased a little. However, to get back to the new releases, I strongly recommend *B*9401, for the very good reason that it is called " Our Greatest Successes " (No. 2) and refers to those two popular and talented singers, Anne Ziegler and Webster Booth. This medley of songs and duets introduces: " Only a Rose," " Smilin' Through," " A Little Bit of Heaven," " What Is Done Can Never Be Undone," " You Just You," " Rose Marie," " Fold Your Wings " and " Indian Love Call." Joe Loss and his Orchestra have recorded two good foxtrots, " I'm Making Believe " and " Just a Little Fond Affection " on *H.M.V. BD*5872. " Hutch " on *H.M.V. BD*1097 offers " Holiday for Strings " and " Little Star."

Columbia

THE Liverpool Philharmonic Orchestra, conducted by Dr. Malcolm Sargent, have made an outstanding recording of Rimsky-Korsakov's " Caprice Espagnol (Op. 34)." The composition consists of (1) Alboada; (2) Variations; (3) Alboada; (4) Scena and Gipsy Song, and finally, (5) Fandango asturiano, and, in the space available, it is impossible for me to attempt to deal with each section. Dr. Malcolm Sargent and the orchestra deserve great praise for their magnificent rendering. The records are *Columbia DX*1180-81 I welcome another of the Old Time Dance Series, this time No. 5, played as usual by Harry Davidson and his Orchestra, who seem to put the very atmosphere into these delightful reminders of the time when dance tunes possessed melody, charm and gaiety. This month they give us the chance to do the " Schottische " (Honeysuckle and the Bee) and the " Polka " (See Me Dance the Polka), or, if we cannot take the floor, we can at least sit back and enjoy the cheery music of Mr. Davidson and his Orchestra. The record is *Columbia DX*1179. Albert Sandler and his Palm Court Orchestra have made a happy selection for his contribution this month, on *Columbia DB*2162. They play a very pleasing selection of " Deanna Durbin Successes," and it includes " Waltzing in the Clouds," " Pale Hands I Love," " Spring in My Heart," " One Day When We Were Young," " When You're Away " and " When April Sings." Turner Layton is in fine form on *Columbia FB*3080, on which he has recorded " My Favourite Dream " and " Shine On Harvest Moon," the latter being featured in the film of the same name. Turner, apart from his pleasing style, has a nice touch on the piano, and he has that gift of knowing how just to mix these qualities.

Monte Rey sings " Give Me the Stars " and " A Kiss in the Night," with orchestra accompaniment, on *Columbia FB*3083.

Victor Silvester's Jive Band play " Coquette " and " There's Honey on the Moon To-night," both numbers being, of course, for jive dancing. These are recorded on *Columbia FB*3085.

Carroll Gibbons and the Savoy Hotel Orpheans play a good foxtrot and a slow foxtrot on *Columbia FB*3088, and I recommend it to all dancing folks. The numbers are " Just a Little Fond Affection "—vocal taken by Gwen Jones, and " The Happiest New Year of All," for which Leslie Douglas takes the " mike."

Parlophone

RICHARD TAUBER sings, in English, " Over Night " and " Secrecy," and his performance is delightful. His rich tenor voice, combined with the artistry he puts into it, has a quality few possess, and the songs he has recorded on *Parlophone RO*20536 give him ample opportunity to reveal his charms, which he does with such good effect. Here are three recommended records for dancing: *Parlophone F*2057, two foxtrots, " The Ranch has Gone " and " A Dream World is Waiting," played in style by No. 1 Balloon Centre Dance Orchestra (The Skyrockets); *Parlophone F*2056, " I'm Making Believe " and " Together," another two foxtrots, but this time played by Geraldo and his Orchestra, with Jimmy Green and Len Camber taking the vocals, and on *Parlophone R*2960 we have Nos. 3 and 4 of The 1945 Super-Rhythm-Style Series, played by Vic Lewis and Jack Parnell's Jazz Men. No. 3 is " Ugly Child " and No. 4 is " Indiana," both being in truly *super-rhythm style*.

Regal

REGINALD DIXON has two selections on *Regal MR*3748, both of them good and making pleasing listening. On one side we can hear " Shine on Harvest Moon—Selection," which introduces " Shine on Harvest Moon "; " Time Waits for No One " and " So Dumb So Beautiful," and on the other there awaits our pleasure " When Irish Eyes Are Smiling—Selection." This includes " When Irish Eyes Are Smiling," " A Little Bit of Heaven," " Mother Macree " and " Let the Rest of the World Go By." Lou Preager and his Orchestra (from the Palais de Dance, Hammersmith) have recorded " The Trolley Song " and " No One Else Will Do," a slow foxtrot. Both of these are on *Regal MR*3749, and they are two good numbers well presented.

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).

Radio Shonan

SIR,—I should like to add a little more to F. B. Bennett's and F. J. Longman's reports on the S.W. station, Radio Shonan. I heard the station almost 12 months ago on the 31 m. band, announced in English as "Radio Shonan, formerly Singapore." After the broadcast in English there was a programme in Arabic. I received this station on an 0-v-1 using a P.M.22 as output.—C. VENABLES (Rotherham).

SIR,—*Re* station Radio Shonan. Some time ago in 1944 I received this station quite often on Sunday afternoons about 14.45. They announced Radio Shonan, Singapore, then. This station is definitely used by Japan for propaganda purposes.—F. WEST (Cheshire).

Identification Wanted

SIR,—Has any reader information regarding the following stations—a station that announced itself as The Polish Radio Bing(?) operating on the 49 m. band, and A.F.H.Q. calling Press Agencies in New York and London? The call sign sounded like DJRN and it operates in Italy.

Another station that I have received lately is VLC2 on 41.99. This was received on December 31st, 1944, and gave the news to the British Isles, followed by a programme "Around Australia." It was received at 16.35 hrs. G.M.T. and is situated in Australia. This transmission, it was stated, was the second transmission to the British Isles. A station that I heard testing on January 4th, 1945, announced itself as "M.C.H. Raylarks testing for the B.B.C. and Absi, testing on 9680 kc/s." This was repeated several times, some music was then played ("Serenade in Blue," sung by Bing Crosby), after which the time of the test was given, that being 10.15 to 10.25 hrs. G.M.T.

In reply to J. M. Ealey's (Swindon) letter the Italian transmitter mentioned operates on 45 as well as 35 metres, giving the News in English from 17.30 to 17.55 hrs. G.M.T. daily. It appears to be "pro-Nazi and/or Fascist."

I think that the "Radio City, Moscow" mentioned in J. H. Brunt's letter is correctly "Radio Centre, Moscow." Thermion's opinion on the Brains Trust(?) is very true indeed.—F. ARMSTRONG (Cheshire).

C.W. Transmissions

SIR,—There seems to be an increasing amount of interest taken in C.W. transmissions on the S.W., but very little information has been published about them.

These C.W. transmissions can be utilised in two main ways:—

1. For DXing.
2. For code practice.

The former, although not generally popular, can bring in some very interesting transmissions and on my own RX (an 0-v-1 by the way) ZLO9, VPC, ZQO8, CEA4A, VPO7, etc., have been received.

One of the main things to know, in my opinion, is the method of transmission, for many mistakes can be made if misinterpreted.

In view of this, therefore, I would like to give for the benefit of those who are contemplating trying their hand at C.W. DX a few of the most general calls.

A series of Vs de and then the call is about the simplest, but this is more often heard like this: VVV XYZ de ABC, this means that ABC is calling XYZ, de meaning from.

What confuses many people on starting is to hear a similar signal to this VVV DFN/DFD, and upon looking it up finds they are both situated in the same place. The reason for this is *not* that they are calling each other, or even a shortened form for DE, but that they are calling together, so that you will hear exactly the same signal on two different frequencies, i.e., DFNs or DFDs.

There are a great number of B and J calls being heard these days, and as far as my information goes the Bs are British Army stations and the Js, American.

Also many new transmitters have been put into operation since the war and have not even been announced, such as ZQOs, ZBIs and VPOs in Ceylon, Ascension and Barbados respectively.

It has been noticed here, too, that American stations in particular are using instead of de, a single V, i.e., VVV JKZA V JEKF.

It will be found that some stations use a QRA signal before their call, i.e., VVV QRA de YVR. These are transmitters using R.C.A. equipment and need not be in America, for as my example shows YVR is in Maracay, Venezuela.—BRIAN G. MEADEN (Liverpool).

Correction

WITH reference to the theoretical circuit and practical wiring diagram given on page 394 of the August issue, to illustrate the letter from E. H. Percy. We wish to point out the wiring should follow the theoretical circuit and not the practical diagram as regards valve holder and wave-change switch.

Mains Transformers

SIR,—In the February issue of your Journal, Mr. C. F. Taylor, of Herts, makes some observations regarding the cathode ray oscilloscope, to which you replied.

In your reply you state: "Readers seem to have had trouble in finding satisfactory mains transformers for the oscilloscope."

Perhaps you would be good enough to pass our name and address on to your readers in the event of your receiving inquiries.

Should, however, we be in error kindly accept our apologies.—H. W. FIELD & SON (16, Colchester Road, Harold Park, Essex).

QSL Exchange

SIR,—I would like to exchange QSL cards with anyon interested, QRA, J. COOPER ("Nairobi," Cairo Avenue, Peacehaven, Sussex).

Up, Thermion!

SIR,—I am assured that C. G. Williams, of Sidcup, will find very few readers who agree with his criticism of "On Your Wavelength," and I am equally assured that most readers look forward to Thermion's article as a definite monthly treat. It would be keenly regretted if it was brought to an end.

To those endowed with a sense of humour (which may not include C. G. Williams), there could be nothing more enjoyable than to watch Thermion draw his flashing rapier, and with it puncture pretentious gas-bags and leave them deflated and ridiculed.

So far as British broadcasting is concerned, Thermion is definitely our No. 1 Public Benefactor and our first line defence against the horrible and damnable crooner and croonette, and the vapid and inane Brains Trust, and the dance-band leaders (who plug "lyrics" and "tunes" more suitable for the Barbary apes on Gibraltar than for any normal-minded listener), some of whom have had the audacity to inform the world that they cannot play any instrument or read one note of music; or "lyric writers" with so little command of human

(*Continued on page 216*)

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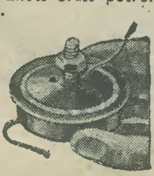

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350-0-350; 150 ma.; L.T.s, 6.3 v. 5 a.; 4 v. 4 a.; Rec. 5 v. 2 a.; 4 v. 2½ a.; can be used with international or English valves. Colour coded. Mains Input tapped 200/220/240 A.C. **50/-**, post 1/1. 400-0-400; 120 ma.; L.T.s. 4 v. 2½ a.; 4 v. 4 a.; 4 v. 2 a.; 4 v. 2 a.; long Colour Coded Leads, with high insulation. (200/220/240) Mains Input Tappings. **45/-**, post 1/-. 350-0-350, 80 ma.; 4 v. 4 a.; 4 v. 2 a.; A.C. Mains Input 230. **30/-**, post 8d. 300-0-300; 80 ma.; 4 v. 4 a.; 4 v. 2 a.; A.C. Mains Input 230. **30/-**, post 8d. 350-0-350. Chassis Mounting, Shrouded, 4 v. 4 a. 4 v. 2 a.; Input 200/220/240. **35/-**, post 9d. 300-0-300. 75 ma., Chassis Mounting, Shrouded, 4 v. 4 a.; 4 v. 2 a.; Input 200/230/250. **37/6.** Mains Transformers, wound to specification.

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language that they cannot rise above "Diddy Diddy Doo" or "Buggy Buggy Boo."

You are dead right, Mr. Editor. The inflictions instanced invite and deserve all the criticisms which Thermion raises against them, and may his "Wavelength" grow ever more effective towards driving them off the air for ever.—K. T. HARDMAN (Birkenhead).

Crystal Circuits Wanted

SIR,—I have been a constant reader of your splendid journal since 1934, and look forward to my copy each month. I have been a keen short-wave fan but my interest in that sphere has somewhat abated since the Huns "went off the air."

I am at the moment keenly interested in crystal reception, long distance, and am experimenting with many old circuits, tapped coils, condensers, series variometers, etc. I should be glad to hear from any readers interested in this branch of wireless, and will exchange circuits of different crystal sets. I should very much like to receive details of circuits, type of detector, coil, former, etc. Any letters on this subject will be answered. Would any reader have details of the famous Mark III crystal circuit, used in the Great War 1914-18, and copies of the old periodicals, to exchange or sell? A portion of PRACTICAL WIRELESS devoted to crystal experimenters would be greatly appreciated. Every success to PRACTICAL WIRELESS.—PHILIP RYAN (Cork).

Leeds Club

SIR,—Thank you very much for inserting notice in your journal *re* the formation of a radio club in Leeds. Below is a notice of the first meeting, which you may care to publish.

A Radio and Television Society for Leeds was formed on Saturday, January 6th, at Swarthmore Settlement. The objects are to cater for the needs of radio enthusiasts in the study of radio technology, television, electronics, and all matters appertaining to radio engineering. The inaugural meeting resulted in enrolling 17 members. —E. BENDEN, Hon. Sec. (Grosvenor House, 40, Grosvenor Terrace, Blackman Lane, Leeds, 7).

Club for Gosport

SIR,—Several amateurs and myself are anxious to start a radio club in Gosport and district. We propose meeting one Sunday in every month to discuss plans for post-war transmission, present-day activities, and the hundred and one other subjects amateurs are always ready to discuss when they get together.—R. G. FOWLES (10, Oxford Road, Ann's Hill, Gosport).

Stroboscope

SIR,—Having read S. Brimstead's letter in your February issue, I should like to comment upon his stroboscopic calculations.

His lighting supply is presumably 50 cycles, consequently there will be 100 flashes per sec. This accounts for the discrepancy in his calculations.

The turntable is required to do 78 r.p.m., this is $\frac{78}{60}$ revs. per second. Therefore for every flash the table will do $\frac{78}{60 \times 100}$ revolutions.

This is $\frac{13}{1000}$ turns. One hole per flash will therefore be $\frac{1000}{13}$ per turn. This works out at 76.922 holes.

The usual formula for finding the number of holes is—

$$\frac{\text{Mains Frequency} \times 120}{\text{R.P.M.}}$$

When the turntable is to revolve at 78 r.p.m. and the lighting is 50 cycles, the number of holes required is

$$\frac{50 \times 120}{78} = 76.922$$

I should also like to enlighten any more "Automatic Speed Control enthusiasts" that the original letter concerning this was published as a joke and, as has already been explained, the writer was listening to the news at dictation speed. Wishing your excellent paper every success.—G. W. YATES (Evesham).

Receiver for Motor-cycle

SIR,—With reference to Mr. Wheeler's letter in your February issue regarding a receiver suitable for reception on a motor cycle, we would suggest, after careful consideration, that such a receiver would be a practical impossibility if it was to fulfil his requirements.

Primarily a loudspeaker of suitable size would be incapable of producing audible sound in the open air and would most certainly not be heard above the engine noise.

Secondly, the space available to Mr. Wheeler—11 cubic inches—means maximum dimensions of less than 2in. × 3in. × 3in. This is hardly large enough to accommodate a vibrator power unit of suitable capabilities without even smoothing, let alone a set of sufficient sensitivity and selectivity to produce the results required. Even if such a set could be constructed the power output required to produce signals audible above the engine noise would make it a source of public nuisance—it would, in fact, be a revolutionary system of Public Address.

However, if any reader is able to produce a receiver up to Mr. Wheeler's standards we would be only too pleased to hear of it and would try it out on our own vehicles.—N. Y. WHALE (North Wales).

Two-valve All-dry Receiver

SIR,—I am writing to you regarding the article in PRACTICAL WIRELESS dated February, 1945 (A Two Valve All-Dry Receiver). I wish to point out an error in connection with the wiring of the 1A7GT; the article states that G1 is coupled to G4 by a 100,000 ohms resistance; I beg to show this wrong. It should read *G1* coupled to *G5* by 100,000 ohms; if you couple G1 to G4 the result is no signal.

The set works very well indeed. I have even improved it by adding a tuned H.F. stage, using a 1N5GT, Wearite P coils with reaction added to detector and two-gang condenser. Trusting you will put this matter right so that too many fellows won't get headaches. Thanks for such a good magazine; keep the good work going.—R. WELLS (Sevenoaks).

Two-volt Valve Operation from Mains

SIR,—The letter from Mr. Wood of Enfield in the January issue prompts me to warn any other reader who may desire to operate 2-volt valves from a mains transformer about one important point.

Most 2-volt battery valves take about 0.1 amps, while the average heater winding on a standard type transformer supplies 4 volts at 2 or 3 amperes. Consequently, if two valves, each taking 0.1 ampere, were connected in series across this winding, there would be a surplus current of very great magnitude, the result of which would be an excess of voltage—perhaps as much as 2 volts.

The idea, though successful in Mr. Wood's receiver, might prove very costly to another reader in the way of valve replacements. The risk (which is a big one) may, of course, be avoided by fitting a small "bleeder" resistance across the heater winding.—P. W. BARNETT (St. Albans).

He Wants to Know

SIR,—As a poor specimen of the contemptible, ignorant, and low-brow licence-holder, who might be much better engaged than in asking rude questions calculated to be offensive to the B.B.C., might one inquire what difference exists between the "Senior Controller of Programmes" and the new "Controller of Programmes," for it is an announced fact that these refer to two separate positions at Broadcasting House.

In many directions we have reached a stage in which the appointments of controllers of controllers is almost the accepted rule and in the best traditions of "This is the House which Jack Built," and no doubt the B.B.C. intends to be right in the front in this modern development. Quoting from memory, the small and almost unknown Republic of Andorra has a standing army of 57, only three of which are privates and the remainder officers, of various ranks, and it seems possible that the B.B.C. has found some inspiration in this direction.

But one thing is certain . . . there is always a tendency to increase executive positions, and these entail further increases in the salary list, and therefore reduce the amount available for the payment of actual artists' salaries, for not even the B.B.C. can spend its revenue twice over. And we have no guarantee that the B.B.C. will not carry this plan to the third degree, and appoint a controller of controllers of controllers, at a suitably increased salary.

Quite a lot of us low-brow ignorant licence-holders would vastly prefer that less of our money was spent on staff appointments, and considerably more on the engagement of well-known and first-class artists, and thus assure us of much better programmes than the present galaxy of controllers of controllers seems able to provide for us. There is a certain specific for the cure of this and other B.B.C. ailments, and that is, that those who foot the bill shall be strongly represented at Broadcasting House, and the day may yet come when they will insist on having more control over the way in which their money is divided up.—"ANTI-JOB MAKER" (Liverpool).

Thanks

SIR,—I would like to point out that your monthly issue of PRACTICAL WIRELESS comes up to all my expectations. I am very pleased with it, and never miss an issue. There are many articles within its pages of which I take much interest.

The monthly series of "Tone Control and Louspeaker Impedances," "L.F. Amplification and Frequency Modulation" which appeared in your 1942–43 issues were of great value to me. I also watch the "Roll of Merit" and "Impressions on the Wax" columns. Your latest issues contain notes on "Servicing Midget Receivers," although I do not have much in the line of this, I still pick up many hints from them. Direct Disc Recording is also a popular item for me.—H. DODGSON (West Malling).

"Italian Social Republic"

SIR,—In my last letter (dated about two weeks ago) I stated that the "Voice of the Italian Social Republic" broadcast in English at 17.30 G.M.T. This is wrong; the correct time is 18.20 G.M.T. Please correct my previous letter accordingly, and oblige.—WILLIAM H. BORLAND (Alexandria).

Home Service Engineers

SIR,—With reference to the letter headed "The Home Service Engineer" from Mr. Steward (2HAB) in your January issue. Mr. Steward makes the statement "in pre-war days there were over 2,000 members of the R.S.G.B.; a great many of them licensed radio hams, *and all with a fairly good knowledge of radio.*" From my experience of members of the R.S.G.B. that is a very sweeping statement to make. Far be it from me to decry such a fine body as the R.S.G.B. They have done fine pioneer work for the radio amateur. They have some of the finest radio hams within their ranks, but—and here is my point. There are far too many so-called radio technicians and radio servicemen *without* the slightest knowledge of the fundamentals of radio sporting the letters R.S.G.B. after their name. I speak from personal experience. A short time ago I had occasion to come into contact with a member of the R.S.G.B. who was unable to calculate simple Ohms Law. $I=\frac{E}{R}$ he had never heard of. Hardly the fit man to repair a modern superhet, I think you will agree. Finally, through your columns I would appeal to the R.S.G.B. to give intending members some form of examination before accepting them for membership, and thereby preserve the good name for technical excellence, which object they have fought so hard to maintain, and then would the letters R.S.G.B. after a member's name be a guarantee that he really was competent, at least in the fundamentals of radio. At present far too many are masquerading as radio technicians by adding to their names R.S.G.B. I would add that I myself am not a member of the R.S.G.B. owing to the fact that in peace years all my spare time was taken up with the R.N.V.W.R. However, I am a great admirer of the R.S.G.B., and do not wish to see "Member of the R.S.G.B." in advertisements after the name of some incompetent home service engineer.—KENNETH M. BAILEY (British West Africa).

Crystal Sets

SIR,—Your magazine (welcome, too) is reaching us out here, and on reading the letters *re* crystal sets I could not overcome the temptation to give you my experiences. Almost two years ago in Africa we were stationed at a place where news was hard to get, and at the time we had no radio and no signs of getting one. To pass on the evenings I decided to make a crystal set. My equipment was nil. I raked about on a salvage dump and found an old 3-gang condenser and an old car coil, then made up a detector from the ball joint of an old windscreen wiper. Using a tyre valve dust cover for a crystal holder I mounted it all on a board, winding a coil on a discarded shell container 3in. in diameter. For a crystal I used the old method of fusing lead filings and sulphur. A length of cable slung between two trees and I was ready. The first station I received was the B.B.C. news (very faintly) telling of the invasion of Pantelleria. The next day I wrote home for parts, and I received them in Italy. As I was near a station I built up a set for medium waves, which gave splendid results on a Blue Spot moving iron speaker. The time came when I left that part, and then I could get next to nothing, so I started on the short waves. Patience was rewarded, and now I own what I consider to be the best crystal set ever. It is in a cabinet with loud speaker which is loud enough on B.B.C. stations for bedside reception. [*Really?*—ED.] It has three short-wave bands, with the B.B.C. "on tap" on 'phones all through the day or night. Stations logged so far are: B.B.C. African Service, Berlin, Algiers. On 'phones: The three mentioned, Moscow, Rome, Bari, Vatican City, Algiers, Berlin, Paris, New York and others not identified. If anyone (particularly Servicemen abroad in the same circumstances as myself) is interested, and would like the circuit and layout of the set I would be only too glad to forward it to you, as it may mean that someone somewhere will be able to receive the news, etc. who is at present unable to do so. The best of luck to PRACTICAL WIRELESS and yourselves.—A. GUMSLEY (C.M.F.).

Short-wave Set Results

SIR,—I am an ardent short-wave listener in my spare time from school. I have graduated from a simple 0-v-0 to a battery 0-v-1 (pen.) with bandspread and other refinements. It works with an *indoor* aerial, and the following is a log of stations of *special interest* received since April last year. I now regard European stations and regulars such as Leopoldville, Brazzaville and the American internationals as very "small beer."

10-4-'44: ZNR, Aden, Arabia, 24.76 m. 24-4-'44 onwards: VLG3 and VLI2, Melbourne and Sydney, 25.27 and 25.68 m. 27-4-'44 onwards: All India Radio, recently heard on 19.54 m. 15-9-'44: Free Jugoslavian Radio, 25 m.; Tokyo, 25 m. 17-12-'44 onwards: VLC2, Shepperton, Australia, 30.99 m. 31-12-'44 onwards: Free German Radio, 28 m. 1-1-'45 onwards: Sackville (CHTA), 19.67 or 19.71 m. 2-1-'45 onwards: Paramaribo, Dutch Guiana, on 15,405 kc/s. (19.4 m.). —one of your correspondents wanted verification of this station. 4-1-'45: CR7BE, Lourenco Marques, 30 m.

11-1-'45: Oslo, 31 m. 16-1-'45: Vatican Radio on 17.19 m. 18-1-'45: Dakar, 41 m. 28-1-'45: Radio Shonan, Singapore, 31 m.; "The Rumanian Short-wave Station," 31 m. 29-1-'45: Radio Sicarto, Jokjakarta, 16 m.

Army and Press stations include: APH, AFHQ, ICA, ICD, GBB2, MCH, MCQ3, WBC, WCP, WQV, PX, PY.

Did anyone hear ICF2 calling the B.B.C. in the 25 m. band in the late afternoon of Thursday, January 18th? A talk was being given on the Brains Trust, interpolated with announcements of identity and frequency (11,695 kc/s.). — JOHN A. S. WATSON (Herts).

Re Radio Examination Paper No. 33

SIR,—There has been either a misprint or some misunderstanding concerning the use of the formula $f = \frac{3 \times 10^8}{\lambda}$. From your August issue, scanned somewhat belatedly, I quote the following: "In the region of 3,000 megacycles per sec. on wavelengths of 1 cm." (p. 372). My knowledge of radar advises me that 3,000 megacycles is equal to 10 cm. wavelength.

I should also appreciate your definition of a relaxation oscillator. The time-base circuit which you suggest, using a neon and described as a relaxation oscillator, saw-tooth time-base generator is exactly the same as a hyratron time-base circuit except for the type of valve used. I would like to proffer my own explanation of a relaxation oscillator: A valve with negative 70 volts suppressor grid bias and control grid bias is supplied with 163.9 kilocycles oscillation on to its control grid. This is sufficient to lift the control grid bias mentioned, but, as you can appreciate, the valve is still unable to conduct due to the suppressor bias. In order to lift this bias a valve termed as a relaxation oscillator is used; it supplies the suppressor grid with a 50 cycle A.C. having sufficient peak voltage to overcome the negative 70 volts: thus the valve is allowed to conduct during the positive tips of this 50 cycle wave-form. As far as my knowledge of time-base circuits goes, the use of a relaxation oscillator to obtain the necessary saw-tooth wave-form would not be practicable.

I hope the above has served to clarify certain technical points and that digging out your past files to trace the reference under discussion will not seriously inconvenience you.—P. TILBURY-DAVIS (Surrey).

[The Experimenters reply: We thank you for your letter, which has been passed to us for comment by the Editor.

With regard to your first point, you are quite right; the wavelength which corresponds to a frequency of 3,000 mc/s. is, of course, 10 cm.; the frequency corresponding to a wavelength of 1 cm. is 30,000 mc/s.

Unfortunately, we find some difficulty in following your other queries, because you give what you describe as your "explanation" of a relaxation oscillator and refer to particular bias voltages and frequencies which are entirely unrelated.

However, we will try to clarify the position by stating that a relaxation oscillator is, in fact, a form of time base. Another term which is virtually synonymous is sweep generator. Any of the circuits described under any of these titles can be used, or modified for use, in the production of a time base. It is, as you state, possible to use a thyratron as a relaxation oscillator; it is also possible to use a normal triode, in which case the oscillator would normally be described as a "hard-tube" or "hard-valve" time-base generator.

All forms have been referred to at different times in "Radio Examination Papers" and elsewhere in the pages of PRACTICAL WIRELESS. In every case the principle is that of producing a gradually rising potential followed by a quick cut-off. It is this action which gives rise to the term saw-tooth in connection with the output from such devices. The desired form of output is generally obtained by the charging and discharging of a condenser, because the rate of charge of a condenser follows the exponential law; discharge can be made to take place almost instantaneously.

It is hoped that the above brief explanation will have removed any misunderstanding which you had, and shown that the explanation which you give is by no means a definition of either a relaxation oscillator or a time-base generator. It would appear that you have quoted certain facts out of their context.—THE EXPERIMENTERS.]

Radio Mechanics

SIR,—Mr. Firth—whose letter was reproduced in your December issue—casts a slur on the very fine and difficult work done by the radio mechanics of both the R.A.F. and the Army.

From his letter it appears that he is himself in the Forces, but he doesn't mention in which arm he serves. Perhaps 'tis the Navy?

I gather that he earned a meagre 1s. 6d. an hour whilst considering himself a radio fault-finding expert. It amazes me that he never opened a private servicing business where—even as a sideline, and with his self-assumed skill—he could have most certainly earned more than his 1s. 6d. per hour.

But most important are his words concerning the Army radio mechanics.

I invite Mr. Firth to join the Royal Corps of Signals as an "average mechanic" out here in the jungles of Burma, and try to discover and rectify his 147 faults a day, remembering that we instrument mechanics and electricians of the Signals have no specially marked-off meters, test panels, moving belts, oscilloscopes and valve testers, etc. Our fault-finding weapons amount to little more than an Avo-minor, self-invented tools, a soldering iron and those "little" items that Mr. Firth considers we so badly lack: ingenuity, excellent technical training, and that great urge to speed, "the message must get through."

It is, Sir, a great tribute to the radio mechanics of all three Serv ces that communications in this war have been kept open to such high standards and efficiency, upon which the successful ending of this war depends. And this, Mr. Firth, has been achieved by the "unskilled, frowned upon mechanics of the Forces."—ARNOLD LEVY (India).

COMMERCIAL RECEIVER DESIGN

(*Continued from page 206*)

in resonance with the secondary circuit. In these conditions identical voltages are applied to the diode and the A.F.C. bias is zero.

With the signal frequency differing from the resonant frequency of the secondary, there will be a phase shift from the quadrature relation, and this gives one diode a greater voltage than the other, and the A.F.C. bias will be positive or negative, according to which diode receives the larger signal. The bias for the A.F.C. is applied to the grid of the pentode valve, the plate circuit is in parallel with the tuned circuit of the oscillator, while the control grid is supplied with an exciting voltage 90 deg. out of phase with the voltage acting on the plate circuit. In this circuit arrangement the amplified grid voltage acting on the plate circuit draws from the oscillator a current 90 deg. out of phase with the voltage across the oscillator, therefore the valve plays the part of an electronic reactance having a magnitude dependent on the amplification of the valve, and the grid bias developed by the A.F.C.

The circuit in Fig. 6 is easy to align as all the circuits are adjusted to the I.F. frequency, and if no signal generator is handy, the discriminator secondary can be adjusted roughly to the correct frequency by tuning it to give a minimum of output from the receiver.

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(Continued top of next column)

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