THREE BIG DEVELOPMENTS

Television and SHORT-WAVE WORLD

1/- MONTHLY

MAY, 1937
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HOW TELEVISION IS RECEIVED IN GREATER LONDON

TELEVISION IN CORONATION WEEK

ACORN-VALVE RECEIVER

6D5 PUSH-PULL TRANSMITTER

TESTING AND OVERHAULING SHORT-WAVE SETS

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BERNARD E. JONES.

Editor :
H. CORBISHLEY.

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COMMENT OF THE MONTH

Publicising Television

THE B.B.C. have available a wonderful means of publicising television if they will take advantage of it. Some months ago we suggested that it would be a good idea to broadcast the sound portion of the television programmes via the ordinary sound broadcast channels, and we were gratified later to learn that the suggestion had been taken up. Unfortunately the first broadcast of this nature that was made was a "flop," and instead of interesting the ordinary listener had the contrary effect of causing a certain amount of irritation—and all because there appeared to be no kind of accord between the sound broadcasts and the actual programme that was taking place at the Alexandra Palace. In the first place the programme was cut at a most inopportune moment which left listeners wondering what had happened and secondly, comment and explanation of the dual programme was of the most meagre nature. The second dual broadcast was but little better and in any case was not of sufficient merit to fire the ordinary listener with sufficient enthusiasm to desire the possession of a television receiver.

How these dual broadcasts could be made to have wonderful publicity value for television requires little imagination. Careful selection of programme matter, a clever compêre to introduce the programme and convey the atmosphere of the studio, close co-operation with officials at Broadcasting House, and listeners to the sound programmes could be made to realise that here was real entertainment which they were missing. The treatment that the first dual programme received seemed to indicate that there were interests antagonistic to television at work.

There is also another distinct advantage that would accrue from this type of broadcast, and this is the matter of economy. Many of the vision programmes could be made to lend themselves equally well for sound broadcasts, and would therefore result in a considerable saving.

Three Big Developments

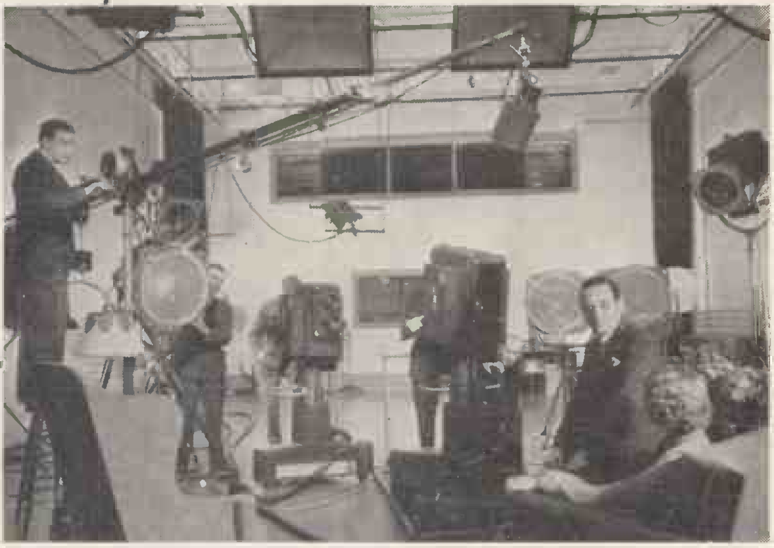
IN this issue we publish details of three important television developments abroad. The real significance of these to the television industry as a whole is that the utilitarian side of television has received further acknowledgment. They mean that plans are being formulated for the practical use of television in two other countries, and they foreshadow a course which every other civilised country will be bound to follow within a comparatively short time. Such developments as these, by bringing more workers into the field, are bound to be of great assistance in the attainment of the degree of perfection that is the objective of the present comparatively small band of workers.

AMERICA'S BIGGEST STEP

"OUT OF THE LABORATORY ——

AN ACCOUNT OF THE RECENT TELEVISION ACTIVITIES OF THE NATIONAL BROADCASTING COMPANY AND RADIO CORPORATION OF AMERICA

Through the courtesy of Mr. J. Vance Babb, of the National Broadcasting Company, itself a part of the Radio Corporation of America, of Radio City, New York, we are enabled to present our readers this month with some real information concerning the development and present position of television in the United States. The fact that in that great country radio is not co-ordinated as it is in Great Britain, but is in the hands of a number of separate companies who transmit on a purely commercial basis, has very considerably influenced the question and the manner of the introduction of a television service. That service can come only from stations—widely separated over an immense territory—who must look to sponsored programmes for their income. And it follows that the development of television in the United States must be on remarkably interesting lines.



General view of the N.B.C. experimental studio in the R.C.A. building. The "cameramen" are focusing Iconoscopes, and the microphone is swinging into position.

FOR over ten years the Radio Corporation of America has been conducting research towards the development of a practical system of high definition television with the result that many of the fundamental principles which are now generally employed have been due to the research engineers of this concern. Among the names of these engineers are those of Zworykin, Joliffe, Engstrom, Epstein, Kell, Bedford and Trainer—names which are well known in television circles all over the world.

In the course of their studies the research engineers of R.C.A. have thoroughly investigated all the different methods by which television may be accomplished, including scanning disc, flying spot, cathode-ray devices and other methods.

Early Experiments

Prior to 1932 there was in operation in the research laboratories in Camden, N.J., a system of television which brought mechanical scanning to what was then believed to be the highest level then obtainable in any system. In the receiving portion of this system a cathode-ray tube was used. On the basis of this work it was decided in 1932 to install in New York City a transmitter using this mechanical system of scanning. At that time it was known that it was necessary to use ultra-high frequencies to obtain the picture quality then possible, and consequently the transmitter was built to operate on a frequency above 40,000 kc. This was the first full scale television broadcast transmitter in the U.S.A. for relatively high definition images. The experimental operation of this transmitter provided information on many of the transmitter problems, one of which was the difficulty of serving a city such as New York.

While this transmitter was being used for the purpose of collecting data on the transmission problems, R.C.A. engineers in Camden were concentrating on a system of television based on electronic scanning in order to overcome the limitations of the mechanical system which had been made apparent by the New York tests. In 1933 there was put into operation in the laboratory in Camden, N.J., a new type of transmitter which employed electrical scanning, a greater number of lines, and other improvements. By 1934 this system had developed into one employing 343 lines interlaced with a frame frequency of 30 per second and a field frequency of 60 per second. A decision was made to test this system in the field by establishing facilities in New York City.

During 1935 work was undertaken in preparation for this experimental field test in New York so that practical experience could be obtained on technical problems, apparatus, programmes, and considerations of television system standards. Tests of the R.C.A. system began on June 29, 1936, with an organised programme of experiments between a high-power transmitting station fully equipped for studio and film programmes and receivers in a number of centres throughout the New York area. Live talent and motion pictures were successfully transmitted.

IN TELEVISION AND INTO THE FIELD"

PRESIDENT N.B.C.

R.C.A.'s famous Iconoscope, the tube which transforms what it "sees" into electric impulses. In the background is the well-known N.B.C. microphone.

Television Studios

The television studios are located in the R.C.A. Building with complete facilities for direct pick-up and film programmes. The vision signals are transferred to the transmitter in the Empire State Building either by coaxial cable or radio relay. The vision and audio transmitters are located on an upper floor of the Empire State Building, with a common aerial at the very top. The vision transmitter carrier frequency is 49.75 megacycles, and the audio transmitter carrier frequency is 52 megacycles. The radio relay channel between the R.C.A. and Empire State Building operates on 177 megacycles.

This experimental system used 343 lines per frame, interlaced, with a frame frequency of 30 per second and a field frequency of 60 per second. Synchronisation at the receivers is by transmitted impulses. The horizontal and vertical synchronising impulses are of the same amplitude using wave shape selection.

The demonstration possessed four features not included in previous demonstrations of television. It was the first made by R.C.A. and the National Broadcasting Company for the press under practical working conditions, although previous demonstrations of laboratory television have been given. It represented the first showing of a complete programme built for entertainment value as well as a demonstration of transmission. It also included the first showing of a new 12-in. receiving tube, which reproduces a picture on a 7½-in by 10-in. screen.

The demonstration was presented and supervised by Ralph R. Beal, R.C.A. Research Supervisor; O. B. Hanson, N.B.C. Chief Engineer, and Charles W. Horn, N.B.C. Director of Research and Development. These engineers explained that numerous problems of transmission and production will still remain to be solved before television on a commercial scale can be attempted.

N.B.C.'s television announcer, Betty Goodwin, as she appears in 441-line transmission.

The demonstration was the first for the press of R.C.A. experimental television under practical field conditions since the Radio Corporation of America assigned the task of setting up a television operating plant to the National Broadcasting Company.

This assignment included the construction of studios adapted to television technique, the installation of equipment in those studios and at the transmitter atop the Empire State Building, the determination of workable engineering methods for the transmission of pictures, and the training of a staff to take over the operation of the plant.

Future of Television in U.S.A.

Mr. Lenox R. Lohr, President of the National Broadcasting Company, introducing Mr. Sarnoff on this occasion said " The rôle of the National Broadcasting Company in television will be operating transmitters, programming and, when it becomes available for commercial use, securing sponsors. In order that we may be prepared to do our part, our engineers are daily putting apparatus on the air under practical service conditions. Our programme department is learning an entirely new technique in continuity writing, make-up, staging, and a multitude of other details which this new art will demand. It is experimenting with commercial programmes to determine the effectiveness of television to sell goods.

" Our engineers are studying the economics of networking, so that several stations may be interconnected by either coaxial cable or short-wave relays, and are developing equipment for the making of outside pick-ups. With the experience that we are gaining daily, we feel that when the time is ripe to offer television to the public, the National Broadcasting Company will be

PROBLEMS OF DISTRIBUTION IN U.S.A.

The two balls on a modulation transformer form a safety discharge gap for heavy overloads of current that might otherwise damage valuable equipment.

prepared to do its part. Results which you will see are largely due to the vision and enterprise of Mr. David Sarnoff, President of the Radio Corporation of America."

Mr. David Sarnoff, President, Radio Corporation of America, speaking to the visitors, said: "June 29 (1936) marked the beginning in this country of organised television experiments between a regular transmitting station and a number of homes. Since then we have advanced, and are continuing to advance, simultaneously along the three broad fronts of television development—research which must point the road to effective transmission and reception; technical progress which must translate into practical sets for the home the achievements of our laboratories; and field tests to determine the needs and possibilities of a public service that will ultimately enable us to see as well as to hear programmes through the air. On all these fronts our work has made definite progress and has brought us nearer the desired goal.

"As you know, we have been transmitting from our television station on top of the Empire State Building in New York City, which is controlled from the N.B.C. television studios in the R.C.A. Building. We have observed and measured these transmissions through a number of experimental receivers located in the metropolitan area and adjacent suburbs. The results thus far have been encouraging, and instructive. As we anticipated, many needs that must be met by a commercial service have been made clear by these tests.

"We have successfully transmitted through the air, motion pictures as well as talent. The distance over which these television programmes have been received has exceeded our immediate expectations. In one favourable location due to the extreme height of our transmitter, we have consistently received transmissions as far as 45 miles from the Empire State Building.

"The tests have been very instructive in that we have learned a great deal more about the behaviour of ultra-short waves and how to handle them. We know more about interferences, most of which are man made and susceptible of elimination. We have surmounted the difficulties of making apparatus function outside of the laboratory. We have confirmed the soundness of the technical fundamentals of our system, and the experience gained through these tests enables us to chart the needs of a practical television service.

"While we have thus proceeded on the technical front of television, the construction and preparation of television studios have enabled us to co-ordinate our technical advance with the programme technique that a service to the home will ultimately require. Under the direction of the President of the National Broadcasting Company, Mr. Lenox Lohr, the N.B.C. has instituted a series of television programme tests in which we have sought to ascertain initial requirements.

"One of the major problems in television is that of network syndication. Our present facilities for distribution of sound broadcasting cover the vast area of the United States and serve its 128,000,000 people. Similar coverage for television programmes, in the present state of the television art, would require a multiplicity of transmitters and network interconnection by wire or radio facilities still to be developed.

"Our programme is three-fold; first, we must develop suitable commercial equipment for television and reception; second, we must develop a programme service suitable for network syndication; third, we must also develop a sound economic base to support a television service.

"From the standpoint of research, laboratory development, and technical demonstration, television progress in the United States continues to give us an unquestioned position of leadership in the development of the art.

"We are now engaged in the development of studio and programme techniques that will touch upon every possibility within the growing progress of the art. The distinction between television in this country and abroad is the distinction between experimental public

Fashion model being made up according to television's special and exacting requirements by an expert.

SPONSORED PROGRAMMES IN U.S.A.

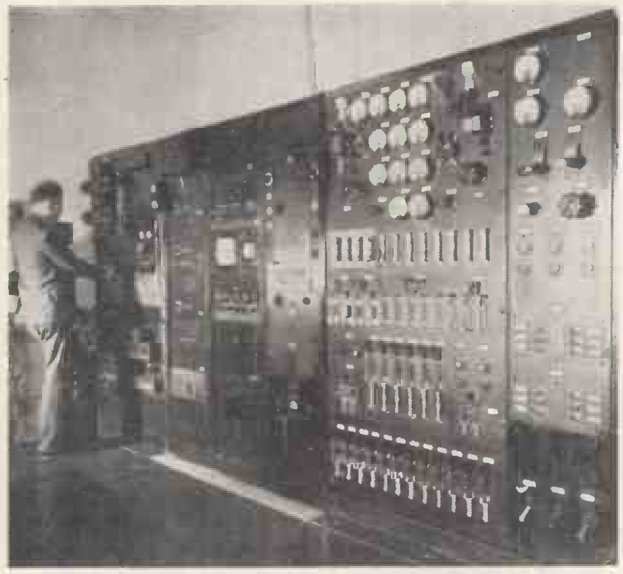
services undertaken under government subsidy in countries of vastly smaller extent, and the progressive stages of commercial development undertaken by the free initiative, enterprise and capital of those who have pioneered the art in the United States. While the problems of television are formidable, I firmly believe they will be solved."

441-line Definition

In co-operation with other concerns engaged in the development of television, R.C.A. recommended to the Federal Communications Commission the adoption of standards including images of 441-lines and a video-audio carrier spacing of approximately 3.25 megacycles and the R.C.A. field test system was consequently changed to conform to these standards, and the following is an account of the results obtained.

The first tests of high definition television using the new standards commenced in January of this year and were conducted by engineers of the Radio Corporation of America and the National Broadcasting Company.

Images scanned by the R.C.A. Iconoscope, the pick-up tube, at the rate of 441 lines per frame have been transmitted from the N.B.C. experimental station in the Empire State Tower and successfully received by a selected number of experimental television receivers in the homes of R.C.A.-N.B.C. engineers and technicians. The pictures obtained on 441-line definition are much superior to those of 343 lines.



The engineer is standing before the sound rack. In the third panel are small buttons controlling television images.

In reviewing the progress of the Radio Corporation of America for the first three months of 1937, Mr. David Sarnoff, president, had the following to say:—

" Many improvements have resulted from the field tests of the R.C.A. television system which are being continued. The requirements of a nation-wide television service must be viewed from the standpoint of eventual coverage of more than 3 million square miles of territory with approximately 130 million inhabitants. The size of this problem is much more formidable here than is the case, for example, in England, where the area is small and the population is concentrated. There, the Government subsidises the television experiments and the broadcasting of television programmes, but the owner of a home-receiving set must pay an annual licence fee to the Government. In the United States, as you know, home radio reception is free and we hope, through the development of private enterprise, also to maintain television reception free.

" Technically, the art of television needs still further improvement in transmission as well as reception. As these improvements are made, the cost should decrease and thereby reduce the magnitude of the financial problems of establishing a nation-wide television service. In addition to these practical considerations, there is the further problem of developing studio and programme technique to meet the requirements of such a revolutionary form of public entertainment, information and education. The programme service will be costly, and its support will devolve primarily upon the sponsors of television programmes, as is the case today with the sponsors of sound broadcasting.

" Before sponsors can be interested in supporting television programmes, it is necessary to provide a seeing as well as a hearing audience; and here we have the age-old question of what comes first, the chicken or the egg. Nevertheless, it is my firm conviction that one day we shall have both the chicken and the egg, and that television ultimately will be established in the United States by private enterprise on a practical basis of free service to the home. The potentialities of television are such as will bring new meaning to the service and business of radio.

" Developments here and abroad have demonstrated the fact that R.C.A. is in the forefront of technical development in this new and promising field. Recently the authorities responsible for television in England adopted the Marconi-E.M.I. system of television in preference to the other systems which they tested. The system thus adopted as the English standard, is based on R.C.A. inventions.

" In our own country, the Columbia Broadcasting System has just announced its plans to enter the field of experimental high-definition television. That company has placed with us, this week, an order for the manufacture of a modern R.C.A. television transmitter to be installed on the Chrysler Building in New York City."

A New Departure in Circuit Diagrams

Constructors will notice that in the S.W. section of this issue we have taken the bold step of modifying the method of showing valve connections in our theoretical circuits. The time is coming when all valves will have a standard 8-pin base as in indicated by the introduction of International valves by two of our leading makers.

This will mean but one type of valve holder in every receiver and these have been shown in our circuit diagrams in such a manner that the constructor will know to which pins the electrodes are connected without having to refer to valve makers' guides.

TELEVISION IN CORONATION WEEK

COMPLETE DETAILS OF ARRANGEMENTS AND PROGRAMMES

THE outstanding television event in Coronation week will, of course, be the televising of the Coronation Procession at Apsley Gate, Hyde Park Corner, on the return journey from Westminster Abbey. The broadcast, which is expected to last one hour, will open at 2 p.m. with views of the Park and crowd scenes between Stanhope Gate and Hyde Park Corner. Telephoto lenses will pick out the head of the procession a quarter-of-an-hour later as it approaches down the East Carriage Drive, and from then until the last horsemen have passed through Wellington Arch to Constitution Hill the whole of the two-mile procession will be shown on the television screen. A descriptive commentary will be given by Frederick H. Grisewood, who will be stationed at a microphone beside the cameras at Apsley Gate.

How the Procession will be Televised

Three Emitron cameras will be used. Two will be mounted on a special platform at Apsley Gate and will be fitted with telephoto lenses for obtaining distant and mid-shots of the procession and the crowds to the North and South of the Gate. A third camera, installed on the pavement to the North of the Gate, will give close-range views of the Royal Coach and other important parts of the procession passing through the Gate.

The cameras will be connected by some fifty yards of cable to the new mobile television unit behind the park-keeper's lodge, when the sound and vision signals will be conveyed by cable to Broadcasting House and Alexandra Palace.

The mobile television unit comprises three vans; one contains the control apparatus and scanning equipment, one the power plant, and the third an ultra-short wave radio-link transmitter of 1 kilowatt power, which on May 12 will be used as a stand-by for conveying signals to the Television Station.

It is necessary to provide for control room apparatus at the scene of the television broadcast, and, to enable this somewhat ambitious process to be carried out, the B.B.C. has purchased from the Marconi-E.M.I. Television Company a mobile control room installed in a large motor vehicle.

The apparatus is mounted on two rows of racks along the sides of the vehicle, leaving clear a middle aisle for the engineers operating the equipment. There are six racks each side, each rack 7 ft. 6 ins. high and 19½ ins. wide. The operators are able to see the televised picture on a reproducer fitted into the compartment over the driver's head, and make the necessary adjustments.

In addition, the vehicle is equipped as a small sound control room with all the necessary " faders " and amplifiers to deal with four microphones, which will pick up the voice of a commentator and local sounds associated with the scene being televised.

The mobile control room vehicle will be parked on the grass on the west side of Apsley Gate, behind the park-keeper's lodge, and three multiple cables for the cameras will run from the vehicle to the top of the gate across which they will pass, concealed, to drop down behind a pillar at the point where the cameras are mounted. These cables are about 1½ ins. in diameter and contain twenty-seven insulated conductors, two of which are of a special low-capacity type to carry the high-frequency impulses required for the Emitron cameras.

The stand-by transmitter vehicle will be parked alongside the other, and will radiate the vision signal from a small highly directional aerial mounted on two low wooden masts close to the scene of operation. The signals emitted from the transmitter will be intercepted at Alexandra Palace my means of a small aerial mounted at the top of the main transmitting mast and conveyed thence to a receiver below through a shielded high-frequency feeder. The output of the receiver will be used to modulate the main transmitter in the ordinary manner, and the signals will then be re-broadcast on the usual vision frequency.

The Week's Programmes

Outstanding among the studio programmes in Coronation Week will be the appearance of Alicia Markova and Anton Dolin on Tuesday, May 11, with members of their company in a Pas de Quatre and Tchaikowsky's " Blue Bird " suite. Special Coronation editions of " Picture Page " will be presented in the afternoon and evening and it is expected that many of the visitors will have been directly concerned with the Coronation preparations. On the same day, Gerald Cock, Director of Television, will give an illustrated account, both in the afternoon and evening, of the arrangements for televising the Coronation Procession. Films and photographs will be used and, through the co-operation of Scotland Yard, special plans will show how London traffic will be controlled on Coronation Day.

A " Music Hall Cavalcade," which will be the main feature in the evening television programme on Coronation Day, will be presented in a novel manner. An elderly couple, who recall the grand old days of Victorian and Edwardian music hall, will see their reminiscences take form and substance as the favourites of yesterday and to-day reappear on the television screen. The artists will include Albert Whelan, Ada Cerito, Tom Costello, Marie Lloyd, junior, and Ida Barr.

Harry Roy's Band will be televised, with Princess Pearl, in the afternoon programme on May 13. In the evening transmission Clapham and Dwyer will be featured in "Starlight."

On Friday, May 14, Jack Hylton will bring his band to the television studio. The instrumentalists and vocalists number nearly forty—the largest musical combination yet televised.

Television will televise itself on Saturday, May 15, when both afternoon and evening programmes will be devoted to a tour of the London Television Station. The Guide will be Leslie Mitchell, television announcer, and the visitor, George Robey, who will accompany the roving camera to the reception hall, to rehearsal, the sound and vision transmitters, the make-up and dressing rooms, production shop, film projection room, control room and studios.

TELEVISION AND SHORT-WAVE WORLD

FIELD STRENGTH MEASUREMENTS OF THE ALEXANDRA PALACE TRANSMISSIONS

RESULTS OF A COMPLETE SURVEY OF THE SERVICE AREA

The information given on this and the two following pages relating to field strength measurements of the Alexandra Palace transmissions is reprinted by kind permission of the B.B.C. from the B.B.C. Annual, 1937. It will provide a valuable guide for the installation of television receivers within the area shown by the maps.

THE institution of a television service by the British Broadcasting Corporation has created, for the Research Department, the necessity of investigating transmission phenomena peculiar to ultra-short waves.

Field-strength measuring apparatus suitable for use on television wavelengths has been designed and used, during the development period, to investigate signals on 7.75 metres radiated by an aerial on the roof of Broadcasting House. These tests showed the necessity of adopting a special technique for ultra-short wave field-strength measurements, and, at the same time, revealed many interesting phenomena regarding the habits of these waves, particularly in built-up areas. Field-strength contours of the Broadcasting House transmitter were charted, and investigations made into the phenomena associated with the propagation of horizontally polarised transmissions. Measurements on the Alexandra Palace transmitters were commenced immediately the experimental transmissions were available, and a field strength contour chart of this station has now been prepared.

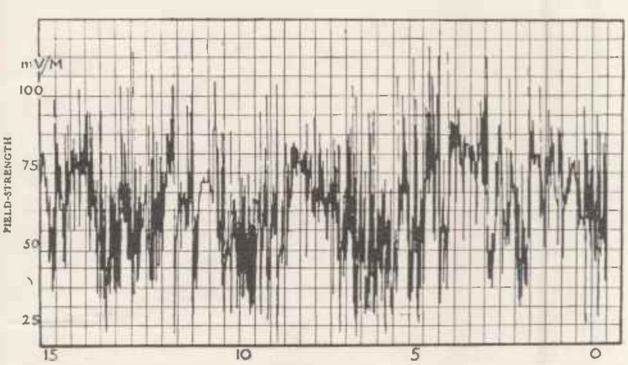


Fig. 1. Variations of field strength due to passing traffic.

The Apparatus Employed

This field-strength measuring apparatus is accommodated in a specially constructed van the bodywork of which is practically free from metal parts. For the reception of signals a dipole is used which is mounted on the roof of the van. By means of a projecting arm inside the van the dipole can be turned to either a vertical or horizontal position, and, when horizontal, can be rotated from inside the van. The direction in which the aerial is pointing is also indicated to the occupants of the van by means of a pointer moving over a scale mounted on the roof. The dipole is collapsible in order to avoid inconvenience when in traffic, among trees, or when passing under low bridges.

The equipment inside the van consists of the field-strength measuring receiver with associated calibrating equipment, a recording milliameter and a subsidiary unit embodying a "Tunograph" tuning indicator which is used to measure the level of interference from motor-car ignition systems. The engine of the van is equipped with ignition interference suppressors as marketed. It is found practicable, when suppressors are fitted, to record field-strengths of less than $50\mu v/m$, with the van in motion without appreciable interference from the ignition system.

Special Technique Necessary

It became apparent very soon after the start of these investigations that established field-strength measuring technique as developed for the medium wave band would have to be abandoned and other methods adopted. It was found that it was impossible to determine a representative figure for the field-strength in a given area by means of spot measurements in a few representative points. Some idea of the impracticability of such a scheme is

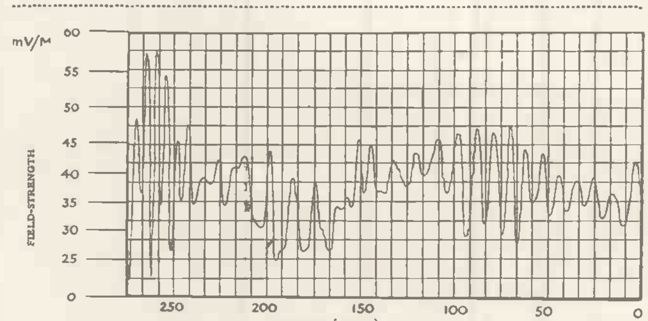


Fig. 2. Standing wave pattern obtained in a relatively unscreened area.

conveyed by the illustrations of Figs. 1 and 2. The first figure shows the variation in received field-strength from the Broadcasting House transmitter with the measuring van stationary on Balham Hill. (The variations are entirely due to reflection and absorption effects of passing traffic. The record of Fig. 2 is typical of the standing wave pattern existing in a relatively unscreened area.

In order to obtain sufficient information to plot field-strength contours it has been found necessary to take continuous field-strength records. Streets carrying much traffic must be avoided and measurements made in quiet by-roads. The normal procedure is to take a continuous record of the field-strength variations throughout a district, and then to determine the average value from the record. A sufficient number of such records having been obtained, a field-strength contour map can be prepared. It must be realised, however, that such a map can only represent the average signal in a region, and that individual measurements may reveal divergencies as great as ± 10 db. in certain cases.

Field-strength contour maps of the Alexandra Palace sound transmitter are shown in Figs. 3 and 4, Fig. 3 giving the field at 2.5 m. above the ground, while Fig. 4

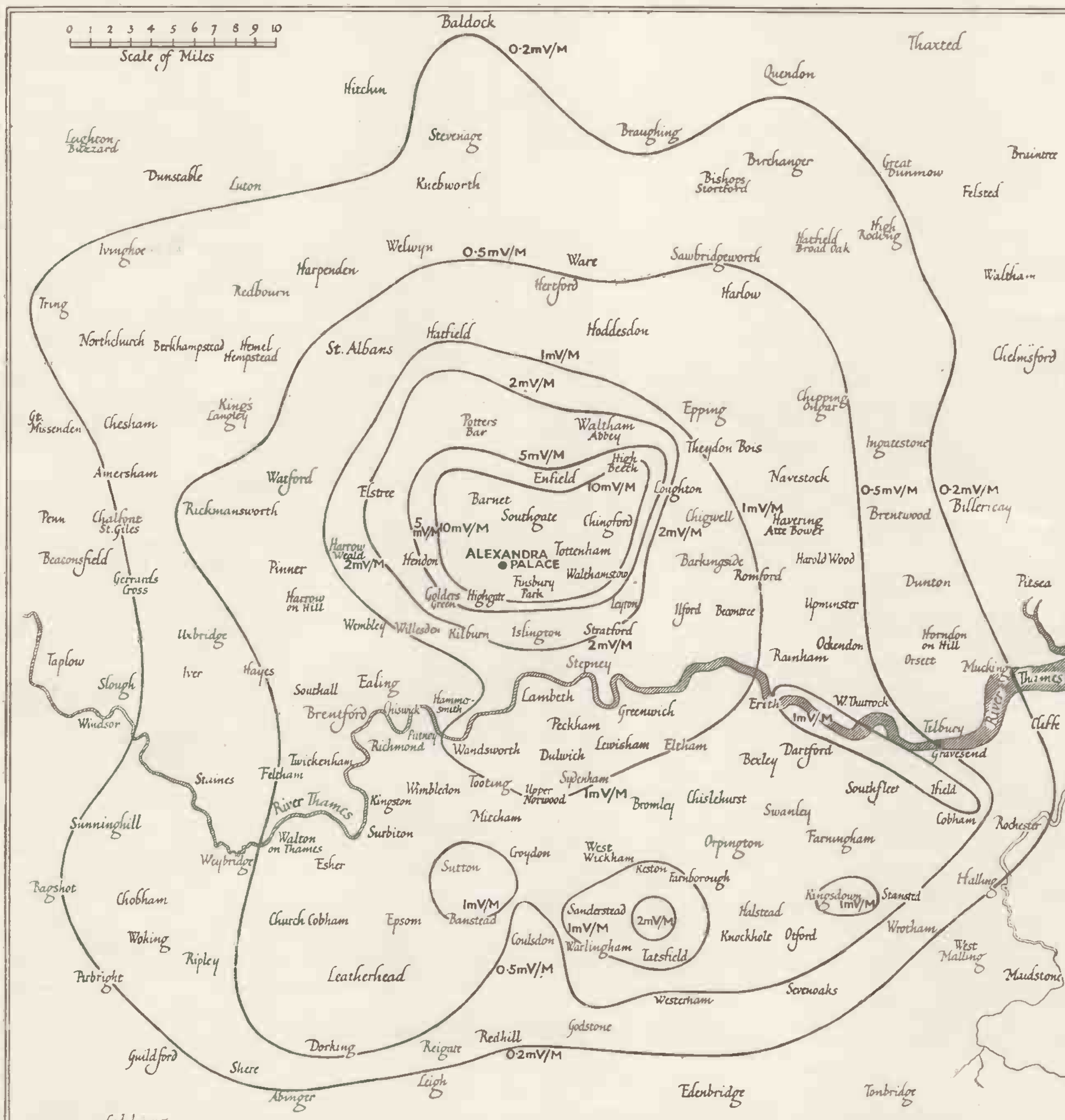


Fig. 3. Alexandra Palace Transmitter field strength measurements; f. = 41.5 Mc/s. Power = 3 kW. Field-strength contours at a height of 2.5 metres above the ground.

gives the field at roof-level, i.e., where a television aerial would normally be placed. The Alexandra Palace vision transmitter gives a field whose average value is about $1\frac{1}{2}$ db. below that of the sound transmitter. The standing wave systems of the two transmitters are, however, independent, and individual measurements have revealed field-strength ratios up to ± 6 db.

On the medium wave band it is quite satisfactory to make measurements at street-level, and to use the results to determine the signal received using elevated aerials. On ultra-short wavelengths this is no longer the case. Measurements using elevated aerials indicate that the received field-strength increases by about 0.3 db. for every foot increase in height above the ground up to a height of about 40 to 50 ft. For greater heights the relative increase in signal strength is reduced. In order, therefore, to determine the probable received signal strength in any position from the Alexandra Palace transmissions, the ground field-strength as indicated by the contours of Fig. 3 should be increased by a quantity appropriate to the height of the receiving aerial. This has been done in the preparation of Fig. 4, assuming a roof height of 10 to 15 metres.

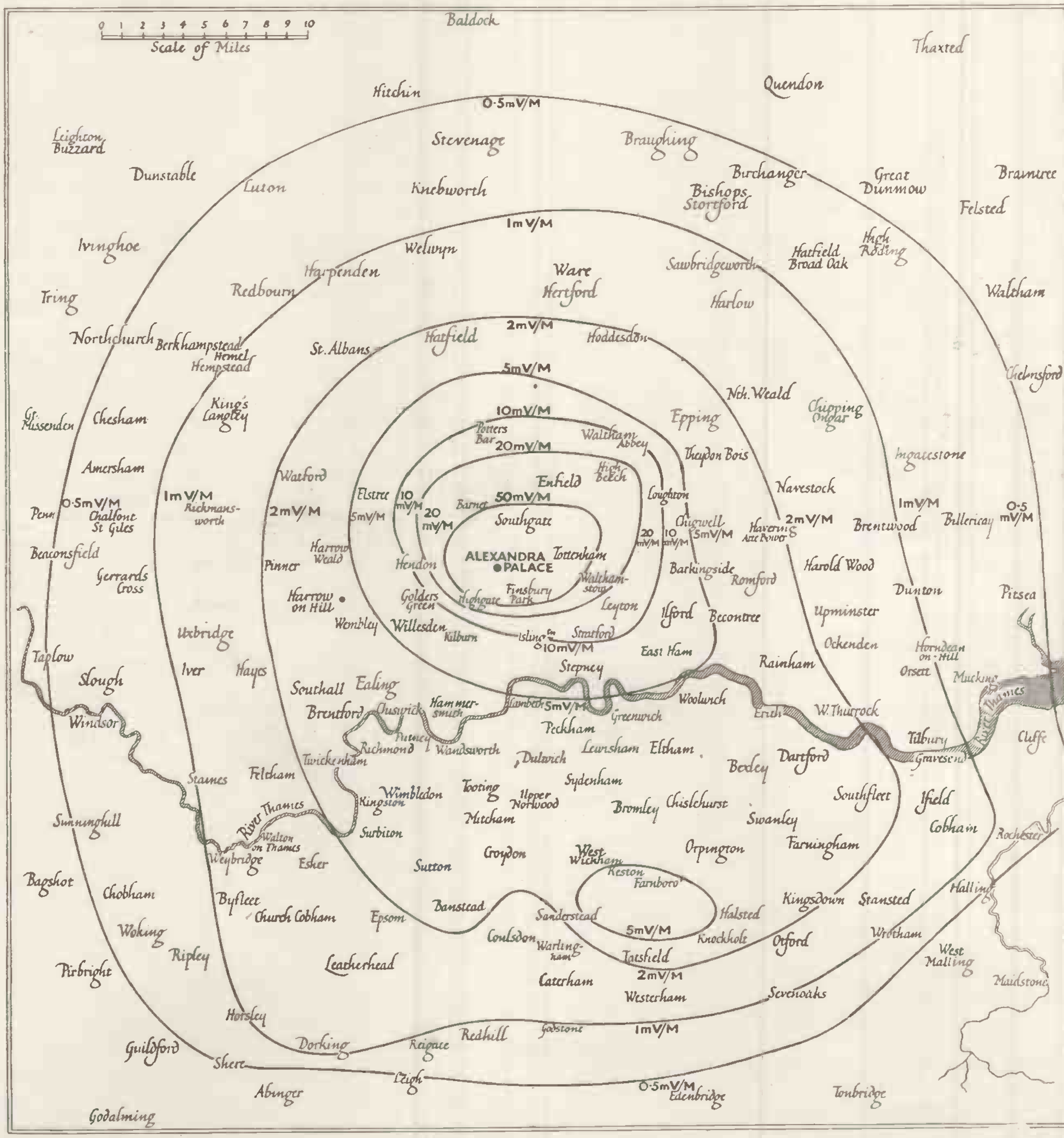


Fig. 4. Alexandra Palace Transmitter field strength measurements; f. = 41.5 Mc/s. Power = 3 kW. Estimated contours at roof level (i.e., 10 to 15 metres above ground).

MAGNETIC SCANNING DEFECTS—AND THEIR CAUSES

Magnetic scanning has received very much more attention in America than it has in this country where electrostatic methods are almost general. Increasing interest is however becoming evident here and in view of this the information contained in this article which is derived from a paper read before The Radio Club of America by I. G. Maloff will be of special interest.

THERE are four important considerations for any deflecting system, the requirements being: deflection sensitivity, freedom from defocusing of the luminous spot, freedom from distortion of the pattern and sufficiently high overall frequency response.

The Ferranti tube is one of the few in this country to employ magnetic scanning.

Two main forms of defects of the scanning pattern present themselves on the screens of cathode-ray tubes. The first is defocusing of the luminous spot, and the second is the distortion of the scanning pattern. By defocusing of the luminous spot is meant the change of the size of the spot when deflected. By distortion of the scanning pattern is meant the deviation of the pattern from its normal rectangular shape. The degree to which the above defects may be present in a particular magnetic deflecting system is determined primarily by the shapes and types of the deflecting fields.

There are two more common defects caused more or less by the deflecting circuit as a whole. They are: non-uniform distribution of the scanning pattern or non-linearity of the sweep, and the cross-modulation between the vertical and horizontal circuits. For the first of these, the wave shape of the magnetic driving circuit and the frequency response of the yoke are responsible. For the second, either the coupling between corresponding driving circuits or the coupling between the fields of the yoke may be the cause.

Both electrostatic and magnetic deflecting systems are subject to the defects enumerated above, and the work of improving both types has been in progress for several years. The early high definition systems in America employed magnetic deflection both ways; early systems in Europe showed preference for electrostatic both ways. At present most of the systems used in America utilise either a combination of electrostatic and magnetic deflection or the all-magnetic systems. (Fig. 1.)

The combined system provides only a partial solution, however. The main source of trouble in such a combination is the defocusing of the spot by the electrostatic field. A certain small amount of similar defocusing shows itself even in the best modern magnetic deflecting systems. The old magnetic systems had an exceedingly large amount of defocusing. All-magnetic systems seem best from the viewpoint of defocusing difficulties, and most of what follows refers to the all-magnetic deflecting system.

Defocusing of the Luminous Spot

Magnetic defocusing is caused by two factors: first, for a given non-uniform magnetic field it is a function of the diameter of the beam while it is under the action of the field, and second, for a given cathode-ray tube it is a function of the non-uniformity of the field in the direction of deflection.

The mechanism of defocusing will be better understood by considering Fig. 2. Consider an electron beam of a circular cross-section with electrons moving parallel to each other. Such a beam before it is deflected will produce a luminous spot B on the screen. This spot will be of a circular shape. Now let us deflect the

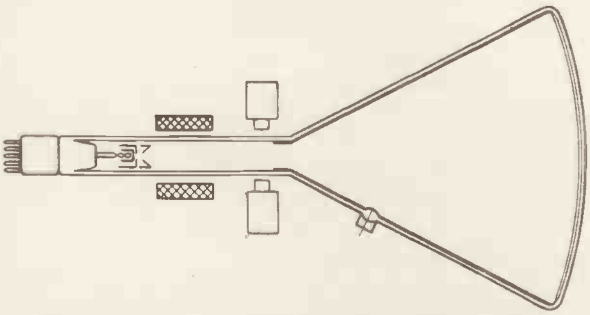


Fig. 1.—Magnetically-focused tube shown diagrammatically.

beam to one side of the screen by means of a magnetic field produced by electromagnets C and C_1. Following the right-handed screw rule the beam will be so deflected that the spot will shift to D. The magnetic field produced by the two coaxial bar magnets will be of a barrel shape form and will be the densest in the middle. The cylindrical electron beam had initial direction towards the centre of this field, but when deflected

SCANNING-PATTERN DISTORTION

it will miss the axis. The side of the beam which is closest to the axis will be deflected more. The side directly opposite will be deflected less. The spot will be compressed along the direction of deflection. It can be shown mathematically that any non-uniform magnetic field possesses a certain curvature, which is a function of the non-uniformity.

Fig. 3 shows a beam of cylindrical shape being deflected away from the centre of a barrel shape field.

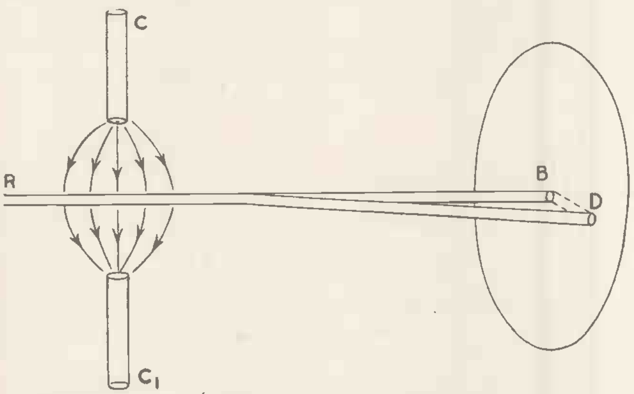


Fig. 2.—The effects causing defocusing.

Away from the plane of symmetry of the field, the curvature of the field results in a component of the field parallel to the plane of symmetry. These components, however, have opposite directions on the opposite sides of the plane of symmetry. In the case shown the upper and the lower parts of the beam will be stretched away from the plane of symmetry in opposite directions, and this will change the shape of the spot from a circle to that of an ellipse with a major axis perpendicular to the direction of deflection.

Therefore we may conclude that the non-uniformity of the field and the curvature of it both act to change the luminous spot into an ellipse with its major axis perpendicular to the direction of deflection. But this will hold only if the direction of deflection is away from the region of the field where it is most concentrated.

When a cylindrical beam is pulled into a field towards the region where it is more concentrated, the beam is stretched into an ellipse with its major axis parallel to the direction of deflection. We may look at the effects of non-uniform fields from another angle. A non-uniform field affects a cylindrical beam as a divergent cylindrical lens.

For deflection towards weaker regions of the field, the axis of this lens is parallel to the plane in which the direction of the deflection lies. For deflection toward stronger regions of the field, the axis is perpendicular to this plane, and the larger the beam diameter the larger the effect of a given field.

So far we have considered only the cylindrical beams. In practice we always have converging beams, which are either focused, or underfocused, or overfocused. It can be shown by reasoning similar to that just given that if a field stretches an overfocused beam in a particular direction, a readjusting of the focusing field to give an underfocused condition will stretch the spot in a direction perpendicular to the former.

Distortion of the Scanning Pattern

By distortion of the scanning pattern is meant the deviation of the pattern from its normal rectangular shape. When all the four corners are pulled away farther than they should be, we get a pincushioned pattern and when these corners are not pulled far enough we get a barrel pattern.

Distortion as well as defocusing is caused by the non-uniformity and the curvature of deflecting fields. A combination of two magnetic deflecting fields each of which is of barrel shape distribution causes a pincushion pattern. A combination of two pincushion fields produces a barrel shape pattern.

The reason for these effects can be better understood by considering Fig. 4. Fig. 4a shows how the components of two pincushion fields add together and give comparatively small resultant for corner deflection and

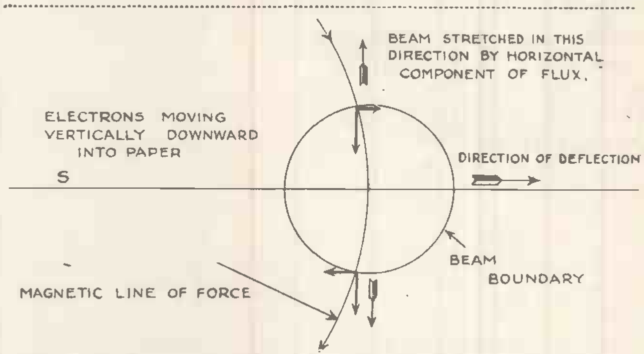
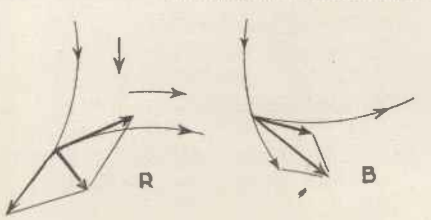


Fig. 3.—Deflection of cylindrical beam from centre of barrel shape field.

a barrel shape pattern. Similarly, the components of two barrel shape fields add together as shown on Fig. 4b and give a pin-cushion pattern.

Overall Frequency Response

To reproduce a saw-tooth wave shape the magnetic deflecting yoke should be capable of responding to many harmonics of the saw tooth frequency. Other ways of obtaining the same result have been suggested, but so far have not proved advantageous. For an infinite ratio of picture to return sweep the co-efficients of successive harmonics are inversely proportional to the order of the harmonic. If the amplitude of the fundamental is 1, the second harmonic comes out as a half, and the third harmonic as a third, and the tenth as a tenth. Therefore the tenth harmonic is of an amplitude equal to ten per cent. of the fundamental.



Figs. 4a and 4b.—Diagrams explaining pincushion effect.

CROSS MODULATION

This is rather high, but it will be interesting to take a simple example. 340 lines and thirty frames makes 10,200 lines or sweeps or cycles of the fundamental per second. This means that the tenth harmonic has a frequency of 102 kilocycles and contributes ten per cent. to the wave. Fortunately we synchronise the picture every frame and every line For positive synchronising we have to take about 10 per cent. of the time. This permits us to have, say, a ten-to-one ratio. Now for a nine-to-one ratio (which is easier to compute than the 10:1 case) of the saw tooth wave, if the amplitude of the fundamental is 1, the amplitude of the second harmonic comes out as .495, the third .300, the fourth .187, the fifth .131, and the tenth is negligible. So we may add to the requirements of a deflecting

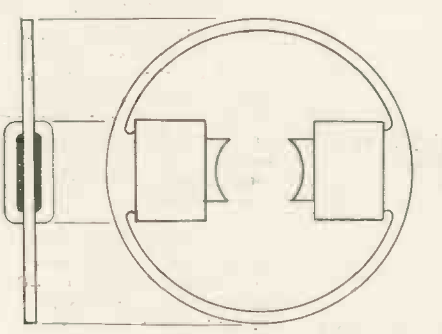


Fig. 5.—Diagram of magnetic deflecting yoke.

system that it must be capable of responding to a frequency band extending from the fundamental of the saw-tooth frequency to its tenth harmonic.

Cross Modulation

Frequently in a deflecting system, a serious cross modulation takes place between the horizontal and vertical circuits. Usually it is the horizontal impulse which finds its way into the vertical deflecting circuit and produces wavy zigzag scanning lines instead of straight lines. It may be caused by coupling of some sort between the driving circuits. This kind of cross modulation is usually eliminated by electrically isolating and shielding the respective circuits. Often, however, it takes place because of either electrostatic or magnetic coupling between the coils of the deflecting yoke.

The type and degree of coupling is usually definitely connected, with electric, magnetic, and physical arrangements peculiar to this particular type. It cannot be treated therefore in general, and has to be studied individually with every particular type of deflecting system. As a rule, however, the cross modulation can be eliminated by so arranging the coils on the yoke that the undesired induced voltages and currents " buck " each other out. Sometimes it necessitates connecting horizontal coils in parallel and vertical in series. In other cases, both should be connected in parallel.

Irregular Defects

In our discussion of defects of the scanning pattern, we have considered so far only the perfectly symmetrical yoke and a centrally located electron beam. If, however, for any reason, either the beam is not centrally located with respect to the yoke, or the magnetic return legs of the yoke are not symmetrical, or the coils are not symmetrically located, irregular defects of the scanning pattern result. If the deflecting field is sufficiently uniform, the position of the beam with respect to the yoke is not as critical as in the case of a non-uniform field. Any non-symmetry in the yoke, however, ruins the uniformity of the field and immediately shows itself by producing defocusing in a part of the picture, stretching a corner or a side of the pattern and usually producing serious cross modulation. The symptoms of the irregular defects are such that they are easily located and eliminated by tracing defective coils and by checking the geometry of the yoke and the cathode-ray tube.

In conclusion, let us consider a deflecting yoke of the type shown in Fig. 5. Two such yokes suitably spaced give a very good pattern for a 340-line 30 interlaced frame picture. It is balanced to give a very uniform field along the directions of deflection. Along the beam it naturally gives a wall of flux, so to speak, and a wall of uniform height.

Book Review

The Low Voltage Cathode-ray Tube and its Applications, by G. Parr, Radio Division, The Edison Swan Co. (Chapman & Hall, 10s. 6d.). 156 pp. plus bibliography 76 figs.

Contents: Construction and Operation, Focusing, Lissajous' Figures, Linear Time Bases, other Time Bases. Applications to Radio and Industrial Engineering, Television.

The author of this book is well-known to readers of TELEVISION AND SHORT-WAVE WORLD through his articles on the cathode-ray tube, and this book will be welcomed as giving a comprehensive outline of the uses to which the tube can be put. A noteworthy point is the number of practical circuit diagrams which would enable the reader to adapt the tube to any particular research desired.

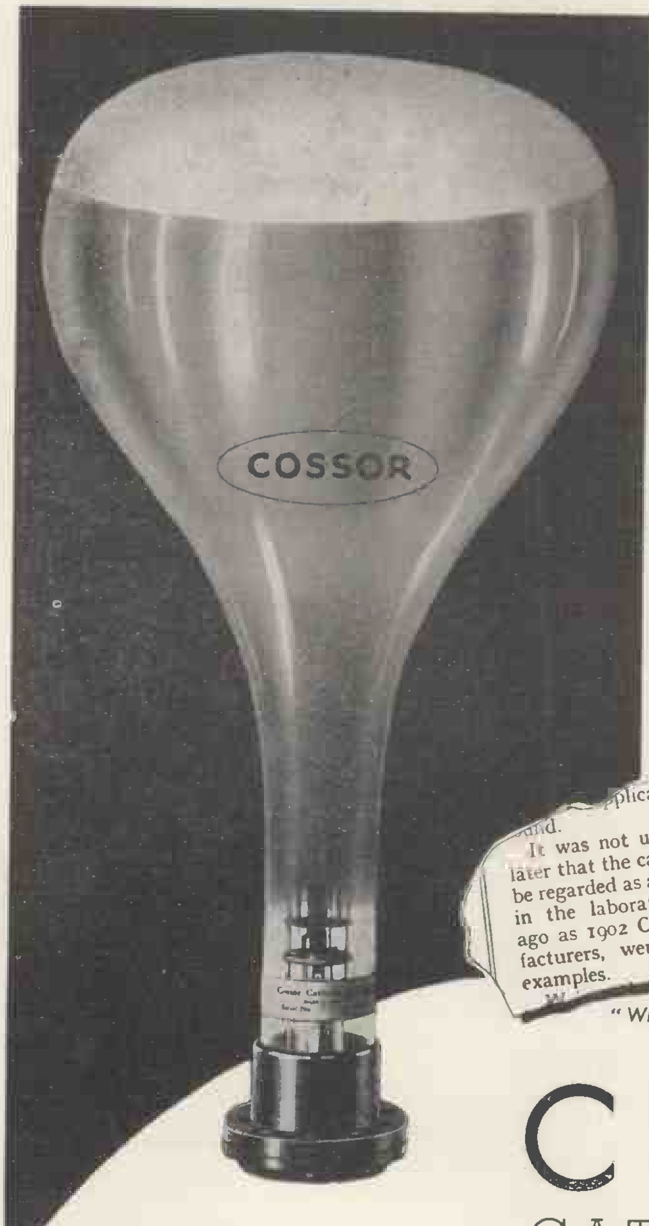
In the chapter on television a description is given of the thyratron push-pull time base and references are made to other types, showing how they can be adapted to television requirements. From a writer as lucid as Mr. Parr usually is we should have expected a better description of the synchronising pulse and the D.C. component, but as television is only treated as one of the applications of the tube, no doubt it was difficult to decide what to compress into the space allocated.

Any brevity in the descriptive part of the book is more than made up for in the bibliography, which is one of the most complete in any book that we have seen for some time.

The author says " no attempt has been made to discriminate between various papers " and wisely, as not everyone has access to a scientific library, but is usually able to refer to one or two technical papers. The references given should enable any user of cathode-ray tubes to find some article bearing on the application in which he is interested.

The book is one which can be confidently recommended to all users of cathode-ray tubes and we hope that it will meet with the response that it deserves.

Pioneers of
CATHODE RAY DEVELOPMENT



The range of Cossor Cathode Ray Tubes is the most comprehensive available to-day and is the direct result of Cossor research having kept continually abreast of Cathode Ray development since 1902.

Pioneers, too, in the Television field, Cossor were the first to successfully apply the Cathode Ray Tube to this problem. Continual research has resulted in an incomparable range of Television Reception tubes which are recognised as unparalleled for their qualities of focus and brilliance.

...pplications for it yet been ...und.

It was not until about thirty years later that the cathode-ray tube came to be regarded as an every-day instrument in the laboratory, although as long ago as 1902 Cossors, the valve manufacturers, were producing their first examples.

" Wireless World " Editorial 2.4.37.

Full data is contained in leaflet No. L.213, a copy of which will be sent on request to "Instrument Dept.," A. C. Cossor Ltd., Highbury Grove, London, N.5.

COSSOR
CATHODE RAY TUBES

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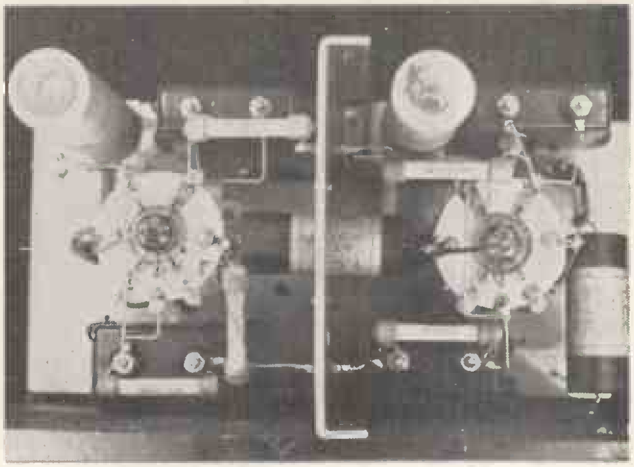
1649

THE FIRST ACORN VALVE RECEIVER FOR VISION SIGNALS

We believe this to be the first published description of a vision signal receiver employing Acorn valves. It is presented as a matter of interest and it is not claimed that it is superior to the more orthodox types, although the use of Acorn valves offers certain advantages.

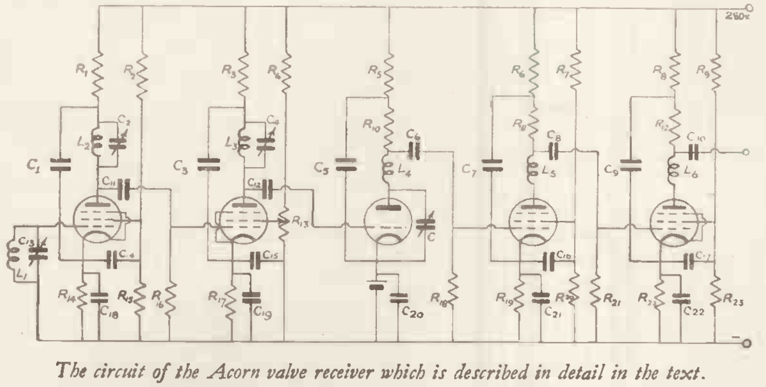


The two L.F. valves in their compartment.

THE Acorn valve, first developed in America and now also made in this country, offers some distinct advantages for ultra-short wave reception and particularly for television. Its most important feature is the small interelectrode capacities, while its small physical size makes it possible to build circuits round it with less than the average stray capacity and therefore of higher efficiency.

The first point which has to be decided when aproaching the design of an ultra-short wave receiver is how much and what sort of H.F. amplification should be used. There are three general classes of design:—

a. Carrier frequency amplification right through to the cathode-ray tube.
b. Carrier frequency amplification followed by a detector and modulation frequency amplifier.
c. Superheterodyne.



The circuit of the Acorn valve receiver which is described in detail in the text.

Of these types of circuit (a) is favoured by some manufacturers, but as five or more stages are needed it would be exceedingly difficult for an amateur constructor without proper facilities to gang and stabilise such a receiver. This therefore can be ruled out of consideration for the constructor. (b) Has the advantage that the stages can be roughly divided as between H.F. and modulation frequency amplification and increased stability thereby secured. (c) Has the usual advantage of fixed tuning for the I.F. stages (a small advantage, when, as in television, the receiver will in any case be used on one wavelength only) but there is the quite serious difficulty of band-passing properly on account of the low ratio of the I.F. to modulation frequency. Even with, say, 20 metres (15 megacycles) the ratio is $7\frac{1}{2}$ to 1 compared with an average of 100 to 1 for medium wavelength sound broadcasting.

It was thought that the method of (b) might be most worth experimenting with.

Before deciding on the number and arrangement of valves one must make a few preliminary calculations as to the stage gain obtainable with Acorn valves. Assuming that of the two types available the pentode will be used for amplifying purposes on account of its high input impedance, and considering first the question of carrier frequency amplification, this is determined by the expression gZ, where g is the mutual conductance of the valve (2 milliamps. per volt) and Z the anode load impedance. The impedance Z depends on the inductance, capacity and resistance of the tuned circuit (it is further assumed that straightforward tuned-anode coupling will be employed) and is given by L/CR, where L and C are together tuned to the carrier frequency concerned—in our case 45 megacycles.

Obviously the greater L and the less C the more the value of Z and hence the amplification. The limiting factor is the capacity C which is made up of the anode-cathode capacity of its associated valve, together with wiring, stray capacities and the input capacity of the succeeding stage. Since, as mentioned, Acorn valves have much lower self-capacities than other valves (the anode-cathode capacity is less than 1 $\mu\mu$fd.) it is possible to get a greater value for Z than would otherwise be obtainable. The ideal method is to have no tuning condenser but to adjust the value of the inductance until it resonates with the inherent capacities referred to at the correct frequency. This is, however, a clumsy way of tuning, and in practice one must have a small tuning capacity, though, of course, the smaller the better. The Bulgin S.W.31 short-wave tuning coil is quite a convenient size to choose and has a nominal inductance of .63 μH. When tuned to 45 megacycles the value of Z is approximately 6,000 ohms, assuming the H.F. resistance of the coil to be 5 ohms. This gives a stage gain of 12—quite a useful figure.

Considering the matter of "low" or modulation frequency amplification, the problem here is to keep the

POINTS IN ACORN VALVE RECEIVER DESIGN

gain constant between 25 and two million cycles. The best method of coupling is that discussed by J. Beardsall in the Feb., 1936, issue of this Journal where an inductance is virtually connected between the anode of a resistance-coupled stage and the grid of the succeeding valve. If a total output and input capacity (with wiring) of a stage is each assumed to be, say, 4 $\mu\mu$fds., then it can be shown that with a suitable inductance we can keep the gain level to within 2 per cent. with an anode resistance of 9,000 ohms. This would make the stage gain 18. One could increase the anode resistance and coupling inductance and improve the stage gain, but the limiting factor is the phase-angle, which is already quite large—32 per cent.—at 2 megacycles, and although a much greater amplitude drop could be tolerated, the larger phase angle would give noticeable distortion.

Components for ACORN VALVE RECEIVER

BATTERY, GRID-BIAS.
1—Type 4½ volt.
CHOKES, SHORT-WAVE.
1—Type HF14 (Bulgin).
2—Type 1010 (Eddystone).
COILS.
3—Type SW31 (Bulgin).
CONDENSERS, FIXED.
2—8 mfd. type 502 (T.C.C.).
2—500-mfd. type 501 „
2—30-mfd. type 541 „
2—.5-mfd. type 250 „
9—.0003-mfd. type M „
1—15-mfd. type 561 „
CONDENSERS, VARIABLE.
3—Type SW54 (Bulgin).
1—Type SW52 „
RESISTANCES.
4—25,000-ohms 1-watt (Dubilier).
6—100,000-ohms 1-watt „
3—50,000-ohms 1-watt „
2—250,000-ohms 1-watt „
2—1,000-ohms 1-watt „
2—9,000-ohms 1-watt „
1—5,000-ohms 1-watt „
1—Variable potentiometer 50,000-ohms (Dubilier).
VALVES.
4—Acorn type 954 (R.C.A.). } or British
1—Acorn type 955 „ } equivalents
5—Acorn valve-holders (Claude Lyons).
6—Insulating pillars, Cat. 1028 (Eddystone).
6—Insulating pillars, Cat. 1029 „
2—Peak electrolytic condenser holders (Bryce).

Since the average cathode-ray tube requires an input of approximately 10 volts for full modulation, we have to be sure that this value can be provided without overloading the acorn output valve. The valve is not made to handle any very large voltage swing, but with a stage gain of 18 the grid input necessary would be under .6 volt and should just about fall within the capabilities of the valve.

The coupling inductance necessary is calculated from the expression LCR^2, where R is the anode resistance. If the latter is 9,000 ohms L evaluates to 324μH. The precise value used is not very critical and it will be found that an Eddystone short-wave choke (Cat. No. 1010) with two of its four sections short-circuited gives an inductance around 400μH which would answer the purpose quite well. It is quite an easy matter to scrape the insulation from the wire joining the middle two sections and connect this point to one end.

From the foregoing considerations two stages of H.F. amplification and two L.F. will give a theoretical overall gain (excluding any in the aerial circuit or detector stage) of approximately 50,000, which is sufficient for most receiving situations within the service area of the London Television Station at Alexandra Palace.

The modulation frequency amplifier should have a good uniform response and low phase angle down to 25 cycles per second and to this end various decoupling condensers have been made suitably large—e.g., the screen grids are each returned to cathode through 30 μfds., the anode decoupling condensers are 8 μfds. each, and the bias decoupling condensers 500 μfds.

The decoupling of the H.F. stages is largely a question of using condensers of low inductance as this is likely to be the predominating reactance. Advantage of this can sometimes be taken by using a capacity which will resonate with its self-inductance at the carrier frequency. It will be found that the small T.C.C. mica condensers of .0003 μfd. have a reactance suitably low for use as anode, screen and grid bias decoupling, and anode coupling to the following stage.

The practice of returning decoupling condensers to cathode has been followed throughout.

The decoupling resistances are calculated for a H.T. voltage of 300, but anywhere between 250 and 300 volts should be satisfactory, though it should not be allowed to exceed 300 on any account, unless screen grid decoupling condensers having a higher working voltage than 100 of those specified are used. In this connection if the H.T. is derived from a rectifier a thermal delay switch should be incorporated so that the valve cathodes are heated before any volts reach the anodes.

The detector stage is one which must receive careful consideration, the chief claimants being the diode and anode-bend methods. The former has the advantage of a good amplitude characteristic, but it is hard to combine with it a good frequency characteristic unless the load resistance is so low as to reduce appreciably the stage gain of the previous H.F. valve. If, however, the load is transferred to the anode circuit we can get a good frequency characteristic without loading the H.F. valve, and the greater amplitude distortion given by the anode-bend detection is not of serious importance.

VALUES OF COMPONENTS.

R. 1— 25,000 ohms Dubilier 1 watt.
R. 2—100,000 „ „ „
R. 3— 25,000 „ „ „
R. 4—100,000 „ „ „
R. 5—250,000 „ „ „
R. 6— 25,000 „ „ „
R. 7—100,000 „ „ „
R. 8— 25,000 „ „ „
R. 9—100,000 „ „ „
R.10— 10,000 „ „ „
R.11— 9,000 „ „ „
R.12— 9,000 „ „ „
R.13— 50,000 „ „ Volume Control.
R.14— 1,000 „ „ 1 watt.
R.15— 50,000 „ „ „
R.16—100,000 „ „ „
R.17— 1,000 „ „ „
R.18—250,000 „ „ „
R.19— 1,000 „ „ „
R.20— 50,000 „ „ „
R.21— 50,000 „ „ „
R.22— 1,000 „ „ „
R.23— 50,000 „ „ „

C. —2.5 mmfds. (Bulgin S.W.52).
C. 1—.0003 mfd., type "M."
C. 2—14.5 mmfds. (Bulgin S.W.54).
C. 3—.0003 mfd., type "M."
C. 4—14.5 mmfds. (Bulgin S.W.54).
C. 5—6.0 mfds.
C. 6—.5 mfd., T.C.C.
C. 7—8.0 mfds. Electrolytic.
C. 8—.5 mfd. T.C.C.
C. 9—8.0 mfds. Electrolytic.
C.10—.5 mfd.
C.11—.0003 mfd., type "M."
C.12—.0003 mfd., type "M."
C.13—14.5 mmfds. (Bulgin S.W.54)
C.14—.0003 mfd., type "M."
C.15—.0003 mfd., type "M."
C.16—30.0 mfds. Electrolytic.
C.17—30.0 mfds. Electrolytic.
C.18—.0003 mfd., type "M."
C.19—.0003 mfd., type "M."
C.20—.0003 mfd., type "M."
C.21—100.0 mfds. T.C.C. Electrolytic.
C.22—100.0 mfds. T.C.C. Electrolytic.

L.1—Bulgin Coil Type S.W.31.
L.2—Bulgin Coil Type S.W.31.
L.3—Bulgin Coil Type S.W.31.
L.4—Bulgin Type H.F. 14 Choke.
L.5—Eddystone S.W. H.F. Choke (½ only).
L.6—Eddystone S.W. H.F. Choke (½ only).

The design of the anode circuit is not without its problems, one of which is to filter the carrier frequency from the modulation frequencies without loss of the latter at the upper end.

(Continued in 1st col. of next page)

Scannings and Reflections

THE CORONATION

VERY complete details of the plans made for televising the Coronation procession are given on another page in this issue. Briefly, the B.B.C. hopes to televise the procession at Apsley Gate, Hyde Park Corner, on the return journey from Westminster Abbey. The broadcast, which will last approximately an hour, will open with crowd scenes and be accompanied by a running commentary. Three cameras will be used. One of these, installed on the plinth of Apsley Gate, will provide overhead views of the advancing procession, while a second camera operated from the pavement immediately to the north of the Gate will provide close-ups as the procession passes through the arch. Another camera facing south will show the end of the procession.

STUDIO "INTERFERENCE"

On several occasions of late there has appeared to be an unwarranted amount of noise in the studio at Alexandra Palace apparently caused by those responsible for rearrangement. During a recent evening talk there was so much noise that it almost drowned the voice of the speaker at times; in addition to the noise one would associate with the moving of heavy furniture about there was shouting and whistling. And the curious part was that when *the next scene appeared* there was no apparent change in what had gone before.

WHAT TELEVISION COSTS

The annual report just issued by the B.B.C. shows that in 1936, for two months of television a revenue expenditure of £111,500 had to be met in addition to a net capital expenditure of £116,546, making a total of £228,046. Though expenditure will not continue to proceed at this rate, the figure for two months' service in 1936 clearly shows that a great deal of money will have to be found every year to maintain and develop the service.

FINDING THE MONEY

There have been many rumours about lately that in order to find the money for television the ordinary listener's licence fee is to be increased to 12s. 6d., in fact, so persistent has the rumour been that many listeners are quite concerned at the prospect of having to pay for something which they do not receive. The improbability of such a happening hardly needs comment, for it would be met with a storm of protest that would be impossible to withstand.

The suggestion of a special licence for television has also been mooted, and though this appears to be the eventual solution of the problem of finding the money to finance the broadcasts, at the present time the income which could be derived from this source would be insignificant. The immediate solution appears to be a claim on that 25 per cent. portion of the licence fee which at present goes to the Exchequer. It will be remembered that the Ullswater Committee recommended that this should be potentially available for the B.B.C. if it was required for further development. The Government accepted the recommendation that the B.B.C. should be entitled to apply for a further allocation should it be required, but whether they will get it is another matter.

ON APPRO.

According to one manufacturer of television receivers several cases have occurred of individuals asking for a television receiver to be installed on approval for the sole purpose of entertaining their friends for an evening. The next day they have stated that they did not wish to keep the receiver and have asked for its removal. Considering the work that is involved in installing a television receiver, which includes the erection of a special aerial and testing, this is a bit tall, so the practice has been obviated by making a fixed charge of three guineas to cover expenses should the receiver not be retained.

TELEVISION IN RUSSIA

A report just issued by the All Union Radio Committee of Russia shows that the total time of television broadcasts in that country during 1936 occupied 480 hours, or 1.7 per cent. of the total broadcasting time. Entertainment accounted for 44.5 per cent., and information, 33.2 per cent.

NO PRIVATE STATIONS IN FRANCE

The French Minister of P.T.T. has announced that all television experiments shall be made by the Government in collaboration with specialists only. Refusals have been made to Poste Parisien and Toulouse for permission to transmit television, despite the fact that in the former case the necessary apparatus has already been installed. The reason given is that the development of television must proceed upon ordered lines and not in the haphazard fashion which was experienced in the development of sound broadcasting.

M. André Serf, president of the Manufacturers' Union, during an interview with M. Godfrein, engineer representing M. Jardillier, French P.M.G., said that it was of the highest importance for the develop-

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"THE FIRST ACORN VALVE RECEIVER FOR VISION SIGNALS"

(*Continued from preceding page*)

The anode load resistance has to be lower than that used in the succeeding stages—5,000 ohms being used. Forming an H.F. filter is a Bulgin ultra-short wave choke (type H.F.14) and, between anode and cathode, a Bulgin 2.5 $\mu\mu$fd. semi-variable condenser (type S.W.52). Owing to the difficulty of estimating the cathode resistance necessary to give the required grid bias for a valve such as this where the anode current depends upon the applied grid volts it will be safer to insert a small $4\frac{1}{2}$-volt grid-bias battery in the cathode lead, tapped to provide the correct bias voltage. The accompanying panel gives the list of components required for this receiver.

The layout and constructional details of the receiver will be dealt with in a following article next month.

MORE SCANNINGS . . . .

ment of television in France, that a single and definite standard for a 2-3 years' period be adopted as soon as possible. Until it is, French industry will be largely handicapped, "particularly in comparison with the British industry, which knows its standard, since about a year ago."

He further stressed the importance of precautions which will prevent the adoption of a standard giving a *monopoly of fact* to any industrial group.

B.B.C. TO PRODUCE A FILM

The B.B.C. is to produce another film for television and propaganda purposes. This film is to deal with the development of television from its earliest beginnings and, in addition, will provide excerpts from some of the most successful programmes. Production will be done at the Cricklewood studios, and in addition to its use for propaganda purposes it will form the principal item for the morning broadcasts which are contemplated to enable dealers to demonstrate receivers.

AMERICA IS INTERESTED

Television developments in this country are interesting the radio industry of America. Mr. M. K. Taylor and Dr. N. H. Searsby, both of the Ferranti Radio and Television Research Department, sailed recently in the *Queen Mary* for the purpose of exchanging information with representatives of the industry in that country. They took with them an example of the latest Ferranti television receivers.

WHERE ARE THE ANNOUNCERS?

Why do those responsible for presentation at A.P. still continue to make announcements of programme matter by means of lettered notices. Even when a verbal announcement is made the announcers are seldom in evidence visually. After all the fuss that was made regarding the selection of the announcers it seems remarkable that so little use is made of them, particularly during the intervals which appear to be so essential in the television programmes.

AERIAL HEIGHT

The importance of aerial height has often been stressed in these columns, and it will be clear how this is borne out in the field strength maps which are published on other pages in this issue. It will be seen that at a height of about twenty feet there is an increase in some cases of as much as five times the strength at about six feet above ground.

KERR MEMORIAL LECTURE

The Kerr Memorial Lecture of the Television Society will be given on Wednesday, May 19th, by Professor J. T. MacGregor-Morris, M.I.E.E., Head of the Electrical Engineering Department, Queen Mary College, and the subject will be "The History and Development of the Cathode-ray Tube." The lecture will commence at 7 p.m., and will be illustrated by experiments and historical exhibits.

It will be given in the Lecture Theatre of the Royal Institution, Albemarle Street, London, W.1, which has been loaned to the Society for this annual lecture.

Cards of invitation may be had on written application to the Honorary General Secretary, J. J. Denton, Esq., 25 Lisburne Road, Hampstead, N.W.3.

PROGRESS ABROAD

From the information that is given on other pages of this issue it will be evident that very serious attention is now being given to television in other countries, particularly in America and France. In the former country both the National Broadcasting Company and the Columbia Broadcasting System are making elaborate plans and, in addition, there are other lesser but important concerns engaged in development. The Don Lee Broadcasting System, of Los Angeles, California, for example, is putting out a series of transmissions which, although experimental, are worked to a schedule, and the Philco Radio and Television Corpporation are also transmitting on the new American standard of 441 lines.

Farnsworth Television Inc. have also been making regular experimental transmissions for a considerable time with 343 lines and this gear has just been altered to conform with the new U.S.A. standard of 441 lines with a power of 4 kilowatts. Radio Pictures Inc. is another concern that is taking an active part in television development and regularly scheduled experimental broadcasts will be made when the new equipment operating on the new standards is completed.

Very little information regarding German activities has been revealed since the last Berlin radio exhibition, but it is known that the German research engineers are now paying serious attention to electronic methods.

In Italy the Italian Broadcasting Company has set up a research board at their Rome station for the purpose of engaging in television work, but so far as is known no public service is contemplated at present. Several private concerns are also experimenting.

High-definition research is also being conducted in Holland, Sweden and Japan, and in Russia the construction of three high-definition stations has been planned for operation in Leningrad, Moscow and Kiev.

SWEDISH LOW-DEFINITION TRANSMISSIONS

Low-definition transmissions of vision are being sent out through Motala on a wavelength of 1,389 metres with a power of 100 kilowatts. These transmissions are merely engineer tests and are not accompanied by sound, although the number of lines and type of system is usually given before the vision signals are put on the air. These transmissions are for one hour, from 11.30 a.m. to 12.30 p.m., Monday to Friday.

FOCUS

Among the many criticisms of the television programmes, that of focus is often brought up. However poorly our receivers may be adjusted we are often aware of the principal artist or objects suddenly becoming much clearer or vice versa. This is due to camera manipulation. Last time we were in the studio we noted that the type of lens used is an F/3 6.5-in. focus. Such a lens, photographers will know, has very little "depth" of focus, that is to say, suppose we focus on an object 3 feet away anything nearer than 2.93 feet or further than 3.08 feet will be out of focus, taking 1/100 inch as the circle of confusion, which in photography is rather a low standard. With such fine limits to work to it is a wonder how anything is even kept in focus at all.

Our Policy
"The Development of Television."

. . . . AND MORE REFLECTIONS

PROGRAMMES FOR SHORT-WAVE LISTENERS

The three American broadcasting groups are being inundated with letters from European listeners, and not all sending bouquets. While American stations are being well received, the programme matter is not always of the highest order. Arrangements are being made by at least one company to record some of the best items and re-play them over the short-wave stations at more convenient times.

This will mean that short-wave listeners will be able to hear the best of the American programmes without burning the midnight oil.

BREAKDOWNS

These have been numerous since the decision to use only one system was made. This is not surprising when one considers how relatively little apparatus is at the Palace, and the amount of work which it has to do. Transmissions probably take only 20 per cent. of the total working hours of the gear. What actually is the cause of these breakdowns is not published, but we gather that they are generally due to failure of the supply circuits, H.T. and L.T., rather than the television apparatus proper.

THE OFFICIAL B.B.C. CORONATION COMMENTATOR FOR TELEVISION

Freddie Grisewood, the popular radio announcer at Broadcasting House, has been moved to Alexandra Palace where he will play a big part in television activities. It has been officially announced that he will be the television commentator of the Coronation Procession; he has already made his debut with the Walking Through Fire transmission on April 20th last. Grisewood's style should do a lot to brighten up the presentation of the vision programmes, while as he is generally full of new ideas we should soon be seeing some of the fruits of his imagination.

SHORT-WAVE FIELD DAYS

The R.S.G.B. National Field Day is, as usual, to take place in June, when the cream of the Society will be operating portable stations no matter what kind of weather may prevail. These field days are very popular amongst amateurs and increasing numbers take part each year. It counteracts the suggestion that the amateur movement is losing interest in actual experimental work. The use of portable stations does much to train young operators to be of use in time of national emergency and should be given every encouragement.

Field day stations will be on the air from 18.00 G.M.T., June 5, to 18.00 G.M.T., June 6, 1937.

Direction-finding competitions are periodically held by the Golders Green and Hendon Radio Scientific Society and directed by Lieut. Col. H. Ashley Scarlett, D.S.O.

This year on Sunday, May 23, a competition on 80 metres is being held in the St. Albans district. On June 5 another field-day for 5-metre stations is being organised to test apparatus, while on September 12 there is to be a full 5-metre competition which is open to members.

By making the D.F. competition open to all interested amateurs a large number of entrants are always obtained, so the competition becomes of national interest rather than only to the members of the society.

CORONATION RELAYS

The General Electric Company, in addition to exporting huge quantities of all-wave receivers to be delivered before the Coronation, are completing the installation of a permanent radio relay service in British West Africa. The service will operate through 5,250 loudspeakers from seven centres. Installations at Lagos, Accra, Cape Coast, Sekondi and Freetown, have already been completed, while installations at Koforidus and Kumasi are in course of construction. This equipment is being fitted up in the main villages for educational and entertainment purposes, but at each point as many as 5,000 natives will be able to listen in simultaneously.

THE TELEVISION SOCIETY

Owing to a typographical error our report on this Society contained on page 211 of the April issue gave readers an incorrect idea as to the membership increase.

Actually there were no less than 394 active members in 1936, as compared with 354 in 1935. During 1936 18 Fellows, 34 Associates and 3 Students were admitted to membership. The Hon. General Secretary of the Television Society is Mr. J. J. Denton, 25 Lisburne Road, Hampstead, N.W.3, from whom all details can be obtained.

MORE ULTRA-SHORT WAVE TELEPHONE CIRCUITS

The G.P.O. continue to demonstrate the value of ultra-short waves in the commercial world. They have already installed 5-7-metre radio links instead of the usual phone cables over distances up to 110 miles. Additional radio-telephone links are now to be erected for use between Oban and Tobermory on the island of Mull, Tobermory, and the islands of South and North Uist in the Outer Hebrides, and possibly between some of the scattered Scottish islands. Experiments are also being carried out to determine the possibility of using radio instead of cable across the English Channel. The saving in cost by using a radio link instead of cable is very considerable.

This photograph shows a section of the recent Television Exhibition at Selfridges which was organised in collaboration with Baird Television Ltd.

TELEVISION AT THE IDEAL HOME EXHIBITION

The replica of the Alexandra Palace Studio at the Ideal Home Exhibition.

THE largest scale demonstration of television so far given was staged at the Ideal Home Exhibition at Olympia, and some idea of the success of this demonstration as a side show will be clear when it is stated that the number of visitors averaged three per second or over 10,000 per hour. With two shows a day this meant 20,000 a day (exclusive of visitors during the time when there was no transmission on) or roughly 230,000 for the entire duration of the exhibition.

Long queues, reaching a considerable distance round the hall, formed up at every transmission time, but the arrangements were so excellent that there was very little time wasted in waiting, and every visitor was enabled to obtain a representative view of some part of the programme. Twenty Marconiphone receivers were in use, arranged in a normal way round that section of the hall devoted to television, and every visitor had the opportunity of passing before all the receivers should he so desire. Another feature was that the television demonstration section was not in total darkness, as was the case at Radiolympia, and viewers therefore did not require to become accustomed to the change in illumination.

Results were consistently good and the degree of technical perfection that has been attained was the subject of a considerable amount of favourable comment by the public. Despite the fact that there were large numbers of different pieces of apparatus in the building likely to cause interference, this was practically non-existent or at the most only revealed itself as tiny specks of light, which did not in any way detract from the pictures.

In addition to the demonstration of reception there was a small replica of the Alexandra Palace studio, complete with Emitron camera and floodlights, etc. As this was of necessity small on account of the space available it perhaps did not convey quite the atmosphere of the A.P. studio, but it gave the public some idea of the arrangement and the apparatus used in putting out television transmissions. The organisers are to be congratulated on placing before large numbers of the public an entirely excellent exhibition of television.

The B.B.C. Annual, 1937

THE B.B.C. Annual, which has just been published, contains 176 pages, profusely illustrated, and covers B.B.C. activities from January 1 to December 31, 1936. It may best be described as the listeners' book of reference, for in addition to a review of the broadcast programmes of the year it presents a wealth of information on such matters as advisory councils, committees of the B.B.C., rules for S.O.S. messages, finance, statistical matters, particulars of arrangements for visits to London and provincial studios, details of weather forecasts, the time signal service, etc. There is also a considerable amount of technical information on radio developments, studio design, transmitter details and a simple explanation of television. In addition the results of the B.B.C.'s survey of field strengths are given which by kind permission of the B.B.C. are reproduced on other pages in this issue. The price of the Annual is 2s. 6d., or 3s. by post, and it can be obtained from the B.B.C. Publications Department, 35 High Street, Marylebone, London, W.1, or the B.B.C.'s Regional offices.

"A 4-valve All-wave Super-het"

IN the January, 1937 issue, on pages 39, 40 and 41, we described a 4-valve All-wave Super-het using the B.T.S. all-wave coil unit. The designers of this unit, in order to simplify assembly, have now colour coded the connecting leads.

Constructors should be guided by the following table when connecting up the coil unit. These are the leads and their respective colours. Plain yellow to aerial terminal; plain red to oscillator grid; plain blue to oscillator anode; yellow and brown to oscillator high tension; plain green to .01-mfd. feed condenser from diode; plain green to top end of volume control; plain black to earth terminal; plain brown to A.V.C. line; and the screened lead to pickup socket.

All the above leads are connected underneath the receiver chassis. The following leads are connected to components on top of the chassis. Yellow and red to front section of ganged condenser; green and black to centre section of ganged condenser; orange to rear of oscillator section of ganged condenser; plain black to rotor plates of ganged condenser.

"French 5-metre Activities"

BY inference, readers would have assumed that this article, appearing on p. 236 of our April issue, had been especially written by correspondent G5UK, but we owe it both to him and to our readers to explain that we ought to have given full acknowledgment to "Radio Ref" in which much of the information had appeared, the matter having been translated for us by G5UK.

THE TELEVISION ENGINEER

THE DESIGN OF VISION-FREQUENCY AMPLIFIERS—III

By P. NAGY, G.I.E.E., Research Dept., International Television Corporation Ltd.

This is the third and concluding article on the design of picture frequency amplifiers. High and low frequency correction is dealt with in detail. The theoretical considerations have been proved by measurements in conjunction with several R.C. coupled photocell amplifiers used for the amplification of signals generated by a television film transmitter.

It was shown in the first and second parts of this article how important the true reproduction is of all the picture component frequencies Phase distortion at low and high frequencies must be regarded as more important than amplitude distortion; this should be always remembered when applying correction calculations. It was also shown that the highest vision frequency is given by the number of lines, frames and the picture ratio; taking into account the aperture distortion one is always on the safe side in applying the theoretically calculated value. Something similar could be said about the frame frequency when determining the lowest important frequency. But here the problem is much more complex, because the synchronising impulses greatly modify the actual picture frequencies.

Taking, for example, the case of a photo-cell amplifier attached to a film transmitter, the amplified vision signals are applied to a mechanical receiver; the rotating parts of the transmitter and receiver are driven from the same mains and there is no necessity to use synchronising impulses. In such a case the frame frequency, as the lowest important frequency, is sufficient for the reproduction of an average picture, but one would fail to reproduce a continuous white background with a corresponding lower frequency.

In the case of the Alexandra Palace transmissions the conditions are much more advantageous. Quite independent of the method of rectification in the receiver, the line frequency can be regarded in a way as a carrier frequency for the lower vision signals. The knowledge of this fact greatly simplifies the task of the constructors; the true amplification of the phase and amplitude at 10,000 cycles does not present any difficulties and can be achieved with the simplest means.

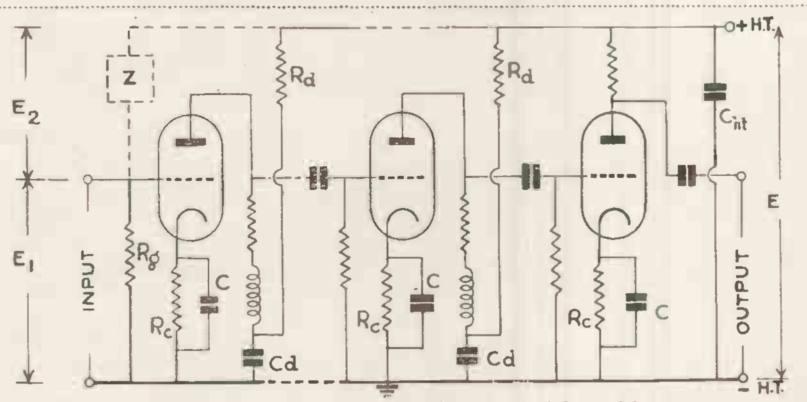


Fig. 17. High- and low-frequency corrected R.C. coupled amplifying stage.

Push-pull Amplifier

The stability and efficiency of the R.C. coupled amplifying stage is increased by using the push-pull circuit. Especially in amplifiers with large amplification, wide frequency range and large output voltage, it represents an ideal solution.

Let us first consider certain characteristics of a usual R.C. coupled stage, as seen in Fig. 17, which are disadvantageous.

1. To be able to achieve constant grid bias, by using the voltage drop of the anode current over the cathode resistance R_c, the impedance $(1/\omega C)$ of the bridging capacity C should be a fraction of R_c

Taking a practical case: $R_c =$ 200 ohms, then $1/\omega C$ must be approximately 10 ohms at 50 cycles per sec., which should be the lowest important frequency, and
$C = 1/2\pi \cdot 50 \cdot 10 = 320$ microfarads.

Such high microfarad values represent constructional difficulties; especially if powerful valves must be used with larger bias voltages, even electrolytic condensers become voluminous over 20-25 volts.

Photocell amplifier atta hed to a film transmitter, showing amplifiers A and B and the mains units for supplying H.T. and L.T. voltages. Note the symmetrical construction. The bias of every stage can be adjusted by the control knobs and the neutralising condensers are also adjustable from the front.

2. Similar difficulties are to be expected regarding the decoupling of the screen grids using high-frequency pentodes. Insufficient decoupling in the above two cases results in amplitude and phase distortion at the lower frequencies.

3. Mention has already been made in the first part of this article of the difficulty which arises when extending the frequency response at the low-frequency side: instability will occur. This instability danger increases with the number of stages, i.e., with increasing amplification. The cause of these troubles is manifold and rather complex, but if one disregards the effects of the grid current and a possible D.C. leakage through the grid coupling condensers, the main cause of oscillation is a feedback voltage E, developed across the decoupling condenser C_{ht} of the H.T. line (Fig. 17). Generally it is impractical to use too high microfarad values as C_{ht} in the smoothing circuit. As seen in Fig. 17, a certain amount of feedback voltage E_1 is always across the grid of the first stage. E_1 is a fraction of the voltage E and depends on the ratio of Z and R_g. By increasing the time constants of the amplifying stages, i.e., extending the response of the amplifier at the low frequencies, one will always reach a point where oscillation starts. Low-frequency correction circuits (R_d, C_d) improve conditions, but do not altogether eliminate the above troubles.

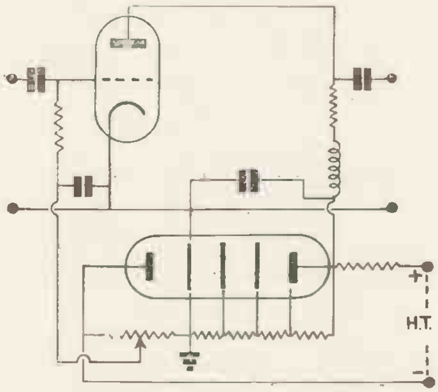


Fig. 18. High-frequency corrected R.C. coupled amplifying stage using stabilising voltage divider.

4. The attenuation of the high vision frequencies, using triodes, is greatly increased by the so-called Miller Effect with the result that triodes are practically rendered unsuitable when comparing their efficiency with H.F. pentodes. This is a deplorable fact, because in the output stages of certain vision amplifiers the use of triodes is highly desirable, due to their better quality and larger voltage carrying capacity.

Calculating an example, one will fully realise the importance of the large grid-anode capacity C_{ag}, affecting the increase of the loss capacity C[1]. The latter is given with satisfactory accuracy by the following formula:—

$$C = C_{ag1} + C_{ac1} + C_{gc2} + (m_2 + 1) C_{ag2} + C_w$$

where

C_{ag1} = grid-anode capacity of the first valve

C_{ac1} = anode-cathode capacity of the first valve

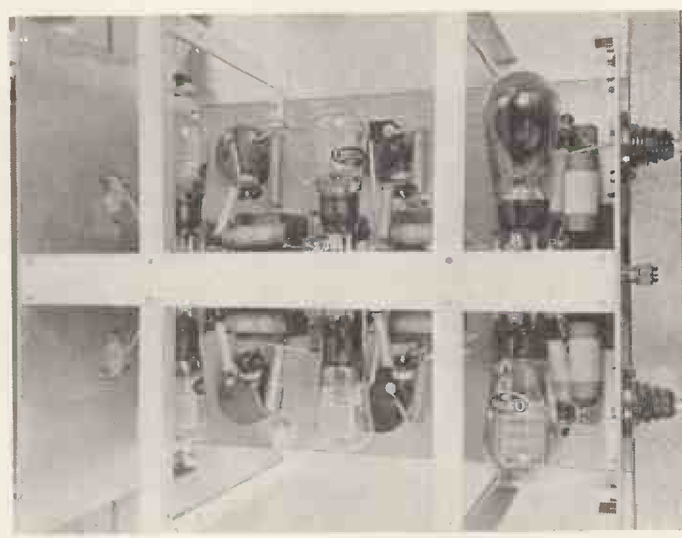
C_{gc2} = grid-cathode capacity of the second valve

m_2 = actual amplification of the second stage

C_{ag2} = grid-anode capacity of the second valve

C_w = wiring capacity.

Choosing an average triode one must expect approximately the following result:



Amplifier B. Three triode stages.

$$C = 5 \text{ mmf.} + 10 \text{ mmf.} + 8 \text{ mmf.} + (5 + 1)\, 5 \text{ mmf.} + 7 \text{ mmf.} = 60 \text{ mmf.}$$

The result of the high loss capacity is naturally very low gain per stage. Quite apart from the lengthy calculations which are necessary for the determination of C in applying high-frequency correction, one has to deal with two unknown values, C and m, and the solution is only possible by a cut-and-try method.

The above-mentioned drawbacks (1, 2 and 3) accompanying good L.F. response, i.e., the use of large microfarad values in the decoupling circuits and general instability, can be improved upon by the use of stabilising neon tubes[2], as indicated in Fig. 18.

The A.C. resistance of the neon discharge tube is very low, approxi-

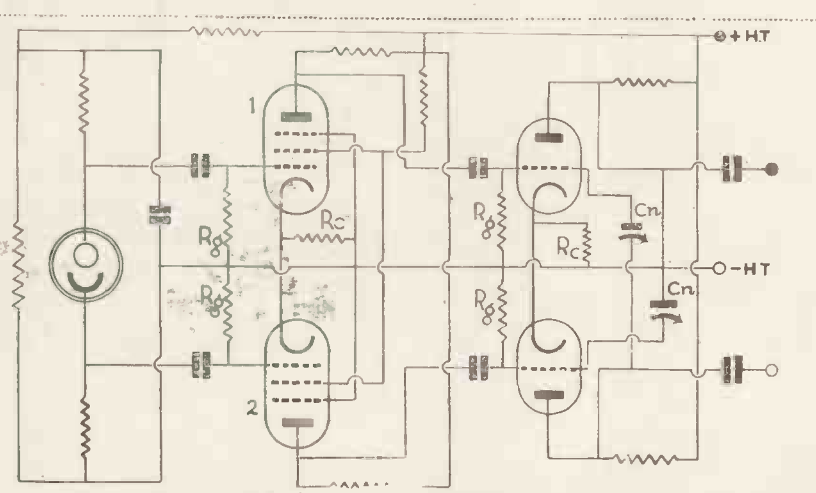


Fig. 19 The circuit diagram of a push-pull amplifier combined with a photocell

[1] See Fig. 13, page 211, TELEVISION AND SH.-W. WORLD, April 1937.

[2] "Stabilovolt" Marconi.

mately 150 ohms per a 70-volt voltage dividing gap, thus being equivalent to the capacitance of a very large capacity at low frequencies. By using neon voltage dividers it is actually

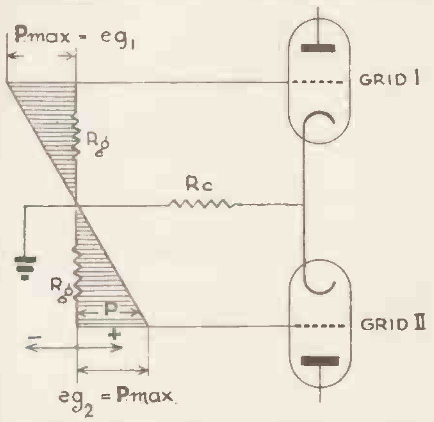
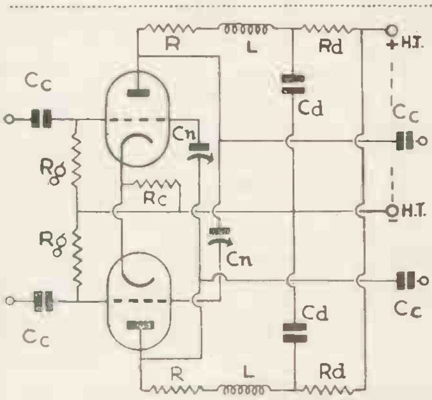


Fig. 20a. Potential distribution across the grid leaks of a P.P. amplifying stage.

possible to build very stable television amplifiers. There are drawbacks, however, which are very high consumption and the necessity of high voltages on the mains side.

By considering the disadvantages of above detailed solutions, the superiority of the push-pull amplifying stage will be apparent.

In Fig. 19 we have the circuit diagram of a H.F. pentode and triode stage combined with a photo-cell. The photo-cell currents will induce on the grids of the first stage equal voltages



but of opposite sense, as indicated in Fig. 20a. There we actually see the potential distribution across the grid leak Rg; P_{max} is the momentary grid voltage. The variations of P_{max}, i.e., the grid voltage, we see in Fig. 20b. Fig. 20 helps to explain the function of the valves operating in push-pull. From the anode current-grid voltage characteristics of the corresponding valves is apparent the following: the sum of the anode currents of valve 1 and valve 2 is constant, supposing that

(*a*) the valves are working in class "A."

(*b*) the slope of the valves is the same along the actually used parts of the characteristics.

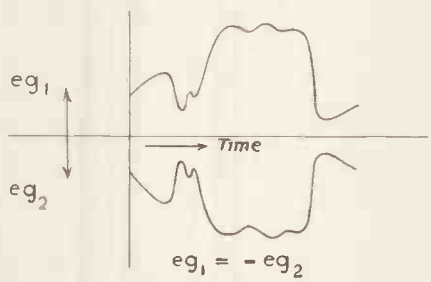


Fig. 20b. Grid voltage changes in case of a photo-cell amplifying stage.

(*c*) the applied signals are equal in amplitude and opposite in sense.

Similar considerations prove that the sum of the screen-grid currents in the corresponding valves is also constant.

This knowledge is of great importance, realising that the constancy of the anode and screen-grid currents represents an ideal decoupling effect. One can eliminate the bridging condenser across the cathode resistance, which is supplying the grid bias. Further one can disregard the use of the screen-grid and H.T. decoupling condensers.

Left—Fig. 21. High- and low-frequency corrected push-pull R.C. coupled amplifying stage.

Right—Amplifier A. Photocell and three pentode stages.

By careful matching the corresponding push-pull pairs one succeeds in achieving such a degree of stability of the amplifier, which is not possible by any other means.

The efficiency of the triode push-pull stage is increased by eliminating the apparent increase of the anode-grid capacity, caused by anode feedback. This is done by the use of neutralising condensers C_n (Fig. 19). C_n must be equal to the grid-anode capacity and it varies between 3 and 15 mmfds. The determination of the loss capacity C is also greatly simplified when applying high frequency correction.

In the case of push-pull amplifiers

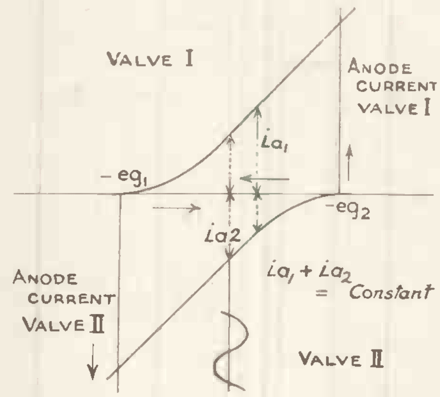
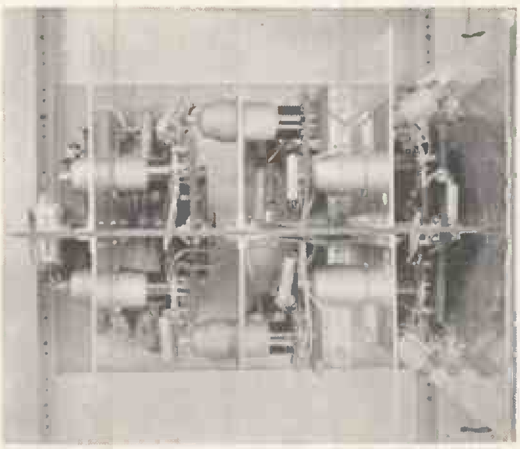


Fig. 20c. Anode current - grid voltage characteristics of the corresponding valves; demonstrating that the sum of the anode currents is constant.

high- and low-frequency correction can be done in exactly the same way as was detailed in Parts I and II of this article. Fig. 21 represents a high and low-frequency corrected push-pull stage.

The gain of the P.P. amplifier is not increased over that of the single amplifier; the undistorted voltage output will, however, be doubled. If large voltage or power output is re-



quired far better quality can be achieved using the push-pull circuit and at the same time the mains eliminator voltages remain low.

There are no constructional difficulties; it is, however, important that the layout of the amplifier should be kept as symmetrical as possible, as seen in the photographs, which show the construction of a three-stage pentode and triode photo-cell amplifier.

The Marconiphone Model 703 Mastergram.

A NEW MARCONIPHONE RECEIVER

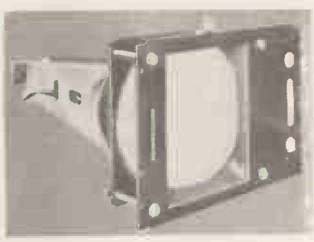
TELEVISION :: ALL-WAVE RADIO GRAMOPHONE

A NEW receiver has been produced by the Marconiphone Co., which comprises a television receiver for pictures transmitted with 405 lines 50 frames per second from the Alexandra Palace, together with the sound accompaniment; a four-waveband radio receiver, covering the following wavelength ranges:—16.7-53 metres; 46-140 metres; 185-560 metres; 750-2,200 metres, and an automatic record-changing gramophone enabling up to eight 10-in. or 12-in. records to be played, repeated, or rejected, at will.

The vision equipment comprises the Emiscope tube unit and vision receiver with, of course, time bases and power pack. The vision receiver unit consists of a 6-valve T.R.F. receiver fixed-tuned to 45 megacycles (6.67 metres). This unit amplifies the signal from the aerial some 40,000 times and rectifies it ready for application to the Emiscope cathode-ray tube. The valve train consists of five Marconi MSP4 valves in series, followed by a Marconi MSP41, the output of which is rectified by a Marconi D42. This output is then split and applied to both the Emiscope tube unit and to the synchronising unit.

The pictures are viewed in a mirror at 45 degrees in the lid of the cabinet, the size of the picture being 10 ins. by 8 ins.

The sound receiver unit is a normal broadcast chassis adapted to deal with the television sound broadcasting on 41.5 megacycles (7.23 metres) as well as the normal long-wave, medium-wave and two short-wave bands. For the sound accompanying the televised pictures the input to this is taken from the second stage of the vision receiver and it deals with the signal in the normal broadcast manner. The circuit, which is a high-fidelity superhet, consists of a VMP4G H.F. valve, H.F. transformer coupled to the X41 mixer valve. The resultant I.F. signal at 460 kc. is applied to the I.F. stage and passed on via a second I.F. transformer to a double-diode-triode which is resistance-capacity coupled to a high-efficiency output pentode.



The Emiscope cathode-ray tube is mounted in a special chassis.

The gramophone equipment has an automatic record-changer which enables up to eight 10-in. or 12-in. records to be played, repeated or rejected at will. An elliptical moving-coil loudspeaker is used, the features of which are non-directional sound transmission and high top-note response. The cabinet dimensions are, height $38\frac{1}{2}$ ins., width $47\frac{1}{2}$ ins., depth $21\frac{5}{8}$ ins.

Refinements include a concealed lamp which flood-lights the television controls for purpose of adjustment, the switch for operations of this lamp being of the constant push-button type. This model is designated the 703 and the price is 120 guineas, which includes a dipole aerial.

Television Lectures

A special course of four lectures on television is to be given at the Regent Polytechnic, 309 Regent Street, W.1, commencing on May 31 next.

These lectures are to be given by that well-known technical authority on television, Mr. H. J. Barton Chapple. We advise readers to attend for Mr. Barton Chapple explains the theory of television in a very lucid manner.

Cheap Components for the Experimenter

Messrs. Galpins Electrical Stores, 75 Lee High Road, S.E.13, have just issued a new list of bargains of all kinds suitable for the radio constructor and experimenter. Amongst some of the items are morse keys and buzzer sets, power resistances, current check meters, charging and lighting plants, metal chassis, transformers, loudspeakers, etc.

This list contains so many items that we cannot possibly give any true idea as to the range of components or to the cheapness of them so we advise readers to drop a card to Messrs. Galpin at the above address, who will send all details.

A Low-loss Coupling Unit

A low-loss shaft coupling unit has been introduced by Messrs. A. F. Bulgin and Co., Ltd. This coupling has the spacing piece made of a special porcelain so that it is suitable for use in all types of high-frequency receivers and in transmitting circuits where high voltage is being handled.

Type E.H.12, with a 1-in. insulator, is priced at 1s. 9d., while type E.H.14, with a $2\frac{1}{2}$-in. insulator, is priced at 2s. 3d.

PHOTO-ELECTRIC EFFECTS

A COMPLETE SUMMARY OF THE MOST IMPORTANT DEVELOPMENTS — PART II. — PHOTO-ELECTRICITY

By G. Windred.

This article is the second and concluding one of an exhaustive review of the literature on photo-electric effects. This section deals with photo-electricity and the two provide a guide to published knowledge of both branches of the subject.

IT was found by Heinrich Hertz* in 1887 that a negatively-charged body lost its charge very rapidly when illuminated by certain kinds of light, whereas a similar positively-charged body gave no such effect. Experiment showed that it was ultra-violet light which was particularly active in this way, and that light of longer wavelength had little or no effect upon ordinary metals.

These conclusions resulted from the work of numerous physicists, among whom may be mentioned Hallwachs,* who can be regarded as the pioneer in this field, Hoor† Righi† and Stoletow.† It was natural that this discovery should stimulate further research with a view to determining the causes of the phenomenon, and a vast amount of work was accomplished in this connection by the famous experimenters Elster and Geitel, who were the first to establish the definite principles of photo-electricity in an important series of researches* commenced shortly after the discoveries of Hertz and Hallwachs.

Since a negative charge of electricity can be regarded as an assemblage of electrons, it follows that loss of negative charge under the action of light, as in the photo-electric effect, must be due to the removal of electrons from the material in some way. It is also evident that since light is the only active medium in this case, it must be responsible for the ejection of electrons. Owing to the fact that the effect was noticed some time before the advent of the electron theory, there was considerable delay in the development of a definite theory. It was not until 1905, some eighteen years after its experimental observation, that a successful theory was developed.

The mechanism of the effect is not thoroughly understood, but the quantum theory allows of a satisfactory explanation of the principal phenomena. It has been found by experiment that the ejected electrons, sometimes called photo-electric, leave the conductor with a velocity depending upon the type of material and the wavelength of the incident light. It was first shown by Lenard* that the velocity of photo-electrons is in no way dependent upon the intensity of the incident light. This fact was confirmed some years afterwards by Pohl and Pringsheim† and by Millikan.‡ It has been shown by the experiments of Lienhop§ and Ladenburg** that the velocity of emission is independent of temperature between the limits of 180° and 800° C.

The photo-electric effect can be detected with all metals, provided that light of sufficiently high frequency is employed. With ordinary metals, such as copper, gold and platinnum, it is necessary to employ light in the extreme ultra-violet, having a frequency of the order of of 10^{16} cycles per second, before the photo-electric effect can be observed. With the alkali metals, the effect is shown with visible light. These metals have particularly unstable atomic structures, so that the detachment of the orbital electrons is unusually easy. The alkali metals most frequently employed in photo-electric work include barium, lithium, potassium, rubidium, sodium and strontium.

These metals are chemically very active, and special methods are necessary for their successful application. It is interesting to note that most of them were known to chemists long before the prospect of their being used commercially. Lithium, for example, the lightest of all metals, was discovered by Arfoedson in 1817, sodium and potassium by Humphry Davy in 1807, caesium by Munsen in 1860, rubiduim by Kirchhoff in 1861.

Elster and Geitel group various photo-electric metals in accordance with their strengths of emission, as shown in the following table, which also gives the chemical symbol and the atomic number of each metal:—

Metal.	Symbol.	Atomic Number.
Rubidium	Rb	37
Potassium	K	19
Alloy of potassium and sodium		
Sodium	Na	11
Lithium	Li	3
Magnesium	Mg	12
Thallium	Tl	81
Zinc	Zn	30

The special methods necessary for handling the alkali metals have been described by Poes,* Fleischer,† Klumb,‡ Campbell,§ and others.

The explanation of photo-electricity has naturally occupied the attention of many workers in the field of theoretical physics, but it was not until 1905 that a satisfactory theory was published by Einstein.‖ This theory is based on Planck's quantum theory of radiation. It assumes that light-energy can be regarded as a shower of light-quanta, or photons, each having a definite amount of energy $h\gamma$, where γ is the frequency

* Wied. Ann., 31, 1887, p. 983.
† Wied. Ann., 33, 1888, p. 301.
‡ Repert. d. Physik, 25, 1889, p. 91.
§ Comp. Rend. 106, 1888, p. 1,439 ; 107, 1888, p. 559.
** *ibid.*, 106, 1888, pp. 1,149, 1593 ; 107, 1888, p. 91 ; 108, p. 1,241.
‡‡ Wied. Ann., 38, 1889, pp. 40, 497 ; 41, 1890, p. 161 ; 42, 1891, p. 564 ; 43, 1892, p. 225 ; 52, 1894, p. 433 ; 55, 1895, p. 684.
* Ann. der Phys., 8, 1902, p. 149.
† Verh. d. deutsch. Phys. Gesell., 15, 1912, p. 974.
‡ Phys. Rev., 1, 1913, p. 73.
§ Ann. der Phys., 21, 1906, p. 281.

THEORY OF PHOTO-ELECTRICITY

of the light and h is Planck's constant, having the approximate value 6.55×10^{-27} erg. secs. The quantum theory, therefore, states that the energy of radiation of any kind is dependent only upon its frequency.* On this basis it is to be assumed that light of short wavelength should be the most effective in so far as energy is concerned, owing to its high frequency.

This leads to the supposition that since, presumably, the photo-electric ejection of electrons from a substance is in some way dependent upon the energy of the incident light, high-frequency illumination should give a stronger photo-electric effect than would be obtained with light of lower frequency from a given substance. Experiment shows that this assumption is in accordance with fact, and that there is for each metal a definite frequency, called the "threshold frequency," below which there is no photo-electric effect. For a given metal, light of lower frequency than the threshold frequency of the metal could fall upon it for years without ejecting electrons. As soon as the threshold frequency is exceeded, there is an immediate photo-electric ejection of electrons.

If, with Einstein, we assume that a certain definite amount of energy, say, E, different for different substances, is required for the task of dislodging an electron sufficiently to detach it altogether from its associated atom, each photon of the incident light must have at least this amount of energy in order to cause the ejection of electrons. On the basis of Planck's theory, this means that the condition $h\gamma = E$ must be satisfied. Owing to the restrictive forces which tend to prevent the ejection of an electron beyond the boundaries of the material, a certain additional amount of energy is necessary actually to produce the photo-electric effect, so that for this condition we must have $h\gamma > E$.

If we assume that the surplus energy is used up in endowing the ejected electron with kinetic energy, we have the important relation

$$\tfrac{1}{2} mv^2 = h\gamma - h\gamma_0 \quad \ldots\ldots\ldots\ldots\ldots (5)$$

where m and v are respectively the mass and velocity of the electron, and γ_0 is the threshold frequency of the particular substance.

Equation (5) is in such good agreement with experiment that it has actually been employed by Millikan as a means for independent determination of the value of h, which remains constant for all metals.* The results obtained in these experiments are as follows*:—

$h = 6.561 \times 10^{-27}$ for sodium.

$h = 6.585 \times 10^{-27}$ for lithium.

Both these values are in excellent agreement with other determinations of h using entirely different methods. Notable results in this connection are given in the following schedule:—

Derived value of L	Authority	Type of Experiment	Reference
$6{\cdot}59 \times 10^{-27}$	Keesom and Kamerlingh-Onnes	Specific heats at low temp.	Verslag Amst. Akad.,1915,p.335.
$6{\cdot}555 \times 10^{-27}$	Blake and Duane	K-ray Spectra	Phys. Rev., 10, 1917, p.624.
$6{\cdot}55 \times 10^{-27}$	Coblentz	Black-body radiation	Bur. Stds. Sci. Paper No. 360, 1920.

There seems little doubt that the foregoing theory represents fairly accurately the phenomenon of photo-electric emission, but the actual means by which a photon succeeds in applying its energy to an electron so as to cause its ejection from a metal has not yet been satisfactorily explained. It is reasonable to expect that not every photon in the incident light will be successful in encountering or dislodging an electron, in which case the incident light energy will exceed the energy of photo-electric emission.

This question has received the attention of Pohl and Pringsheim,† who showed that the incident energy was always very much in excess of the energy emitted. Experiment showed that with a potassium surface the total energy of the emitted electrons was only some 2 or 3 per cent. of the absorbed light energy.

A theory, alternative to the foregoing, is based upon the radiation theory developed by Bohr‡ which states that in the process of emitting radiation an atom shrinks to a different state. If it be assumed that the process is reversible, the incidence of a quantum of energy $h\gamma$ on the atom of a photo-electric substance will result in its expansion owing to the absorption of this energy. Experimental proof of this effect has been provided by Hartman,* Franck and Hertz† and others, as a result of observations on line spectra.

A further theory has been proposed by Richardson‡ on the basis of statistical theory relating to the interchange of energy. It is not concerned with the actual mechanism of the photo-electric effect, and is based on the assumption that the photo-electric substance is in thermal equilibrium, with complete radiation of equal intensity in all directions.

Experiment has shown that the time lag between the incidence of light and the ejection of electrons is practically negligible. Early experiments by Stoletow|| gave no evidence for the existence of a time lag, and showed that if it existed it must be less than 10^{-3} second. More recent examination of this question by Lawrence and Beam§ has established this limit at less than 3×10^{-9} second, either at starting or stopping the incident illumination.

Other Photo-Electric Phenomena

During recent years other effects have been discovered which do not strictly belong to either the photo-conductive or photo-electric classes of phenomena. It has been found that if light is allowed to fall on to a copper oxide layer carried on a copper plate, and a circuit be established externally to the plate and the oxide, then a current will flow in this circuit so long as the illumination continues. This arrangement is as used in the copper oxide rectifier, and cells employing the principle are generally known as rectifier type cells.

* Phys. Zeits., 18, 1917, p. 429.

† Verh. d. deutsch. Phys. Gesell., vols. 15 *seqq.*

‡ Phil. Mag., 23, 1912, p. 594; 24, 1912, p. 574.

|| Phys. Rev., 1, 1892, p. 725.

§ Phys. Rev., 29, 1927, p. 904.

(*Continued on page* 286)

RECENT TELEVISION DEVELOPMENTS

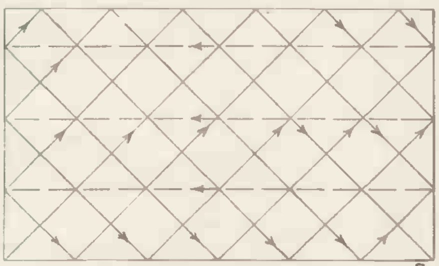
A RECORD OF PATENTS AND PROGRESS
Specially Compiled for this Journal

Patentees :—J. C. Wilson and Baird Television Ltd. :: The General Electric Co., Ltd. and D. C. Espley :: Zeiss Ikon Akt. :: J. L. Baird and Baird Television Ltd. :: Baird Television Ltd. and C. Szegho :: Farnsworth Television Incorporated.

"Cross-ways" Scanning

(Patent No. 459,178.)

INSTEAD of scanning the picture in a series of lines all of which lie in the same direction, the lines are arranged in groups, the direction and sense of all the lines within a group being the same, but being different in



System of cross-ways scanning. Patent No. 459,178

different groups so as to give a cross-wise effect. In other words the picture is explored in a series of strips, the strips in different series lying in different directions, and one series at least lying in a direction inclined both to the horizontal and vertical axes of the picture.

This result is secured by using two time-base circuits, one generating saw-toothed oscillations, and the other producing waves substantially triangular in form. This causes the spot to start at the corner A and to follow the path indicated by the arrows, terminating at B.—*J. C. Wilson* and *Baird Television, Ltd.*

Cathode-ray Tubes

(Patent No. 459,963.)

It is sometimes convenient to earth the cathode of the tube. The screen end is then at a high positive potential to earth, and it is necessary to provide an electrostatic shield from neighbouring objects. This may be located inside the glass bulb, but it is easier from the manufacturing point of view to have it outside. In that case, of course, an extra shield is necessary in order to protect the user.

According to the invention the first outer shield consists of a conducting layer of carbon formed on the external walls of the tube—stopping short of the fluorescent screen, whilst the second or "extra" shield consists of a metal case. The latter surrounds the tube and is held in place by insulating members which bear against the carbon layer on the outer walls. —*The General Electric Co., Ltd.*, and *D. C. Espley.*

Photo-electric Cells

(Patent No. 460,012.)

A thin layer of antimony or bismuth is deposited from vapour on to a suitable backing, and after being oxydised, is mixed with a thin layer of caesium or rubidium, also vaporised, so that the metals form an alloy. The resulting layer, which is so thin as to be transparent, is highly sensitive to all light-rays, from red to violet.—*Zeiss Ikon Akt.*

Scanning by Mirror-screw

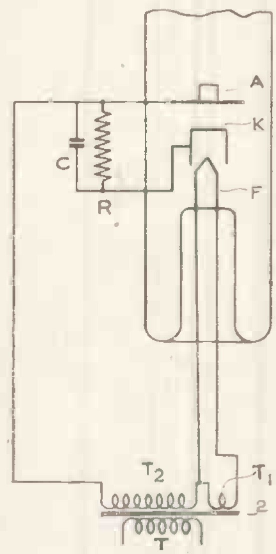
(Patent No. 460,197.)

In order to secure the effect of interlaced scanning, a mirror-screw is keyed to a driving shaft so that it is free to move slightly to and fro along the shaft whilst in rotation. This movement, which produces the necessary displacement from line to line, is imparted to the drum by a heart-shaped cam geared to the driving motor. The same result can be secured by imparting a vibratory movement to a mirror which is interposed between the mirror-screw and the observer.—*J. L. Baird* and *Baird Television, Ltd.*

Cathode-ray Tubes

(Patent No. 460,445.)

Instead of using a separate rectifier to supply D.C. voltage to the anode of a cathode-ray tube, the rectifier is incorporated in the tube itself. As shown, one winding, T1, of the supply transformer T heats the filament F, whilst a second winding T2 is connected across the filament and the anode A of the tube. The anode A and indirectly-heated cathode K are shunted by a condenser C and resistance R, the latter acting as a load across which the required D.C. voltage is built up. The inside surface of



Combined rectifier and cathode-ray tube. Patent No. 460,445

the pot-shaped cathode K is coated with amorphous carbon to prevent emission, whilst the outer surface carries a highly-emissive substance, preferably one of the rare-earth oxides. —*Baird Television, Ltd.*, and *C. Szegho.*

Fluorescent Screens

(Patent No. 460,479.)

Fluorescent materials are divided into two classes. The first, of which zinc borate is an example, only produces a very weak light unless it is "activated" by the addition of a foreign substance such as manganese dioxide. It then gives a brilliant response, but shows a time-lag effect, similar to that of phosphorescence.

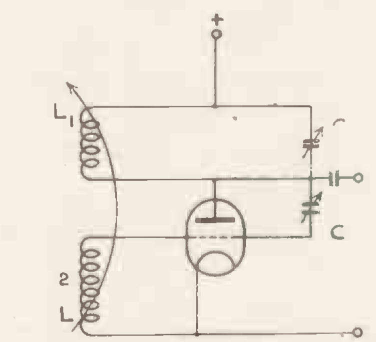
The second class, of which zinc sulphide is an example, does not require any activating agent, and gives a practically instantaneous response. But it must be used in an exceptionally pure state, the presence of even minute particles of foreign matter usually causing the intensity of fluorescence to fall off very considerably.

According to the invention, activated zinc borate is mixed with chemically-pure zinc sulphide, and the mixture is sprayed on to the inner glass surface of the bulb of a cathode-ray tube. The latter is then "processed" at a temperature lower than that at which the pure zinc sulphide can combine chemically with the material used to activate the zinc borate. The combination is stated to give a brilliant light, closely approximating to white.—*Farnsworth Television Inc.*

Super-regenerative Sets

(Patent No. 459,300.)

In order to secure a finer control over the "quenching" of a super-regenerative valve, an auxiliary coupling condenser C is arranged in series with the grid coil L and the plate of the valve. The plate coil L1 is back-coupled to the grid coil L, as usual, and is tuned by means of the condenser C1. The additional regulation of feed-back energy through the condenser C permits the valve to be used closer to the point of self-oscillation, where the amplifying action is most effective.—*L. R. Merdler, M. Scott,* and *Baird Television, Ltd.*



Method of securing fine quenching control. Patent No. 459,300

Summary of other Television Patents

(Patent No. 459,177.)

Method of scanning in groups of parallel lines, the inclination of each group of lines being periodically altered or "crossed."—*J. L. Baird* and *Baird Television, Ltd.*

(Patent No. 459,400.)

Combining saw-toothed and square-topped oscillations to give interlaced scanning.—*Farnsworth Television Inc.*

(Patent No. 459,422.)

Circuit for amplifying saw-toothed scanning oscillations in a strictly linear fashion.—*Radio-Akt D. S. Loewe.*

(Patent No. 459,506.)

Generating impulses of rectangular wave-form for synchronising in television.—*J. C. Wilson* and *Baird Television, Ltd.*

(Patent No. 459,610.)

Time-base for a television receiver in which the potentials of both deflecting plates are varied in push-pull. —*The General Electric Co., Ltd.*, and *D. C. Espley.*

(Patent No. 459,723.)

Television amplifier for handling all frequencies, down to zero, with substantial fidelity.—*T. M. C. Lance, P. W. Willans* and *Baird Television, Ltd.*

(Patent No. 459,735.)

Combining the output from two P.E. cells, so as to give uniform amplification in a television transmitter. —*The General Electric Co., Ltd.*, and *D. C. Espley.*

(Patent No. 459,853.)

Preventing distortion due to the loss of D.C., or "zero" frequencies, in amplifiers used in television.—*E. L. C. White.*

(Patent No. 460,198.)

Automatic volume control system for a combined sound and picture receiver.—*L. R. Merdler* and *Baird Television, Ltd.*

(Patent No. 460,204.)

Intermediate-film method of receiving television pictures.—*T. E. Bray* and *Baird Television, Ltd.*

"Photo-Electric Effects"

(*Continued from page 284*)

The original form of rectifier cell consists of a layer of cuprous oxide on a copper plate forming one electrode. A conducting gauze placed in contact with the oxide serves as the second electrode and admits light to the oxide surface. Illumination results in the liberation of electrons in the oxide, which flow in one direction only, on account of the rectifying properties of the arrangement, and give rise to the current in the external circuit.

This type of cell has been described by Lange,* while the theory of its operation has been worked out by Schottky† and also by Auwers and Kerschbaum.‡

Special methods for obtaining thin metallic films on copper oxide have been devised by Duhme and Schottky§ for producing a different kind of operation, in which the direction of current in the external circuit is opposite from that corresponding to the previous arrangement. In this case the light passes through the metallic layer before acting upon the oxide.

The effects of temperature in such cells have been examined by Teichmann,‖ who finds that at + 6° Celsius there is a four-fold increase in sensitivity, whereas there is no sign of reduction of sensitivity down to the temperature of liquid air.

* Phys. Zeits., 31, 1930, pp. 139, 964.

† Phys. Zeits., 31, 1930, p. 913.

‡ Ann. der Phys., 7, 1930, p. 129.

§ Naturwiss., 18, 1930, p. 735.

‖ Zeits. für Phys., 65, 1930, p. 709; 67, 1931, p. 192.

The Electrical Encyclopedia

One of the finest handbooks for the working electrician is the "Electrical Encyclopedia," published by The Waverley Book Co., Ltd., 96-97 Farringdon Street, E.C.4.

It is complete in four volumes and priced at 70s., but hire-purchase terms can be arranged so that the purchaser need only pay 2s. 6d. on the eighth day after he has had time to examine the volumes, after which further sums of 5s. have to be paid each month, concluding with a final payment of 6s.

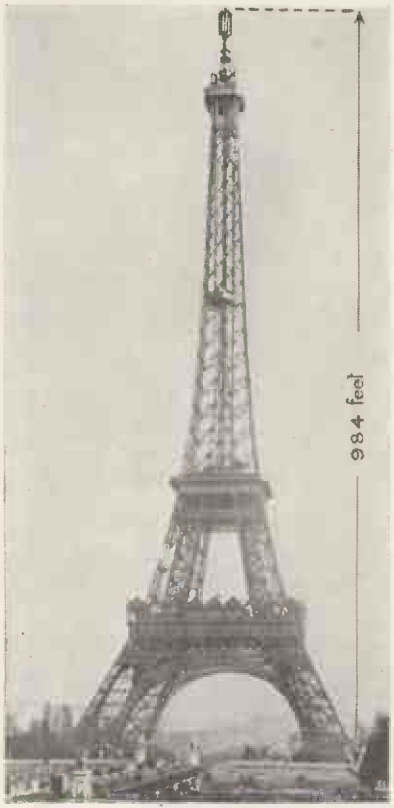
The four volumes consist of 1,400 pages and include over 2,300 illustrations. The volumes are a fine source of information for the practical electrician, also as the theoretical side is most comprehensive it can be used as a standard book of reference.

The books have been compiled by no less than six expert editors and include the work of 32 qualified contributors under the general editorship of S. G. Blaxland Stubbs.

We strongly advise readers to write to The Waverley Publishing Co., Ltd., for the seven-day free examination offered; to all purchasers a 66-page pocket reference book of tables is being presented free.

A SUPER-POWER TELEVISION TRANSMITTER FOR THE EIFFEL TOWER

WILL THE PICTURES BE RECEIVABLE IN THIS COUNTRY?



The high-power transmitter is to be housed at the base of the Eiffel Tower.

EXPERIMENTAL television transmissions from the Eiffel Tower have been taking place since December, 1935. These were with a definition of 180 lines and at 25 pictures per second, and it has generally been recognised that they were a stage in the process of development and not intended to provide a public service.

Another move has now been made, for an order has been placed for a new transmitter which will be the most powerful commercial television broadcasting installation in the world.

30 Kilowatts

This new transmitter has been commissioned from Le Materiel Telephonique, the French company associated with Kolster Brandes, Ltd., by the French Ministry of Posts, Telegraphs and Telephones. It will have a peak power of 30 kilowatts, fully modulated, in the aerial. The definition will be 405 lines, with a band width of 2.5 megacycles.

It is proposed to install the new transmitter at the base of the Eiffel Tower with the aerial projecting from the top of the flagpole, which is 984 feet above ground level. The transmission cable from transmitter to aerial will be approximately 400 metres long, over 5 ins. in diameter, and will weigh about 12 tons. Of the semi-flexible coaxial type necessary for the high frequencies, it will run up the framework of the tower to the centre of the topmost cupola, from which the present flagpole protrudes.

Special Problems Involved

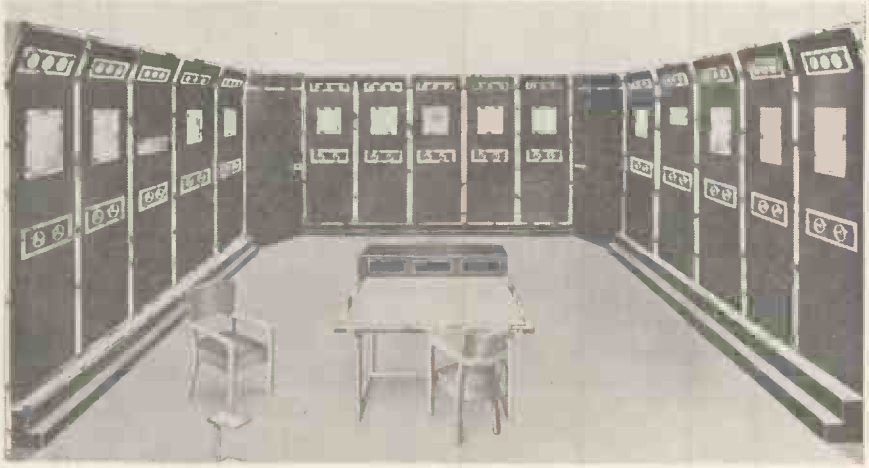
The construction of the transmission cable has provided several novel and difficult problems. Since the cable is to pass upwards from the top of the framework of the tower it will be necessary to substitute a new hollow metal flagstaff for the present one. This, with the transmission conductor inside, will have to be pushed up through the opening in the collar that crowns the steel structure to a height of 12 metres above. The aerial will continue for a further vertical distance of three metres above the flag.

Another problem concerns the installation of the transmission cable between studios and transmitter. This will be accomplished by a specially adapted transmission cable with special terminal equipment necessitated by the alternative systems of positive or negative control which require different characteristics in the transmission lines leading from the studios.

Programme Arrangements

The equipment will include a monitoring set which will enable a technical operator to have full control, and to know at all times just what quality of television broadcast is going out on the air. The audible portion of the programmes will be put out from a regular P.T.T. broadcasting station. Programmes will be produced from two studios, situated in the Radio Building of the Exposition and the Post Office Building. Thus the Eiffel Tower, whose career began with the Exposition of 1889, is to play a leading rôle in one of the most ultra-modern features of the 1937 Exposition.

The contract just signed with Le Materiel Telephonique, in whose laboratories the equipment has been developed after two years' research, specifies that the new station shall be ready for service with reduced power



The 30-kilowatt transmitter for the new Eiffel Tower station.

by July 1 of this year, and operate with full power by the autumn.

In view of the aerial height, and the large power which is to be used, it is interesting to speculate whether the new station will be receivable in this country. Actually, even the south coast of England will be beyond optical range, but the experience which has been obtained in the case of Alexandra Palace transmissions shows that the optical range is exceeded in certain circumstances.

The diagram shows the optical range of the transmitter assuming a transmitting aerial height of 1,000 feet and a receiving aerial height of 60 feet. This can be worked out as follows:—

In the diagram r is the radius of the earth (approximately 4,000 miles), h and h^1 the heights of transmitting and receiving aerials, and d and d^1

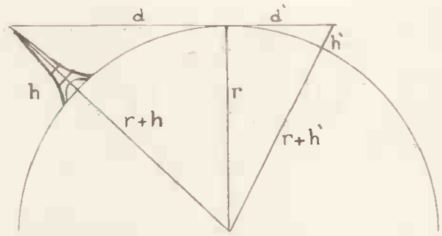


Diagram showing how the optical range of an aerial is calculated.

the horizon distance of transmitter and receiver respectively. It will be clear that

$$d^2 + r^2 = (r + h)^2$$

$$d^2 = 2rh + h^2, \text{ neglecting } h^2$$

we have

$$d = \sqrt{2rh}$$

$$= \sqrt{8{,}000h} \text{ miles.}$$

Similarly $d^1 = \sqrt{8{,}000h^1}$ miles.

In the case of an aerial height of 1,000 feet it will be seen that the horizon for this aerial is approximately 39 miles. To this must be added the horizon distance of the receiving aerial which, assuming a height of 60 feet, will be roughly $9\frac{1}{2}$ miles. The total horizon distance will therefore be $39 + 9\frac{1}{2} = 48\frac{1}{2}$ miles.

As the distance from Paris to the nearest point on the south coast of England is roughly 170 miles, it does not appear, assuming the range is quasi-optical, that the transmissions will be receivable in this country, but short-wave reception is full of surprises and it would be a mistake to make any pronouncement on the matter until actual experience has been obtained. Certainly if these transmissions were receivable in the southern parts of England, they would provide an immense fillip to television.

COLUMBIA PLANS HUGE TELEVISION STATION

THE Columbia Broadcasting System (U.S.A.) has applied to the Federal Communications Commission for permission to construct one of the world's most powerful combined television and sound transmitters at the top of the Chrysler Building in New York City.

When fully modulated the proposed station will operate at a peak power of 30 kilowatts, which is equal to that of a transmitter soon to be constructed on the Eiffel Tower in Paris.

The Transmitter

The transmitter, which is to be located on the 74th floor of the skyscraper, will incorporate the latest developments in high-power wide band design. Because it will operate on a frequency somewhere between 42 and 56 megacycles—it is expected that the station will have a range of approximately 40 miles over a total area of about 4,800 square miles.

The aerial is to be built around that portion of the building immediately below the stainless steel needle surmounting it. This will mean that a distance of less than 100 feet and separates the transmitter from the aerial and, therefore, that an almost distortionless transfer of power should be assured.

The Chrysler Tower was chosen as the best location for the transmitter after an exhaustive study of the whole New York skyline within a radius of one mile from that point, according to Dr. P. C. Goldmark, who is at the head of Columbia's television research department.

Experiments conducted by C.B.S. engineers disclosed that the height of the aerial was not the only thing to be considered. The fact that most of Manhattan's population is concentrated to the north of the tower, and that no higher buildings are located in that direction, was of prime importance in selecting the site. This situation indicates that the radio waves will not be broken up or refracted by the steel skeletons of other skyscrapers, and that therefore the production of double images will be avoided.

Columbia is not a newcomer in the television field, but is merely continuing experiments started many years ago. After the transmission of low-definition pictures over W2XAX, five years ago, elaborate research was pushed by C.B.S., both in America and abroad. The comparison of such experimental work with that done by the British Broadcasting Corporation as well as other radio organisations here and abroad led to findings which make possible the construction of the new station.

The Columbia Broadcasting System was among the earliest pioneers to undertake practical experiments in television in the States. In 1931, after extensive laboratory research in the United States, it was believed the time was ripe for broadcasting of images via the ether, Columbia was the first broadcasting company to transmit sight and sound simultaneously from the same transmitter.

Columbia started the first regular television broadcasts in the United States, continuing them from 1931-1933. During that time what are technically known as low-definition, 60-line pictures were transmitted daily on a frequency of 2,800 kilocycles. These were discontinued in 1933 because it was appreciated the pictures had little entertainment value.

Since 1933, the C.B.S. engineers have carried on intensive research on the requirements of high-definition television.

The present transmitter will operate on a 441-line basis as compared to the 60-line images of 1931 and 1933. In addition the new transmitter will produce 60 pictures a second, as compared with 20 pictures a second in the earlier television broadcasts. The maximum frequency of the new transmitter will be 2,500 kilocycles.

OUR POLICY
The Development
of
TELEVISION

STUDIO & SCREEN

A MONTHLY CAUSERIE on Television Personalities and Topics

by K. P. HUNT
Editor of "Radio Pictorial"

OUTSTANDING among the many enthralling television programmes devised by the B.B.C., none has aroused such general interest and expectancy as the forthcoming vision broadcast of the Coronation Procession, which is to take place on May 12. Here is a broadcast the successful achievement of which assuredly will find a permanent place in the world's history books of television.

In these notes last month I was able merely to indicate the B.B.C.'s television arrangements for the Coronation in a vague manner, but I hazarded a guess that although at that time the exact location of the television cameras was not disclosed, the site when known would immediately be recognised as the most suitable one possible.

It has since been announced that the B.B.C. has chosen Apsley Gate, Hyde Park Corner, which really is a splendid position. This site was selected, I am told, because after a careful consideration of the entire route which the Procession will take, this particular point conferred the most comprehensive view of the Procession approaching and departing.

A decision has now been made to use three cameras: one will occupy a special platform beside the plinth of Apsley Gate; while the other two will be operated from pavement level, one on the south side of the arch and the other on the north side.

Camera No. 1 will look along East Carriage Drive, which is parallel to Park Lane, and thus the lens will embrace in its view a very long distance, which will be an ideal arrangement for seeing the approaching Procession. In case some readers may not recall the environs of Apsley Gate, I should explain that the base of the columns of the Gate is well raised, and offers a fine commanding view. I do not think any more appropriate site could have been selected, because, in the way that the cameras are now going to be arranged, viewers will have a wide sweep of view in both directions.

Camera No. 1 will, therefore, show a sort of panoramic view of the approaching procession, and will be facing north.

Camera No. 2 will also be installed on the opposite side facing south, and thus will give a rear view of the procession as it wheels across Piccadilly towards Green Park and Constitution Hill.

Camera No. 3, with which it is hoped to obtain a number of close-up views of the procession as it passes through the arch, will be supported in the usual way on a tripod on the pavement.

Freddie Grisewood will give the commentary in the B.B.C.'s television programme of the Coronation Procession.

The actual programme will last approximately one hour, and is scheduled to begin at 2 p.m. Exact times cannot be given, of course, but the probable arrangement of the programme will be that in the first ten minutes general crowd scenes will be broadcast, together with a commentary, but it is expected that the procession will reach Apsley Gate in the region of 2.10 p.m. It is probable, owing to the length of the procession and the relatively slow speed at which it will travel, that it will take fully fifty minutes for the procession to pass any given point.

Their Majesties doubtless will be towards the end of the procession and are expected to pass the television cameras very approximately at 2.45 p.m.

* * *

Honour of being the B.B.C. commentator on this momentous occasion has fallen to Freddie Grisewood, the well-known London sound broadcast announcer whose cheery "Goodnight" is familiar to millions of listeners. Some surprise naturally has been expressed that the Ally Pally television staff—who have been specially trained in television work—appear to have been superseded on this important occasion with no apparent advantage.

The general public naturally will evince considerable interest in the television cameras at Apsley Gate, and I can reveal that effective measures have been taken to safeguard the instruments from excessive curiosity.

What few of the crowds of onlookers may know, however, is that the cameras themselves constitute only half of the story.

Concealed some 200 yards away from Apsley Gate, on the green sward adjoining Rotten Row, will be the three quite ordinary looking motor vans which constitute the B.B.C.'s first television O.B. unit. There will be a cable, of course, connecting the cameras to the unit.

The vans will be stationed at a point where the special high frequency cable, referred to in these notes last month, ends. This cable is housed underground in the existing Post Office telephone conduits, the route taken from the point near Apsley Gate being along Park Lane to Marble Arch, thence by Oxford Street to Broadcasting House. Broadcasting House has another cable connecting it with Alexandra Palace.

It is by no means certain that the cable will be used for this important broadcast, and in any case there will be the new wireless link as a standby.

* * *

I think I can safely prophesy that this new mobile television unit, which obviously has such great possibilities, is destined to play a very prominent part in the television programmes of

TELEVISION TRANSMISSION TRICKS

the near future. Already, its use in providing viewers with the often proposed "Seeing the Derby from the Armchair" is again being seriously discussed, and indeed is a distinct possibility for this year's great classic race.

* * *

At the time of writing these notes, I understand that the mobile unit has not yet been delivered to the B.B.C. It is being made by the Marconi people at their Hayes works, and I believe the delivery date arranged is only a few days before the Coronation. I am told that everything is working to schedule, and that the three vans will certainly be delivered and the whole apparatus tested and in working order on time.

* * *

Various statements have appeared in the lay Press as to the cost of this unit, many of which have been quite wide of the mark. I was told authoritatively a few days ago that the cost is in the region of £40,000.

Van No. 1 will contain the scanning equipment, van No. 2 the generators and amplifiers, while van No. 3 will house the ultra-short wave transmitter. The transmission will take place from a standard dipole aerial on the roof of van No. 3. This will be of the collapsible type and will be erected for use as required.

It is interesting to note that this mobile television transmitter will employ a wavelength of the order of 3·5 metres.

* * *

As I write these notes I hear that a new producer solely in charge of O.B. vision broadcasts has just been appointed. He is Mr. Moultrie Kelsall, and comes from Aberdeen with an impressive record.

If these vans are used for the Coronation, the broadcasts from the mobile unit will be picked up direct at Ally Pally and re-broadcast. In anticipation of this, a new receiving aerial is now being put up and doubtless will be complete before these notes are in print. At the moment, only the mast has been erected right on top of the existing aerials. The new aerial is of the dipole type and will tower about 20 feet above the others. The aerial mast at Alexandra Palace therefore will now support three aerials, the lowest being for the transmission of sound, the middle one for the transmission of vision broadcasts, while the new one on top will be the new receiving aerial which incidentally will be the highest ultra-short wave receiving aerial in the country.

Preparations are being pushed on hurriedly at Alexandra Palace to ensure the best possible reception from the mobile unit and for rediffusion via the usual transmitter. I understand that the receiver to be used has been designed by the Marconi-E.M.I. Company, and will be housed in a little room over the tele-cine room above the studio floor.

It is generally felt at the Palace that the introduction of this mobile unit is likely to bring about the most impressive improvements in the television programme since they began last November, and its employment will be watched with great interest.

Elizabeth French the Covent Garden opera singer, has appeared in many television programmes.

I referred last month to the use of what might be called "trick" photography in television production, and some further amazing and exceedingly clever instances have occurred in the past month. On March 31, being the eve of April Fools' Day, "Picture Page" was transformed into a sort of "crazy page," as suited the occasion. A dreadful hitch occurred! Leslie Mitchell, the popular television announcer, came on with eyes glazed with apprehension. Where were the artists? What had gone wrong?

Suddenly, looming up on the screen, came a ghostly figure clad in Victorian clothes complete with topper.

Said the eerie visitor to Leslie in frigidly formal tones: "I gather, young man, this is some kind of festive entertainment." The theme was considerably elaborated and proved a fine example of trick effects.

Early in April another case occurred which must have caused many viewers to wonder how the effect was accomplished. This was in an excellent programme on April 12, entitled: "Cabaret Cruise," which, by the way, was one of Harry Pringle's greatest triumphs to date. In this programme a ship was seen to be gently rocking with the swell on the waves.

Now I can tell you definitely that the stage was not being rocked. The set with the actors upon it also was quite rigid. The camera itself was not rocked.

How, then, was the ship as seen on the receiving screen made to sway as by waves? I will give you three guesses!

You will be surprised at the clever manner in which this was achieved. It was an inspiration on the part of one of the senior studio engineers. The camera did not directly photograph the set at all, for what viewers saw on their screens was a photograph of a reflection of the set-piece. The camera itself was looking at right angles to the set, and pointing towards a small mirror inclined at an angle of 45 degrees to the axis of the camera in such a way that it reflected to the camera a full picture of the set. This device, of course, was not discernible on the viewing screen, and it appeared that viewers were looking at the ship directly.

The intermediate mirror was mounted flexibly so that it could sway, and a slight movement to and fro was arranged by the periodic pulling of a wire against a spring, the oscillatory movement being governed by a gramophone motor. Thus the mirror was given a slow but regular seesaw displacement, which in turn slightly shifted the reflection of the ship, which was seen by the television camera and transmitted to the viewers. The result was a perfect simulation of the movement of the ship as by the waves. A really clever piece of work.

* * *

The programme entitled: "Fugue for Four Cameras," by Stephen Thomas, with Maude Lloyd as the dancer, which I mentioned last month, will be repeated on May 1, and those who did not see it when

ITEMS IN FUTURE PROGRAMMES

it was broadcast early in March should not miss it this time.

I notice that Rita Grant has come into the television limelight again. She was the girl who was televised at the first Press reception at Ally

Alex Moore and Pat Kilpatrick who give the dance lessons via television. They are shortly to be married.

Pally. Rita was three years with C. B. Cochran and in 1935 was a *Daily Mail* beauty winner, and should have a bright future in television.

Gerald Cock, the television chief, is making a notable effort to put out some really strong programmes during Coronation week, but I have space here only to indicate some of the high lights.

On Monday, May 10, replicas of the crown jewels will be broadcast, while on May 11 a special Coronation edition of "Picture Page" is being staged. The usual 3 p.m. to 4 p.m. programme on Wednesday, May 12, will of course be replaced by the slightly earlier Coronation programme mentioned above; but at 9 p.m. on Wednesday, Harry Pringle will be in charge of a special variety performance which I gather will be after the lines of the "Old Music-hall Memories" popularised in sound broadcasting by Wilson Dissher.

On Thursday, May 13, a notable contribution to "Starlight" will be made by Clapham and Dwyer, the famous comedians; while on Friday, May 14, the outstanding feature will be the second television performance of Jack Hylton and his band, which is scheduled to occupy 25 minutes.

Jack Hylton's appearance early in April was a great success. The band consisted of 24 pieces, six vocalists, including Peggy Dell and Alice Mann, Fred Schweitzer in comedy, and Joe Rossi, the boy wizard of the accordion, not forgetting Jack himself, who is an incomparable showman. In discussing the televising of dance bands nine months ago, I ventured to prophesy that as soon as Jack Hylton and Jack Payne were given a chance they would quickly establish themselves ahead of all others in this new field. They are without competition as show bands, as distinct from mere sound broadcasting bands, and accordingly I am looking forward personally to seeing Jack Hylton's programme on May 14, which from the purely entertainment standpoint should be one of the best yet radiated from the Palace.

* * *

Cinemagoers have now become quite familiar with the backstage type of film which takes you behind the scenes of theatres and the film studios, and it was not to be expected that long would elapse before our television producers took a leaf from the same book. So on Saturday, May 15, we are to have the first show which televises television. This will be a backstage affair in which viewers will be taken around the studios, into the dressing rooms, and shown exactly how a show is produced. We shall even go down to the Ally Pally restaurant and see someone having a nice cup of tea.

A good deal of comment has been made during the month about the B.B.C.'s lack of funds for the development of the television service. In some places it has been suggested that wireless licences in future may be increased to 12s. 6d. to provide for the additional expenditure. I am authoritatively told there is no truth whatever in this suggestion, which

Dennis Van Thal appears in Reggie Smith's "Queue for Song" shows which are now a regular Saturday feature in television.

obviously would be very unfair to the listeners at present residing outside the television reception area.

5-Meter Tests from Ashurst Beacon

On May 2, G2IN and G5ZI will be transmitting phone and modulated C.W. on the 5-metre band with directional and non-directional aerials.

Transmissions start at 10.00 B.S.T. and continue without break until 16.00 B.S.T. Transmitting and listening stations are asked to co-operate and to fix schedules so that there will not be any loss of listening time. Details from G2IN.

Public interest in television is apparent from this photograph taken outside the G.E.C. showrooms in Kingsway.

MORE PROGRAMME IDEAS AND CRITICISM

Here are some further letters containing suggestions and criticisms for which we asked in our February and March issues.

ADDING VISION TO BROADCASTING

Sir,

The natural application of television is (*a*) as an aid to sound broadcasting, and (*b*) as a means of looking in on something which happens to be occurring at some distant place.

The B.B.C. have taken an opposite point of view and are endeavouring to use television as a separate entertainment channel. Think what this means in programme building: They are finding it difficult already to always find suitable material, and the result is a lot of very boring padding.

Entertainment brought to the camera must be of such quality and so full of lively interest that the viewer is lost to the fact that it is a televised programme. We have had about half a dozen such programmes.

As an aid to sound we want television "piped" from B.H. and St. George's Hall to show us the comedian's grimaces, the effect of which we can already hear; to give us the conductor of a symphony orchestra to help concentration; and to show us the actors in radio drama. The boxing broadcast from the "A.P." concert hall showed us the difference between real television and studio entertainment. There was a thrill in the real thing.

DRAMA

Until the O.B. apparatus is ready, however, studio production must go on. Good variety turns are welcome. Persons interviewed in "Picture Page" must be well known for their art, skill, profession or something they do and they should for that reason give examples in their interview; we are not interested in seeing just faces. The "London Character" type of subject is not, generally speaking, of much interest.

Slow moving and heavy items do not hold the attention sufficiently for television. Films of good entertainment value could always be used to swell programmes, or excerpts linked up with a commentary to make a story.

Films should not be repeated within months. Most of the films televised to date have been very poor.

Instead of giving the same news reels twelve times per week, cannot the B.B.C. have a news camera man out filming items daily—giving delayed television in effect?

More televised drama is required.

As regards times, traders will want the afternoon transmissions, and in the evenings, although more is desired, it should be in two sessions. The actual timing should be arranged in conjunction with televisable sound programmes.

L. Bounds (Hillingdon).

MORE FILMS

Sir,

The recent extension in "direct" television transmissions made possible by the development of the Emitron camera, appear to have placed the film, as a means of televised entertainment, in a somewhat inferior position.

Interesting and desirable as studio and outside broadcasts are, I should like to see the full length dramatic feature film given its proper place in future programmes and suggest that these inclusions would be a practical method of providing an immediate extension of the service without prohibitive cost.

Many of us regret the very limited opportunity we have of seeing for a second time films of a year or so ago and the many good productions that we have missed from time to time. These films produced at great cost and upon which so much time and thought have been expended, have their two or three weeks run and then, apart from a few exceptional revivals and some Sunday showings, are heard of no more.

Here then exists a storehouse of ready-made entertainment of infinite variety and definite appeal. Does is not seem desirable that the best of these forgotton filmt should be brought to light in order to entertain us once more?

It may be argued that the film companies will not readily concede that such a policy would prove beneficial to them, but I am of the firm opinion that the re-issue of out-of-date films for television purposes would not in any way harm the film industry, but rather provide an additional source of revenue and foster an even greater appreciation of the screen.

As an enthusiastic film goer, I believe the introduction of well chosen re-issue feature films into television programmes will prove a great incentive to others of that great army, to possess a television receiver. Let us therefore do all in our power to further such an ideal, for the future development and ultimate perfection of television must to a great extent depend on the support given by the public to those whose untiring effort and tenacity of purpose have demonstrated that television has arrived.

Frank S. Wise (London, W.C.).

THE GRAMOPHONE PARALLEL

Sir,

As an enthusiastic viewer and constant reader of your journal, I have for some time been wishing to express my opinion of the television programmes and feel that here is an opportunity.

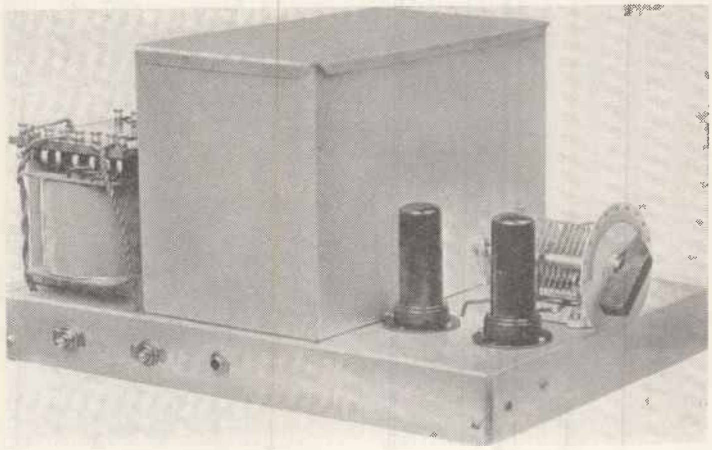
In view of the fact that most of the sets now working are used by demonstrators, the number used by home viewers being very small, I suggest a more suitable time for transmissions be, say, between eight and nine p.m. This would obviate the necessity for demonstrators returning to their premises after ordinary business hours in order to allow their interested clients, who, for business reasons, are unable to call during the afternoon, to view transmissions. I consider the length of programmes, at present, quite adequate, but hope the number of hours will be at least doubled—should suggest four separate hours—as soon as the service becomes established.

In my opinion there is no entertainment value in pictures televised more than twice, and would abolish educational films dealing with insects, etc. I would

(*Continued on page* 316)

A 6D5 Push-pull Transmitter

In accordance with many requests received from transmitting readers, G5ZJ has designed this simple but effective 5-metre phone transmitter which is sufficiently robust for portable work yet has an input of up to 15 watts. It is fed from A.C. mains or miniature rotary converter.



These are the 6D5's with the split stator anode condenser to which is fixed the anode coil. The switch on the extreme left is in series with the mains transformer, while the second switch merely breaks the H.T. supply.

MANY requests for a reasonably transportable 5-metre phone transmitter have been received during the last few months. Presumably amateurs are again preparing for the boom in ultra-short wave working that invariably begins in the early part of the summer.

It is still too early to try and convince the average constructor that a crystal controlled transmitter is essential, for, despite the fact that simple equipment of this kind can be built using 6A6's and 6L6's, the expense is too high compared with the straightforward push-pull transmitter.

For local working, local being up to 30 miles or so, the push-pull transmitter has a lot in its favour. Super-regenerative receivers are still the most popular, so that the frequency shift with a non-crystal controlled transmitter and, of course, with only a single stage, is not of primary importance.

Transceivers for serious work are not popular unless they are confined to very low power with a dry battery source of supply. For such reasons this 6D5 transmitter is straightforward and intended for use with an A.C. or battery-operated flatly-tuned receiver, such as was described on pages 230, 231 and 232 of the April issue.

Metal Valves

Metal valves are becoming more popular, for, despite the fact that they get very hot, this is counteracted by their stability and efficiency. After testing glass and metal valves of all kinds, the 6D5's were chosen for this transmitter for, with 275 volts applied, they handle an input of 15 watts and give a good R.F. output over long periods.

As the metal valves were so satisfactory as oscillators, it was decided to use this type of valve in both the modulator and power pack. The wisdom of this choice was soon proved, for the transmitter has been badly knocked about during several outdoor tests, but so far results have always been satisfactory and no troubles cropped up due to valve defects.

Altogether there are five valves in this complete phone transmitter. First of all is the 6D5 which actually is the glass equivalent of the type 45 triode power amplifier. As with all the valves in this transmitter, it has a 6.3 volt heater, so that if necessary it can be run from a large capacity car accumulator. The maximum anode voltage permissible is 275 and this voltage is not exceeded even though the power pack delivers 305 volts on full load. The excess 30 volts is dissipated in auto-bias and slight losses across the smoothing and modulation chokes.

The Maximum Input

It is recommended that the anode current of the 6D5's be limited to approximately 30 M/a per valve. The maximum input is approximately 15 watts with the circuit as shown, so that the valves take less than 25 M/a each with correct loading.

In the modulator section there are two valves, a 6C5 into which is fed the microphone, followed by a 6F6 pentode which has an equivalent in the glass type 42 valve. The 6F6, used as a modulator, is run with 305 volts on both anode and screen, and in such circumstances provides an audio output of 5 watts.

This audio is insufficient completely to modulate the 15 watts input, but although nothing like 15 watts of carrier are obtained, the audio is still too low to give maximum modulation. This has been done deliberately to reduce local interference to broadcast listeners.

Modulator Bias

Going back to the characteristics of the 6F6, the makers recommend that a

COMPONENTS FOR A 6D5 PUSH-PULL TRANSMITTER

CHASSIS.
1—Aluminium 14 by 9½ by 1½ in., 16 gauge, turned down on four sides.

1—Aluminium screening box with lid but without base, 5 by 9 by 6 in. (Peto-Scott)

CHOKE, HIGH-FREQUENCY.
1—Type 1021 (Eddystone).

CHOKE, LOW-FREQUENCY.
1—Type 30V (Sound Sales).

COILS.
2—Home constructed to specification.

CONDENSERS, FIXED.
2—8-mfd. electrolytic type 0281 (Dubilier).
1—2-mfd. type BB (Dubilier).
1—12-mfd. type 3001 (Dubilier).
1—25-mfd. type 3016 (Dubilier).

CONDENSERS, VARIABLE.
1—2-gang type E double spaced (Polar).

DIAL.
1—Type 1027 (Eddystone).

HOLDERS, VALVE.
5—Octal type chassis (Clix).

MICROPHONE.
1—Type A (Leslie Dixon).

MICROPHONE BATTERY.
1—3-volt miniature type (Ever Ready).

PLUGS, TERMINALS, ETC.
1—Plug type P15 (Bulgin).
1—Jack type J3 (Bulgin).
1—Stand-off insulator type 1019 (Eddystone).
2—Stand-off insulators type 1029 (Eddystone).

RESISTANCES, FIXED.
1—25,000-ohms type 1 watt (Erie).
1—10,000-ohms type 3 watt (Erie).
1—1,000-ohms type 1 watt (Erie).
1—500,000-ohms type ½ watt (Erie).
1—120-ohms type 2 watt (Erie).

SUNDRIES.
2—Coils quickwyre (Bulgin).
3—Dozen 6BA round-head bolts with nuts and washers (Peto-Scott).
8—Ft. 14 gauge hard-drawn bare copper wire (Peto-Scott).
1—Two-piece plug and adaptor (Clix).

SWITCHES.
2—Type S80T (Bulgin).

TRANSFORMER, LOW-FREQUENCY.
1—Type AF3 (Ferranti).

TRANSFORMER, MAINS.
1—Special type to give 300-0-300 volts; 6.3 volts; 5 volts (Premier Supply Stores)

TRANSFORMER, MICROPHONE.
1—Type LF35 (Bulgin).

TRANSFORMER, OUTPUT.
1—Type OPM8 (Ferranti).

VALVES.
1—5Z4 metal (Eves Radio).
1—6F6 metal (Eves Radio).
1—6C5 metal (Eves Radio).
2—6D5 metal (Eves Radio).

bias resistance of 440 ohms be used, but several tests have shown that this value is far too low with the higher voltage of 305. So for that reason constructors need not query the 1,200-ohm resistance actually used in this transmitter. The total anode and screen current is approximately 50 M/a, of which 8 M/a are taken by the screen. In case of variation in valve characteristics, constructors are advised to measure the total cathode current of this valve, and if high or low, to adjust the cathode resistance accordingly.

In this plan view, the metal screening can has been removed, showing the exact layout of the components. Note in the text the remarks concerning the mains transformer, inter-valve transformer and smoothing chokes.

The 6C5 triode amplifier is rated to handle a maximum voltage of 250, but in practice the actual applied voltage is much lower than this owing to the fact that there is a 25,000- and 10,000-ohm resistance in series in the anode circuit. This ensures adequate decoupling, and even though the voltage is reduced to 150, there is still sufficient gain from this stage fully to load the 6F6. Actually, the 6C5 has an amplification factor of 20 with a slope of 2 M/a per volt, so it is an ideal valve for use in this circuit.

Transformer coupling has been employed between the two speech amplifier valves, so in case of low input from the microphone there is ample gain in hand. A type AF3 Ferranti transformer is used in the original instrument, and providing this is mounted as shown, there is absolutely no hum pickup by this component despite the fact that it is so close to the mains transformer. It should be remembered, however, that there is double screening between these two components by virtue of the aluminium box and metal shroud around the transformer.

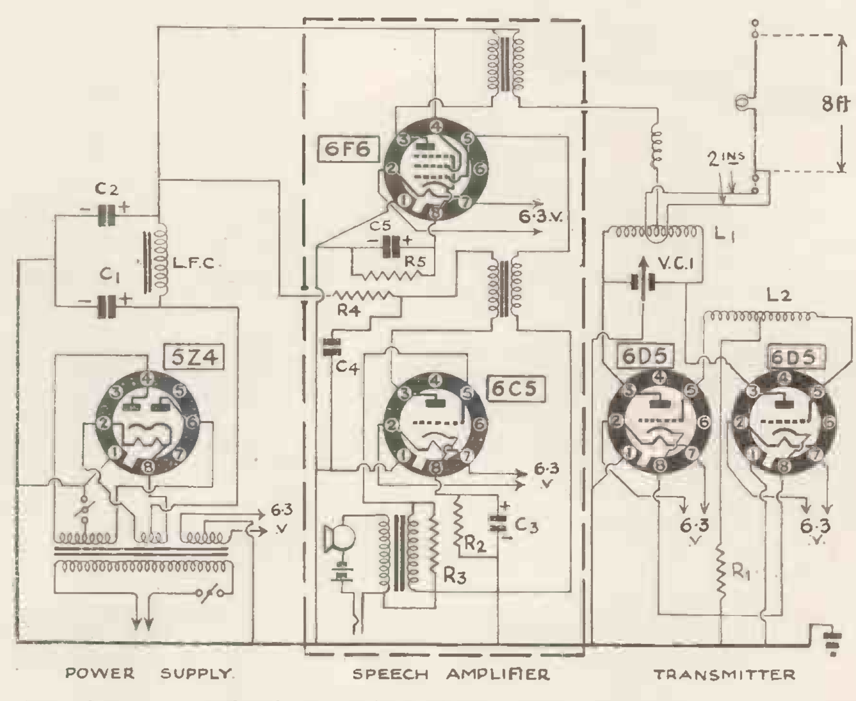
There is nothing unusual in the power pack, for it consists of a standard transformer giving 300-0-300 volts at 100 M/a plus two filament windings giving 6.3 volts and 5 volts for the filaments of the remaining valves. The 5-volt winding is for the rectifier which is a 5Z4 rated to handle 400 volts at 125 M/a. It is being well under-run so that there is no source of worry from this end of the apparatus. Actually, as all the valves are below their rated limits, it probably accounts for the stability and freedom from trouble experienced.

Numerous contacts have already been made with other stations on the 5-metre band and without exception all have commented on the quality of this transmitter. Even so, if the metal screening box is omitted, hum level increases very noticeably and quality goes off to an alarming extent, so it can be taken for granted that complete screening between the three sections is absolutely essential.

First, build the power pack. With the chassis specified, which is 14 ins. by $9\frac{1}{4}$ ins. by $1\frac{1}{2}$ ins., one-third of the space can be allocated to each part of the transmitter. Make a particular point of mounting the smoothing choke, a Sound Sales type 30V, in the position shown in the illustrations. Any other position immediately causes an increase in hum. By-passing this choke are two 8-mfd. electrolytic condensers, a combination which gives really smooth D.C. for the modulator section.

Wiring the Valve Holders

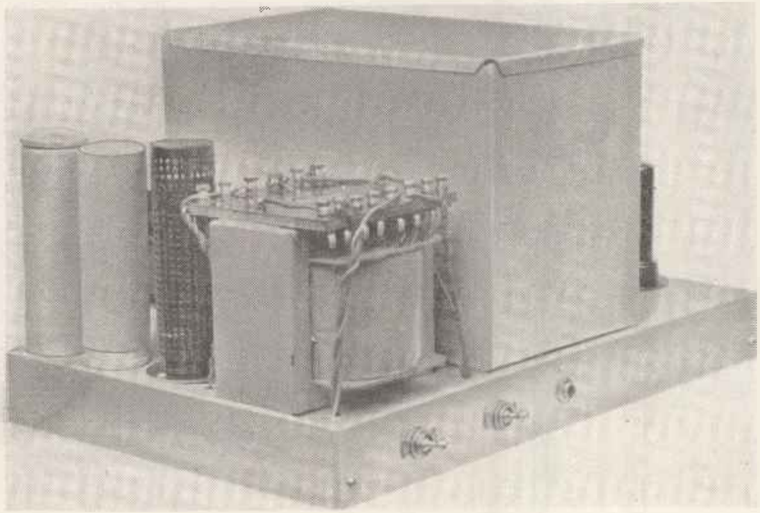
It will be noticed that 8-pin octal valve holders are used throughout. This is yet another feature in favour of these new metal valves, for it enables constructors to use one type of valve-holder in all apparatus. In case constructors should be a little doubtful as to the pin connections, the circuit diagram has been drawn so that the valve-holder agrees with the layout of the pins. A key indicates a starting position, and going from left to right the pins are numbered 1 to 8. Generally speaking the pin numbers are the same for all types of valves. For example 1 is always the metal case, 2 and 7 are the heater, 3 is the anode, 5 is the grid and 8 is the cathode. The remaining pins are used with multi-electrode valves. It



A new idea is incorporated in this circuit, for the valves are shown within their holders and actually in the way they are wired. The numbers and key match up with the valve-holders specified.

should be remembered that in this transmitter the 6C5, 6F6 and 5Z4 all have pin 1 connected to chassis, but with the oscillator valves, the 6D5's, pin No. 1 is left unconnected. Tests showed that with the metal case earthed, the capacity increased so that some difficulty was experienced in tuning down to 5 metres.

ever, in practice, the measured centre is not always correct. How to check this is discussed under the operating notes. So as to anchor the high potential end of the anode choke, a small stand-off insulator is bolted to the chassis as shown, and this is then connected to one side of the secondary of the modulation transformer. An OPM8 output



This mains transformer has a screened primary which is earthed to the metal case of the transformer. Fix the rectifier valve-holder so that the connections are correct as indicated in the sub-chassis view of the transformer.

Construction

Wiring the oscillators is very simple, but it should be carefully done. Arrange the valve-holders so that the control grid pins come together towards the front of the chassis, and by referring to the illustration of the under-chassis wiring, it can be seen that the grid coil then fits directly across these two pins. This grid coil consists of 14 turns of 14-gauge bare copper wire wound to a length of 2 ins., and with a diameter of ½ in. It must be accurately centre tapped with the grids tied down to earth by means of a 10,000-ohm 3-watt resistance.

A two-gang double-spaced split-stator condenser, having a capacity of approximately 30 mmfd. each half, tunes the anode circuit. If it is arranged as shown, the connections from the stator plates can be taken straight through the chassis to the anode terminals of the 6D5's. As the condenser is fitted with duplicate connections, two on each side, the anode coil is soldered directly to the opposite side of the condenser, as can be seen in the plan view.

Coil Winding

Wind the anode coil with 9 turns of 14-gauge copper wire to a length of 1¼ ins. and with a diameter of ½ in. This again has to be centre-tapped and the H.T. supply is fed in through an ultra-short wave choke at this point. How-

transformer has its primary connected in the anode circuit of the 6F6 and its secondary to the anode feed to the 6D5's. In this way very satisfactory modulation is obtained with the minimum amount of trouble. Of course, one connection from both primary and secondary is taken to the common H.T. feed.

Make a special point of earthing the rotor plates of the tuning condenser to the actual cathodes of the 6D5's, and not to the nearest chassis point, which will probably be more convenient.

Cutting the Aerial

Mount two more stand-off insulators near the anode ends of the anode coil, and wind a single turn around the centre of the anode coil and terminate it on the soldering lugs of these two insulators. Erect an aerial at the frequency to which the transmitter is to be tuned, and couple it by untuned twin feeders. It is suggested that the aerial have a total length of 8 ft. In the exact centre solder into circuit a 4-volt low-current flash-lamp bulb. Make the feeders approximately 4 ft. long and 2 ins. wide, and couple to the single anode turn.

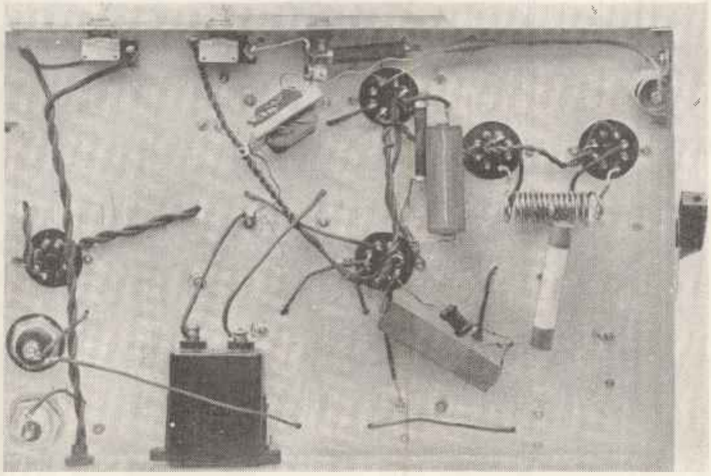
Check the anode voltage and current and then when the condenser is tuned the lamp should light in the centre of the aerial. If it does not it shows that the anode coil is not of the correct inductance, so it should be compressed or extended until the lamp lights to maximum brilliance with approximately one-third tuning capacity.

When the anode circuit has been adjusted, the grid coil must be lined up, for this is untuned. The amount of light in the aerial should be noted and then the grid coil should be compressed and extended to find a position where both grid and anode coils are in resonance, so increasing the R.F. output from the 6D5's.

The Correct Tuning Point

It may be noticed that the lamp lights at two settings of the anode condenser. This can be caused by too tight an aerial coupling or to the anode coil not being correctly centre tapped. First remove the aerial coupling altogether and make a tuning indicator. This

(*Continued on page* 319)



The few components needed are self-locating in the wiring, but particular attention should be paid to the untuned grid coil and associated 10,000 ohms resistance.

The B.B.C. to Lead in S.W. Transmission

It is interesting to note that the B.B.C. by their erection of three new 50 k.w. short-wave stations, have now the most powerful programme transmitters in the world. It is hoped that they will be in full operation in time for the Coronation.

This is the final stage of the modulator unit with mechanical water interlocks which are arranged that the transmitters cannot be switched on until the correct amount of water for valve cooling is flowing.

THREE new B.B.C. high power short-wave stations are to be put into service during May in time for relaying Coronation programmes. These stations will have an average input of 50 kW, which can be increased up to a maximum of 75 kW, should a higher field strength be needed in certain parts of the world.

There are already three of the original short-wave stations still in operation at Daventry, so that six independent transmitters will be available for peak traffic work. Two of these transmitters are rated for an input of 10 kW, while the original G5SW, which was hired by the B.B.C. from the Marconi Company, is still in active use. It is, however, being adapted to handle an input of 25 kW

The total input to the six transmitters is no less than 195 kW, and as three of the stations have 50-watt ratings, the B.B.C. is in the happy position of operating the most powerful short-wave programme broadcasters in the world.

Although there are but six stations, they can operate on 16 different wavelengths with separate call signs, and all are active with the exception of GSK, which has been allocated the experimental wavelength of 11.49 metres. Here are the call signs and the wavelengths used by the B.B.C. transmitters.

GSK	11.49 metres	GSF	19.82 metres
GST	13.92 metres	GSE	25.29 metres
GSJ	13.93 metres	GSN	25.38 metres
GSH	13.97 metres	GSD	25.53 metres
GSG	16.87 metres	GSC	31.32 metres
GSP	19.60 metres	GSB	31.55 metres
GSI	19.66 metres	GSL	49.10 metres
GSO	19.76 metres	GSA	49.59 metres

Rarely is it found necessary to have more than three stations radiating simultaneously, although in order to provide a reliable service, complicated beam aerials with reflectors have been erected.

There are 23 aerial systems capable of transmitting in twelve different directions. By having sharply defined beams the signal strength can be intensified in any given area where difficulty has in the past been experienced in picking up B.B.C. programmes.

A complicated switching system enables any of the six transmitters to be connected to any of the 23 aerial systems, while altogether there are six miles of feeder wire.

To give some idea as to the efficiency of these new stations, it has been discovered that approximately 75 per cent. of the programme material transmitted is received so as to be of entertainment value.

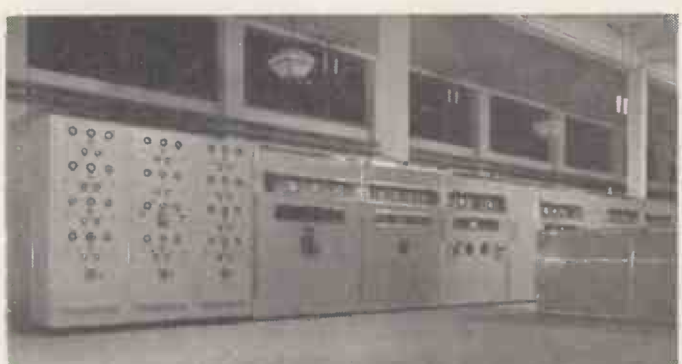
Gramophone records showing just what the B.B.C. consider to be entertainment value, have been made and sent to a number of recognised listeners in all parts of the world so that they can give reports on how the stations are being received, secure in the knowledge that their idea of good reception coincides with that of the B.B.C.

Valuable data has been obtained over a period of years and this has enabled the B.B.C. in collaboration with the Marconi Wireless Telegraph Co., and Messrs. Standard Telephones & Cables, to design these new high-power stations which are supreme in their class.

Correspondence shows that the programmes are regularly heard, not only in our own colonies, but in all parts of America, from where 50 per cent. of the correspondence originates.

The six zones which cover most of the British Empire make it necessary for the transmitters to be on the air from 6 a.m. until 4 a.m. the following day. Each zone has a transmission which is complete in itself, including a time signal, and news bulletin or news letter at regular intervals. Where the programme times coincide with the normal Regional or National transmissions suitable items are relayed and transmitted without the use of any recorded matter. Transmission 1, using GSG, GSO and GSB, begins the day at 6 a.m., closing down at 8.5 a.m.

The other extreme is transmission 6, intended for the west coast of Canada and the whole of that area; this uses GSF, GSD and GSC.



On the left is one of the new transmitters, showing the crystal oscillator and frequency doubling stage. The intermediate amplifier and power amplifier stage is in the centre, while on the extreme right is the modulator unit.

A Mains-operated Short-wave Converter

By Kenneth Jowers.

In order to provide constructors with a reliable short-wave converter with a high-frequency stage, we publish this two-stage unit. It will convert the average broadcast receiver into a modern high-efficiency all-wave superhet.

EVERY listener at some time or another feels the need for a short-wave receiver or some means of tuning in the dozens of short-wave stations broadcasting every day. Many are still very sceptical as to the programme value of these short-wave stations, so cannot be persuaded to go in for a special short-wave receiver or commercial all-waver. However, it is a very simple matter to construct a mains-operated converter which can be added to almost any receiver, taking its energising voltage from the parent set.

By simple switching once the converter has been connected up, it only means two wires to do this, it can be left in circuit and cut in and out as required.

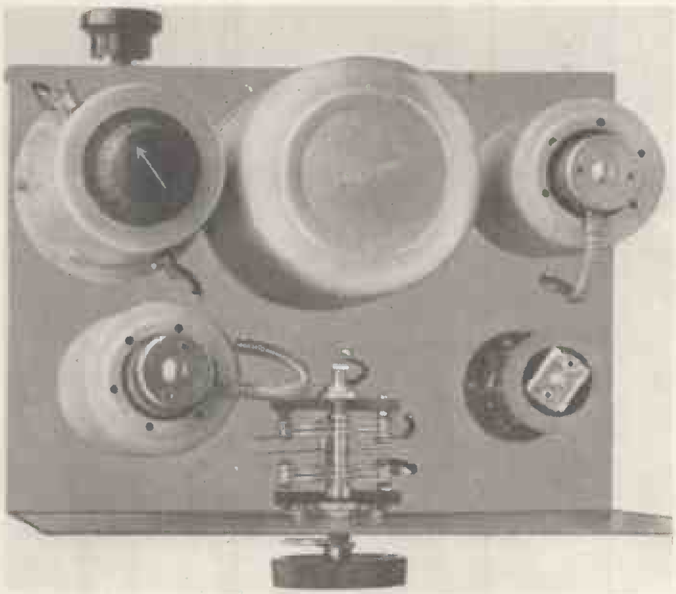
An All-wave Super

A converter is merely a separate receiver that tunes to the short-waves, and uses the normal broadcast set as an amplifier or booster. So, for example, if a 4-valve broadcast set is in use, by connecting in front of it a two-stage converter, a 6-valve modern short-wave super-het is obtained. What is more to the point, despite the use of an adaptor, the results are fully equal to those given by a modern all-wave super-het.

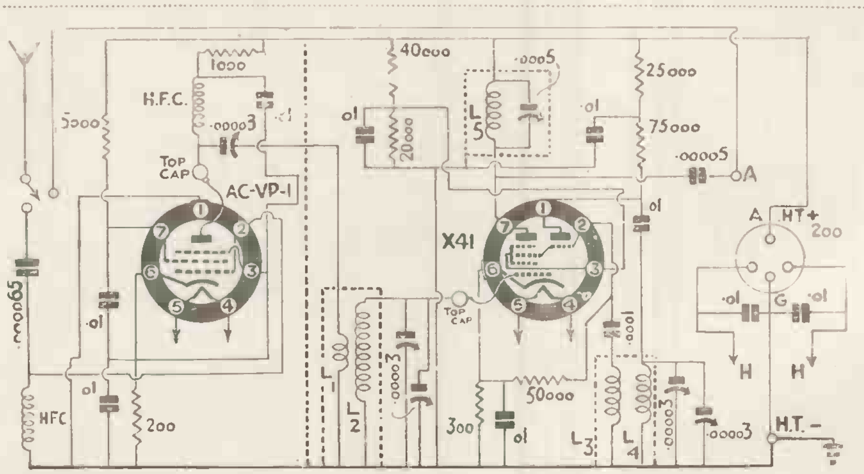
There are many who, having bought a receiver fairly recently, find they do not wish to scrap it merely because it only covers two bands and if they were to sell it in part-exchange for a new all-waver they would probably lose on the deal.

Here is the solution to that problem. A two-stage short-wave converter using a modern circuit having a pre-selector stage in order to provide adequate signal strength, minimum noise and no second-channel interference.

Refer to the circuit, for it gives a complete picture of the system employed. The aerial, first of all, comes to a rotary switch of the simple type normally used for gramophone pick-up circuits. The aerial is connected to the centre point so that in one direction it is connected directly to the grid of the AC/VP1 first amplifier, and in the alternative position to the output of the converter, which virtually means that it is re-connected back to the parent broadcast receiver.



Except for approximately 1 in. of wire, the whole of the connections for the oscillator circuit are either screened or beneath the chassis to prevent coupling to the grid circuit of the X41.



The numbered pin connections on these valve holders coincide with the numbered pins on B.V.A. valves. The positions of the valve pins viewed from underneath coincide with the circuit drawing.

Untuned H.F. Stage

In order to reduce the number of controls, the high-frequency stage is untuned and has a H.F. choke in the grid circuit. In this way a reasonable amount of gain is obtained, while the aerial damping is kept off the detector-oscillator stage, which would cause uneven results on various wavebands.

A .000065-mfd. semi-variable condenser is connected in series with the aerial. This is of the pre-set type and should be connected in the wiring. Minimum capacity gives maximum selectivity but it will be found in practice that a lower capacity is needed on the lower wavelengths. In fact on the 160-metre amateur band it is an advantage slightly to bend the last rotor plate so that it short-circuits at maximum capacity and connects the aerial directly on to the grid of the AC/VP1.

The makers recommend that this valve be run with 250 volts on both

A Pre-selector Stage :: A.C. Operated :: All Bands

anode and screen, but constructors will find that this recommended circuit is as a general rule more fool-proof. The screen voltage is approximately 180, being reduced from 200 by means of a 5,000-ohm fixed resistor. This is by-passed to cathode as indicated and not

This is the anode coupling unit, consisting of L5 and a .0005-mfd. condenser. Isolate the tuning condenser from the chassis as well as the two terminals on the body of the can.

to earth. In the anode circuit there is a very slight voltage drop of approximately 10 volts across the 1,000-ohm decoupling resistance in series with the main H.T. supply. Notice also that this is by-passed by a .01-mfd. condenser, the earthy side being taken to cathode as with the screen by-pass condenser.

So as again to reduce damping, or at least to be able to control it, the output from the AC/VP1 is coupled to a two-turn primary coil, L1, via a special midget type 30-mmfd. condenser which is semi-adjustable to give the correct value. In addition to providing even oscillation on all wavelengths it also enables the inter-stage selectivity to be increased or decreased as required.

A Novel Tuning Arrangement

The tuning arrangements for L2 and L4 should be noted. Instead of using the conventional panel-operated band-setting condensers which take up a lot of room, small postage stamp trimmers of the Eddystone 1023 type are mounted in the top of the coil, as indicated in the illustration. Normally these trimmers are not easy to mount but a simple way to overcome the trouble is to wire them into circuit directly to the valve pins in the base of the coil form by 18-gauge wire, when they will keep in position very easily.

One condenser will be needed for each coil, so that if four wavebands are to be covered, 8 coils and 8 condensers have to be mounted and adjusted. Once the adjustments have been made there is no further need to worry about these trimmer condensers, for all tuning is carried out by means of a Jackson midget 2-gang condenser.

Electronic Coupling

As a super-het circuit is used, the main problem is the design of the detector-oscillator circuit. An X41 triode-hexode valve provides the solution to the constructor's problem in this respect, for as electronic coupling is employed between oscillator and detector circuits, the efficiency of the converter remains more or less constant and of a high order at all wavelengths.

The old troubles of adjusting coils to provide correct inductive coupling between stages is once and for all overcome by means of the X41 valve. Constructors who are a little diffident at trying their hand at a super-het circuit

This close-up view of the detector coil shows how the trimming condenser is mounted. The X41 valve is also shown without screening.

should have no doubt about the results being in every way satisfactory.

Building L5

L5 is a home-constructed component and a most important one. The normal super-het receiver needs to be correctly coupled from the detector to the I.F. stages through a carefully aligned transformer of the proper frequency. In the case of a short-wave converter the tuned grid stage in the succeeding parent receiver partly takes the place of the I.F. transformer. In the anode of the detector-oscillator is generally a high-frequency choke of a given inductance which rarely matches the inductance of the grid coil in the broadcast receiver. This means a loss of efficiency generally shown up by high noise level and weak signals. To overcome this trouble the coupling unit L5 has been introduced, for this takes the place of the primary in the I.F. transformer.

It is recommended that the broadcast receiver be tuned to approximately 500 metres, while L5 should be adjusted to the same wavelength so giving more or less correct matching. L5 can be seen from the illustration and is to the left of the main screening can. It consists of a 2½-in. length of 1½-in. paxolin former wound solenoid with 150 turns of 30-gauge enamel-covered wire. In the top of the screening can is mounted a

Components for A MAINS OPERATED SHORT-WAVE CONVERTER

CHASSIS.
1—Zinc 8 by 6 by 1½ ins. with screening to specification (Peto-Scott)
1—Zinc panel 8 by 7 ins., 16 gauge (Peto-Scott)

CHOKES, HIGH-FREQUENCY.
2—Type SW69 (Bulgin).

COILS.
2—4-pin type 932 (Eddystone).

CONDENSERS, FIXED.
9—.01-mfd. type tubular (Bulgin).
1—.0001-mfd. type Mica (Dubilier).
1—.00005-mfd. type Mica (Dubilier).

CONDENSERS, VARIABLE.
1—Type 978 (Eddystone).
1—Type 2148 (J.B.).
2—Type 1023 (Eddystone).
1—.0005-mfd. type 2093 (J.B.).

DIAL.
1—Type 1026 (Eddystone).

HOLDERS, VALVE.
2—7-pin ceramic chassis less terminals, type V6 (Clix).
1—4-pin chassis type V1 without terminals (Clix).

PLUGS, TERMINALS, ETC.
2—Plug top connectors type 1224 (Belling-Lee).

RESISTANCES, FIXED.
1—5,000-ohm 1 watt type chassis (Erie).
1—1,000-ohm 1 watt type chassis (Erie).
1—200-ohm 1 watt type chassis (Erie).
1—20,000-ohm 1 watt type chassis (Erie).
1—40,000-ohm 1 watt type chassis (Erie).
1—300-ohm 1 watt type chassis (Erie).
1—50,000-ohm 1 watt type chassis (Erie).
1—25,000-ohm 1 watt type chassis (Erie).
1—75,000-ohm 1 watt type chassis (Erie).

SUNDRIES.
Connecting wire and sleeving.
1—Standard coil screen (Colvern).
2—Open top screening cans (Colvern).
1—2 ins. length 1½ ins. paxolin former (Peto-Scott).
¼—oz. 36 gauge enamelled covered wire (Peto-Scott).
1—Coil screened connecting wire (Bulgin).

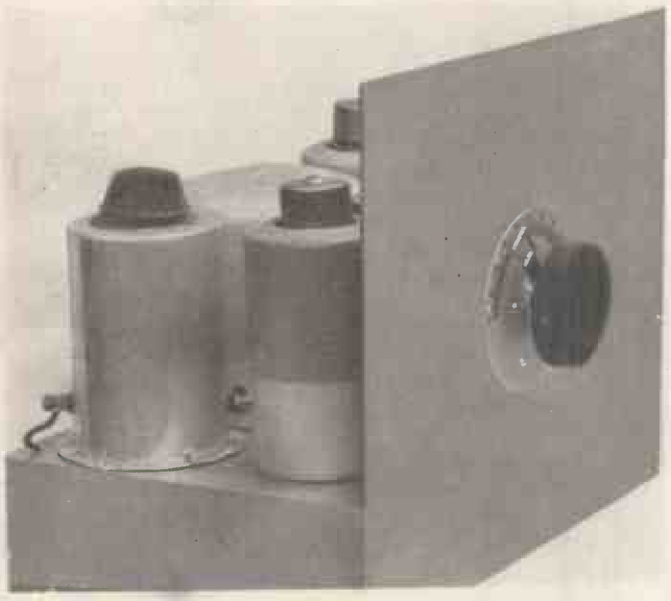
SWITCH.
1—S114 (Bulgin).

VALVES.
1—X41 Met. (Osram).
1—ACVP1 Met. (Mazda).

Connecting to the Main Receiver :: A Zinc Chassis

.0005-mfd. mica di-electric tuning condenser which has its rotor carefully insulated from the metal can.

At the top of the former should be riveted two strong soldering tags, for these are soldered directly on to the contacts on the tuning condenser. In this way the coil and condenser can be built and tested before it is finally fitted to the can. Two thin, but insulated leads, should be taken to the two insulated terminals on the body of the can, as shown in the illustration. If these are correctly positioned the leads will be kept quite short. Reference to the theoretical circuit will show that the anode side of L5 drops through the chassis and is connected to the rotary switch via a .00005-mfd. fixed condenser.



There is only one control, the main tuner, although padding condensers are across each coil and an aerial switch is mounted on the back of the panel.

The Correct Resistance Network

The resistance network which is the main part of the X41 circuit should be very carefully wired. The 50,000-ohm grid leak, associated .0001-mfd. condenser and the wiring to grid and L4 should be carried out with some heavy 16-gauge wire. The control grid of the X41, coming from the top of the valve, is taken directly to the stator plates on the front half of the tuning condenser, or alternatively, can be taken directly to the grid side of L2, whichever is more convenient.

Anode voltage to the X41 on the oscillator section is reduced to well under 100 volts by means of an anode impedance of 75,000 ohms plus decoupling resistance of 25,000 ohms. The junction of these two resistances is bypassed to earth by a .01-mfd. condenser.

Similarly with the screen of this valve. Owing to the low current flow it is not advisable to obtain the voltage by means of a series resistance, for it would not be possible accurately to give the correct value for all valves, as there is bound to be slight variation in characteristics between individual samples. However, a fixed resistance network across the main H.T. supply provides a steady voltage, and this resistance with 200 volts input should consist of 40,000 ohms on the high potential side and 20,000 ohms on the earthy side.

As mentioned previously, coupling between stages is obtained electronically. To prevent any possibility of external coupling due to wiring, the detector-oscillator circuit must be assembled in the manner shown. It will be seen that the oscillator coil is completely screened by a 3-in. Colvern coil screen. Also with the exception of a very short lead from the stator plates of the oscillator tuning condenser, the entire oscillator section is either screened or below chassis. In this way there is no need to provide an additional screen for the grid coil.

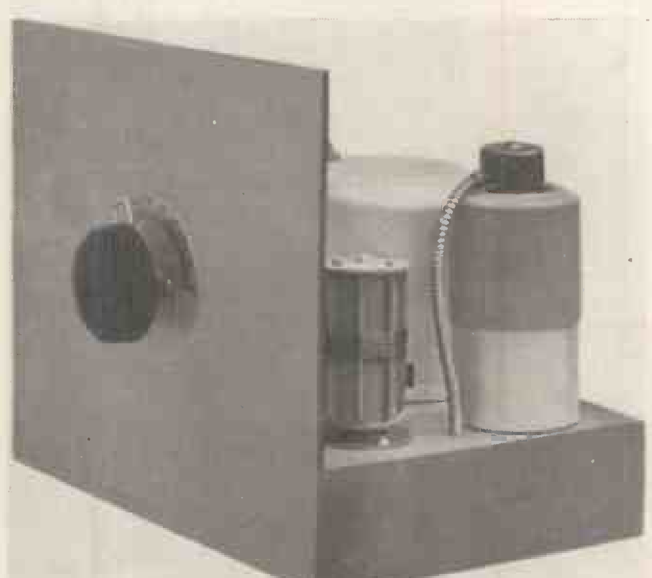
The only defect in this arrangement is that owing to the mass of metal around the oscillator coil the effective wavelength is slightly increased above that given by the makers. However, the wavelength covered by L2 can be increased accordingly by means of the trimmer condenser mounted across it.

Coils and Wave Bands

It is recommended that Eddystone type 932 coils be used, using pins 1 and 4 for grid and earth in the detector circuit and 2 and 5 for the primary winding. These coils will cover satisfactorily 14 to 170 metres with coils LB, Y, R and W, but it is advisable to experiment with the number of turns on the primary winding in each coil in order to obtain correct selectivity. This will be a matter of personal taste for it depends so much upon local conditions and the type of aerial employed.

A standard 4-pin chassis mounting valve holder is fitted to the back of the chassis and to this are taken the four battery wires. H.T. is taken to anode and grid with filament to the normal filament pins. A 4-pin Bulgin plug can then be used for connections and the battery leads taken away to the parent receiver. Another Bulgin tapped filament adaptor will enable the operator to tap-off 4 volts from the main receiver to feed the X41 and AC/VP1.

(*To be continued next month*)



This is the grid coil and the padding condenser can be seen fixed in the top. The coil is a standard Eddystone product, but the primary winding may need adjusting.

Programmes for Short-wave Listeners

By A. C. Weston.

Although the high spots for this month are the Coronation programmes there are many famous radio film and stage stars to be heard over the short waves. News of the new German programmes are given in this article which covers Europe Australia and America.

SHORT-WAVE programmes generally seem to be re-shuffled around May, but this year the re-shuffling seems to be a bigger scale than ever. The change to summer time usually only affects the American stations which are generally re-timed, but in addition, the Coronation relays which are going to be done on a grand scale, are making all schedules most unreliable. On the other hand, owing to the greater amount of daylight, the lower wavelength stations will be much simpler to hear, while some of those items which are scheduled for the wrong side of midnight have, with the retiming, been scheduled for 10.30 to midnight, so that many items the average listener misses can now be put in the notebook.

Jack Oakie and Penny can be heard over the Columbia network. The best station is W2XE New York.

One of the most reliable stations for this month is going to be Boundbrook. From 2 p.m. until 7 p.m. it is on the air on 16.87 metres.

It can be taken for granted that on May 12 this station and, in fact, most American short-wavers, will be linked to London for relays of the Coronation procession, and some of the other items. Special commentators have been sent over and they have been allocated points of vantage where, they can actually see all that is happening and relay the news via Rugby to their American audiences.

Columbia are doing things on a great scale, for they have sent over Bob Trout and Paul White, who will spend most of their time around Trafalgar Square, Whitehall and Westminster Abbey. To get their hand in they are going to do some pre-Coronation commentaries on the sights of London, so keep an eye on the Wayne stations for these programmes.

A number of prominent speakers can also be heard through Columbia stations, and as most of these are being relayed from London it will be interesting to hear what they have got to say. Amongst those already scheduled are Sir Josiah Stamp, the Marquis of Donegal, Dr. Harold Laski, Viscount Cecil of Chelwood, Lord Strabolgi, who is chairman of the Radio Association, Hector Bolitho, and the Duchess of Atholl. Finally, on May 9 at 8 p.m., the Archbishop of Canterbury is to be relayed when he delivers his pre-Coronation sermon.

Milton Cross in the Coast-to-Coast on a Bus programme also announces R.C.A. Magic Key on Sundays at 7 p.m.

Boundbrook Programme

Here are the programmes that I promised you were scheduled for transmission through Boundbrook. East Sunday at 2 p.m. Milton Cross comperes a programme entitled "Coast to Coast on a Bus." "Give Us the Funnies," a variety programme, supported by an orchestra under the direction of Frank Novak, comes over at 2.30 p.m. Jerry Belcher interviews typical American families in their own homes. What he says and hears is relayed every Sunday at 6.40 p.m. Milton Cross again comes on the air at 7 p.m., when he is the M.C. for the Magic Key programme, featuring Frank Black and his Orchestra. Col. Stoopnagle and Budd and blues singer, Gogo deLys, are special favourites that broadcast at 10.30 p.m.

Most Mondays at 2 p.m. brings the Breakfast Club with Annette King, the Ranch Boys, and Bob Brown. Tim Healy, the unusual news commentator, has 15 minutes from 3 p.m., which is followed by Ma Perkins at 3.15, and the Three Marshalls at 5.15.

Journalist Anne Hard introduces a feature entitled "Let's Talk it Over," on May 3, with Johnny O'Brien and his harmonica at 9.30. Every week-day brings Lowell Thomas to the microphone at 11.45, also Lum and Abner at 12.30 a.m. At 11.5 every evening an orchestra is relayed from Boundbrook, and it is usually Harry Kogan or Meredith Willson. The Easy Aces have a long term contract calling for their appearance for 15 minutes every weeknight from 12 midnight, in which they introduce a comedy sketch plus occasional guest artists.

Listen to Bob Crosby

The Story of Mary Marlin still goes on and this N.B.C. feature is scheduled for 10 p.m., Monday to Friday, through May. Listeners will discover for themselves that the majority of the programmes come on at the same hour every day with the exception of Saturday and Sunday. Here is a typical Saturday programme for May: 2 p.m., the Breakfast Club; 3 p.m., Sweethearts of the Air; 4.30 p.m., The Magic of Speech; 8 p.m. to 10.30 p.m., Famous Orchestras, including Bob Crosby, Harry Kogan, who is usually supported by Jack Baker, Ricardo and his caballeros, Charles Stenross and Bert Block. That is a pretty good assortment from Pittsburgh.

Agnes Moorhead, another Columbia Star, is a regular Sunday broadcaster best heard through Philadelphia.

American :: German and French Programmes

Schenectady have advanced all their times one hour, so that there are many new items for British listeners. W2XAF, on 31.48 metres, has a new schedule of approximately 9 p.m. to 5 a.m., with the exception of Saturday, when it is 5 p.m. to 5 a.m. W2XAD, on 19.56 metres, radiates from 3 p.m. to 11 p.m. every day.

A very good sketch scheduled for 3 p.m. every week-day is "David Harum," which has now been going for approximately 20 weeks. This is always followed by "Backstage Wife." For those who like really good murders, Thatcher Colt will be transmitting indefinitely every Sunday evening at 6.30 p.m. This programme lasts 30 minutes and is one of the best of its kind.

Jack Armstrong, the All-American Boy, is another regular broadcaster at 9.30 every week-night, while Little Orphan Annie, who has been on the air at 9.45 for the last few years, is carrying on through May with a similar type of programme. This feature has had such a long life, even longer than Amos 'n' Andy, so it speaks for itself.

W2XAF feature Dr. Maddy's Band Lessons at 6 p.m. every Tuesday. This programme is not intended to be humorous, but the idea of teaching a listener to play the cornet or the trombone by radio, rather amuses me. It is a programme which should be heard, for it is about the only one of its type on the air at the moment.

Whenever Lorenzo Janes is scheduled, make a point of tuning in. 8 p.m. every week-day is the time he generally broadcasts, but every now and then his programme is moved an hour to 9 p.m. The Three X Sisters, a new harmony trio, have five transmissions per week at 10.15 p.m., after which you can listen to the answers to short-wave listeners in the Schenectady Short-wave Mail Bag at 10.35. All these programmes are from W2XAD, but there are quite a number on W2XAF which are receivable before bedtime.

Nadine Connor features in the Sunday presentation of Vicks Open House, a Columbia broadcast through Philadelphia.

Amos 'n' Andy, at 11 p.m., are perhaps the best-known American artists, but close in popularity is Uncle Ezra's Radio Station, a Wednesday evening programme at 11.15 p.m. Walter Logan's Musicale can be best heard through W2XAF at 7 p.m. on Saturday evening, which is followed by a very similar programme, the Week-end Revue, at 7.30 p.m.

Alma Kitchell is making a name for herself, and this charming soprano has ten minutes to herself at 10.35 on Saturday nights. Agnes Moorhead can be heard through Columbia's network most Sundays at 1.45. She has a programme in which numerous personalities from the stage and screen are persuaded to come to the microphone.

Montana Slim, the singing Cowboy, has a 15-minute period on Monday at 12. 45 p.m. Listen to his programme through W2XE on 13.9M.

German Programmes in May

No matter what type of short-wave receiver you may have it will invariably receive the Zeesen short-wave programmes. They have quite a number of special features for May, and here are a few of them that can be put in the notebook. At 4.15, on May 4th there is going to be a visit to a harmonica factory, suitably illustrated with mouth-organ and harmonica solos. At 5.45, on the same day, Walter Rummel is giving a solo concert. He has a unique style, for although educated in Germany, he has been for many years in America and has partially adopted their style. This programme will be devoted to the works of Liszt.

A programme featuring the works of young German composers is being broadcast at 4 p.m. on May 5th, and it is claimed that this programme will set a standard for modern variety. Compositions, old and new, are to be played by Hans Neeman, at 7.30, on May 7th, while the star feature of the week is some special dance music, at 7.30 p.m., on May 8th.

Deanna Durbin, whose first film, The Three Smart Girls, has been released in this country, was discovered by Eddie Cantor who has sponsored her over the air.

"Turandot" is being relayed at 5.15 on May 22nd, but this version will not be anything like the one known in this country. It is a new arrangement of this fairy comedy created last year by the German composer, Schiller.

May 25th, at 5 p.m., brings a solo concert by Fritz Steinkamp, the clarinet virtuoso, while on the following day, at 6.30, Hans Ziegler introduces a programme entitled "The Music of Our Youth." Finally, from this station listen to Songs From Other Nations, at 6.30, on May 29th. It will include some of the best know compositions from England, Spain, Denmark and Italy.

News from Paris

Radio-Colonial, the French International station, operates on three wavelengths of 19.68, 25.24, 25.60 metres, and is on the air with programmes of all kinds from 9 a.m. until 6 a.m. During May they have some programmes which can be heard in this country on quite average receivers. A concert is being relayed at 2.30 p.m. on May 1st, on the lowest wavelength. On the same day, at 3 p.m. on 25.6 metres, there is a concert of gramophone records which seems to be rather attractive. It consists of orchestrations by the Lener Octet. Most evenings, at 7 p.m., half-an-hour is devoted to new gramophone records, and all sorts of surprises crop up, for some of the records are British, some American, and the rest Continental.

A Cheap Aerial Mast

By G6LJ

Cheap bamboo poles can be used to advantage when a light pole is needed. In this article it is explained how the poles, in 10 ft. lengths, are joined together.

UNTIL recently, the aerial has been in danger of becoming extinct, at least as an adornment of the suburban garden. The popularity of the all-wave receiver and the growth of short-wave reception, however, together with the increase in man-made interference, has resulted in a renewed interest in the aerial. It is now appreciated that the main requirement is to raise the aerial as high as possible above the screening effects of houses and trees, and as far as possible from the disturbing field of the miscellaneous electrical appliances to be found in practically every "built-up area."

The aerial mast is therefore once more a problem to be solved by the progressive amateur. He may be forgiven for jibbing at a mast that requires three men to erect it, or one that has to be set in a block of concrete. What he needs is a lightweight mast which can be erected single-handed and which, if necessary, can be moved to various positions with the minimum of trouble. To meet these requirements, the writer strongly recommends the bamboo mast. It has all the advantages of cheapness, transportability, ease of erection and dismantling, light weight and durability.

Bamboo

Bamboo, although sometimes available in 30 ft lengths at the docks, are seldom obtainable at retail stores in lengths greater than 14 feet. The 10-ft. length, tapering from about 1½ ins. in diameter to about 1 in., and costing 1s. 3d., can be bought almost anywhere nowadays. It is therefore usually necessary to join two or three lengths of the shorter bamboos together.

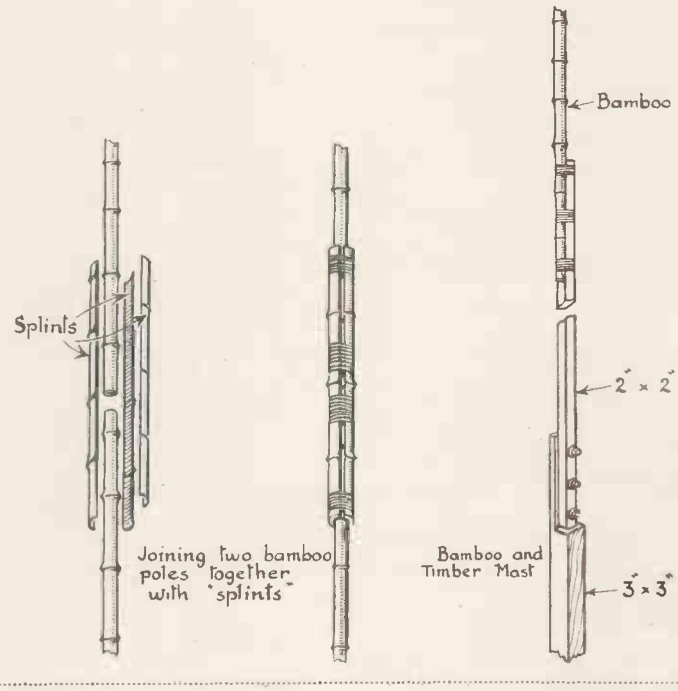
For various reasons, it is impractical to join more than three sections together. If greater height is required, it is better to use ordinary timber for the lowest section, in the manner which is explained below. The joining of two bamboos is best carried out by the use of bamboo splints. These are made by splitting a piece of bamboo, about 3 ft. long and 1½ to 2 ins. in diameter, into three equal lengths. A strong knife will serve this purpose quite satisfactorily. The sections of the mast are then placed in a line with either the thicker or the thinner ends touching, and the splints are held round the butted poles with one hand while they are bound tightly together with the other hand. Fairly thin galvanised iron wire should be used for this job—about 22 s.w.g.—as it is difficult to make a really tight joint with thick wire. The drawings above show how the joint is made. If properly constructed, a joint of this type is stronger than the bamboo pole itself.

Three 10-ft. lengths of bamboo can thus be made into a 30-ft. mast. A method which the writer prefers is to join two sections of bamboo (totalling between 20 and 28 ft.) to a 20 ft. length of 2 by 2 in. timber. It is still better to make the lower half of the timber section of stouter material, such as 3 by 3 ins. In joining the bamboo to the square section timber, it is best to cut away part of the top in order to make a neat and reliable joint. The general arrangement is shown in Fig. 2. This construction is suitable for a mast having a total height of 40 to 50 ft.

When the lowest section consists of timber, the base can be housed in a temple such as is used for the foot of a flag-staff. The mast can then be "run up" quite easily by one man. Alternatively, if the mast consists entirely of bamboo, it can be simply swung up into its vertical position, and the base can be allowed to rest on a flat stone or brick. The bamboo mast is so easy to erect that the base may even be rested on a brick wall or on the ridge tiles of a roof.

The rigidity of the bamboo mast is dependent on effective guying. Galvanised iron wire is again used, but here it is preferable to use something thicker, say, 18 or 19 s.w.g. Guy wires should be fixed at each joint, or approximately at intervals of 10 to 14 ft. up the height of the mast. The top set of guys must be fixed at the point where the pulley is attached—not higher or lower. At least three guy wires are required at each point of fixing on the mast: four wires from each point will provide much greater strength without adding greatly to the difficulty of erection. In order to avoid introducing electrical losses by the presence of so much wire near the aerial, the guy wire should be broken into various lengths of 5 to 12 ft. with small "egg" insulators, thereby reducing the possibility of resonance.

The wind resistance of the bamboo mast is very small, and therefore quite light anchorages for the guy wires will suffice. A 2 by 2 in. wooden stake driven 2 ft. into the ground at a slanting angle will be quite satisfactory. Alternatively, existing fence posts may be used, or any other rigid fittings that happen to be conveniently placed. The anchorages should be set as far as possible from the base of the mast in order to reduce the tension in the guy wires. The distance from the base should not be less than one-fifth of the height of the topmost set of guy wires. Where the distance must be small, as, for instance, when the mast is to be erected on a restricted ground space, it is desirable to use more wires.



The left hand diagram shows how the bamboo poles are spliced together. In the centre is the bamboo pole after splicing while on the right is the bamboo pole at the junction where it is bolted to the timber mast.

(Continued in third column of next page)

Simplified Super-regeneration

By O. J. Russell, Reading University

THE merits of the super-regenerative system for ultra-short wave working have been often discussed in this journal, but there is one type of circuit, however, that seems both neglected and misunderstood. I refer to the so-called "Squegger Quenched" circuit. This relies for the quenching frequency upon the rapid charge and discharge of the grid condenser in the oscillating detector stage, by the grid leak at a frequency determined by the "time constant" of the grid leak and condenser.

To a first approximation, the quenching frequency so developed may be taken as equal to the reciprocal of the time constant. Thus with this system, the quenching frequency is given by

$F = \frac{1}{RC}$, where R is the resistance of the grid leak in megohms, and C the capacity of the grid leak in microfarads, the result being in cycles per second.

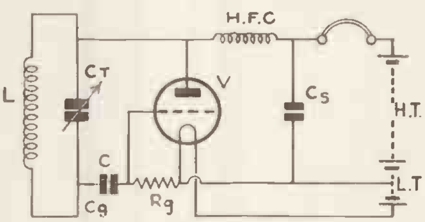
The Best Quench Frequency

The optimum quench frequency for 5- and 2-metre work being 100 kc. is conveniently obtained by the use of a grid leak of 100,000 ohms, and a grid condenser of .0001-mmfd., as in the circuit to be described later. It will be seen, therefore, that if an oscillating detector stage with suitable values of grid leak and grid condenser may be induced to squegger, super-regeneration will be obtained. The saw-toothed waveform of the "squegger" is theoretically more suited for super-regeneration than the sinusoidal waveform of the normal type of quench coil receiver. Side by side comparison of the two types of receiver has confirmed that the simple squegger-quenched receiver is superior to the usual type employing quench coils, an extra valve and the numerous potentiometers necessary for securing correct operation.

The Anode By-pass

Although an oscillating detector stage by itself may possibly produce squeggering, and hence super-regeneration, it does not seem to be appreciated that the essential factor for the production of the squegger in the receivers of this type is the so-called "anode by-pass" condenser connected from the "cold" end of the high-frequency choke conveying H.T. to the detector anode, and earth. Removal of this condenser, which is usually far larger than need be for its legitimate purpose of H.F. by-passing, causes super-regeneration to cease. For stable operation of this type of receiver, this by-pass condenser should have a value of about .01-microfarad. This ensures that the quench frequencies are safely by-passed to earth.

It should be noted that if a low-frequency amplifying stage follows the detector, that instability may be caused, possibly due to the "shock" action of the transient circuits occurring in the anode circuits of super-regenerative receivers, and which are the cause of the hissing noise audible in normal action when no signals are being received.



This is the simplest type of super-regenerator. Its operation is fully explained in the text.

Such instability is manifest as a high-pitched whistle, varying in intensity with the setting of the tuning condenser. Although such instability presumably occurs in the detector stage, it may be cured by adding a grid stopper to the L.F. stage, or by the usual methods for L.F. stabilising.

Suitable Valves

For the circuit to operate as a super-regenerative receiver with the above precautions, a valve of high mutual conductance is desirable and the LP2 battery class appear to work very well. The Marconi, Lissen LP2's, as well as the Tungsram LP220 and Mazda P220, work well, while the Marconi-Osram MH4 valve can be used in mains-operated equipment.

When using the circuit shown, battery valves will be found to work best with values of high-tension over 70 volts. The parasitic oscillations tend to develop if the receiver is operated with high-tension only slightly more than that necessary to produce oscillation. When the technique of producing correct squegger quenching is mastered, numerous variations of the circuit can be produced. The system may be used on short-wave reception, but the quench frequency should not then be more than 10 kc., an increase in grid leak favouring the production of the squegger. The 100 kc. quenched receiver, however, operates well up to the 10-metre band, and with a single L.F. stage puts amateurs and police cars over well on loudspeaker. At 100 miles from Alexandra Palace it gives good loudspeaker reception of the television sound signals, moreover it has been operated down to 2 metres in a modified circuit, and in America similar circuits using Acorn valves have been used at even lower wavelengths.

"A Cheap Aerial Mast"

(Continued from preceding page)

The writer has one bamboo-and-timber mast erected in the centre of the roof of a garage when the anchor points lie at the corners of a rectangle 16 by 8 ft. Four sets of guy wires are taken from three points on the mast spaced at intervals of 10 ft., and the whole system is thereby made extremely rigid. Another bamboo-and-timber mast, which the writer has erected, is nearly 40 ft. high and has only 6 wires, 3 at the top and 3 at a point 25 ft. up. Although this mast has only half the number of guy wires used for the shorter mast on the garage roof, it is perfectly safe and almost as rigid because the anchor points in this case are 16 to 20 ft. from the base of the mast.

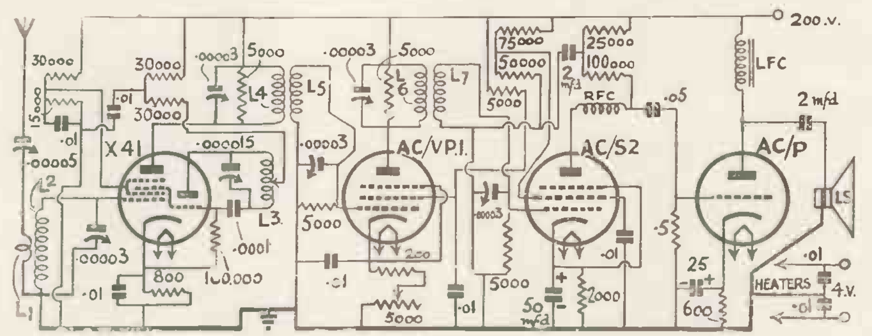
Before the mast is erected, the bamboo should be given two coats of good paint, and if there is a wooden section, it may be either creosoted or painted. The halyard, which should be of the closed-loop type, and be looped through the pulley before the mast is erected, may consist of best-quality cord of a size that runs freely through the pulley, and should be first boiled in candle-wax in order to prevent shrinkage in wet weather.

Now for the actual erection. The mast is laid out in a straight line with its base close to the point where it is to stand, or resting in the housing if one is used, and all the guy wires are firmly fixed to the mast and laid out free from kinks and entanglements. It is a great help if some of the guy wires can be measured out roughly to the "erected" length and then temporarily fastened to the anchors.

It is certainly an exciting moment when the mast reaches a vertical position. To decide whether the mast is vertical, stand away from it in each of two directions in turn, viewing it if possible against the edge of a building. To decide whether it is straight, stand at the foot of the mast and look up. The adjustment of the guy wires to the correct lengths need only occupy a few minutes. Obviously, the erection of the mast should not be attempted if there is a strong wind blowing.

Points in the Design in A 5-metre Super-het

We hope that this article will convince amateurs that 5-metre super-hets are simple to build. The circuit suggested can be used on wavelengths between 2.5 and 10 metres.



The transformers are wound to a wavelength of 80 metres with shunt resistances in order to obtain broad tuning. There are only two variable controls tuning and volume.

A SHORT-wave super-het adapted for ultra-short-wave working is rarely satisfactory owing to the high degree of selectivity, and the wide frequency shift for a small change in condenser capacity. Perhaps the only exception to this rule is when a 10-metre super-het is adapted by using a 5-metre aerial circuit and a 10-metre oscillator, so using the harmonic of the oscillator. In such circumstances results are reasonably satisfactory providing the tuning condenser is of small capacity.

A 5-metre super-het need not be very complicated or use more than four valves, as extreme gain is not required, while selectivity must be of a low order.

Amateurs who have endeavoured to construct such a super-het in the past have usually been in difficulty with the detector-oscillator circuit, and perhaps in ganging the tuned circuits. The Marconi or Osram triode-hexode has been used so frequently in commercial and amateur sets that it can be taken for granted that it removes most of the troubles experienced in short-wave supers.

By careful design ganging troubles can also be eliminated so that a super-het should not be any more difficult to build than the average super-regenerator. For example, the receiver, of which the circuit is shown in this page, has but one tuning control, with broad tuning as compared with the normal super-het, and will receive all but the worst amateur 5-metre transmissions.

Naturally, owing to the use of high-frequency I.F. transformers with low resistance shunts, the gain in the I.F. stage is low, but even so, the receiver is more satisfactory than the best super-regenerator, and once and for all overcomes the inherent noise level in such receivers. It will be agreed that the super-regen. receiver fails at the critical moment, for it has a high noise level with weak stations and a low noise level on powerful local stations.

Refer again to the circuit of the suggested super-het. The X41, which consists of two valves in one bulb, an oscillator and a detector, has a loosely coupled tuned grid circuit. The aerial coupling is of one turn and the grid coil 4 turns of ½-in. diameter. Across this coil is 30-mmfd. postage stamp type of trimming condenser. As the grid of the X41 comes to the top of the bulb, the whole of this grid circuit is mounted on a stand-off insulator, so that the leads are kept very short.

The X41 must be well screened and it is suggested that the oscillator section be beneath the baseplate, so that there is no possibility of external coupling between the oscillator and grid circuits.

A 15-mmfd. oscillator condenser is required and the oscillator coil, L3, is connected directly across this condenser, the coil, of course, being air-spaced.

During initial stages of construction the shunt resistances across the I.F. coils should be omitted, for they merely reduce the gain in providing the broad tuning. With one I.F. stage using the AC/VPI, the I. F. transformers should have a wavelength of approximately 80 metres. The primary and secondary coils in both transformers are identical and consist of approximately 50 turns of 30 gauge enamelled covered wire wound solenoid fashion, on a 1½ in. former, with both primary and secondary in the same direction. The gap between the coils is approximately ¼ in.

Both transformers must be screened and as the coil form is approximately 1½ in. the screening can should have a diameter of at least 2½ in. in order to reduce damping. The padding condensers are mounted externally and are again of the postage stamp trimming type and are used to take up any inaccuracies in winding and variations due to external connections.

An anode-bend detector gives such a large increase in gain over a diode that we have to dispense with the original project and use a diode-triode in the final stage. One of the most suitable valves is an AC/S2 which should be biased so that it is operating well down its characteristic curve. With a 200-volt supply a cathode-bias resistance of 2,000 ohms is required and shunted by a 50-mmfd. condenser.

Screen voltage is very critical and should be obtained from a fixed potential divider having 75,000 ohms in the high potential side and 50,000 ohms on the earthy side, the mid-point being by-passed to earth by a .01-mfd. condenser.

R.C. coupling between detector and output stages allows for ample step-up for small outputs, providing the external anode impedance to the AC/S2 is at least 100,000 ohms. Where the voltage can be increased beyond 200 this resistance can be correspondingly increased to advantage.

Conventional practice is followed in the output stage, where an AC/P triode is used in a choke filter circuit with bias obtained automatically by current flow across a 600-ohm cathode resistance. This valve will give approximately 1 watt, with a current flow of approximately 20 M/a.

Signals can be received no matter how badly out of gang are the grid and oscillator circuits, that is L2 and L3. However, a signal in the 5-metre band should be received and the padding condenser across L2 adjusted to give maximum signal strength. Then, even though L2 will be slightly out of resonance at the top and bottom edges of the amateur bands, the loss is not sufficient to make it worth while including two separate or one two-gang condenser.

If the receiver is to be used for reception of unstabilised transmissions, the 5,000 ohms resistors across L4, L5, L6 and L7 are essential. This will cause a big decrease in gain, but will also make the receiver flatly tuned, so that frequency modulation can be tolerated.

There are only two variable controls, one being the tuning condenser in the oscillator circuit across L3, the other being a 5,000-ohm variable resistance. Also in this circuit is a fixed resistance of 200 ohms, so that a slight bias is always applied to this I.F. amplifier.

Current consumption in each circuit should be carefully checked, and should reasonably follow these figures. In the anode circuit of the X41 detector 3 M/a, the anode of the oscillator 2 M/a, the total cathode current is approximately 5.3 M/a.

The AC/VP1 approximately 5 M/a, with a screen current of 1.7 M/a. The total cathode current of the AC/S2 is under 1 M/a, while the anode current of the AC/P averages 20 M/a.

Accurate Test Equipment for Servicemen and Constructors

Overhauling S.W. Receivers

The modern complicated radio set calls for modern servicing methods with efficient equipment. In this article several useful instruments suitable for the serviceman and amateur constructor are described. In most cases the latest type of Westinghouse rectifiers are used. These are now suitable for use at high frequencies.

VERY few servicemen or amateurs can afford expensive test gear whicb may have only limited application. We are, however, going to describe several instruments which can be cheaply made and used for a multiplicity of purposes.

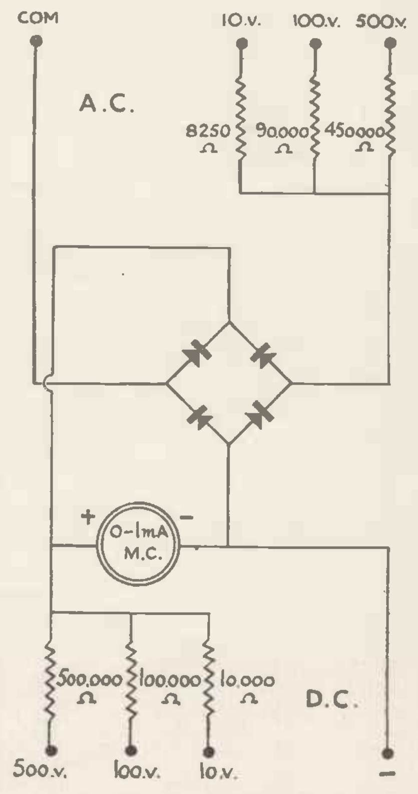


Fig. 1. This type of voltmeter can be adapted to read almost any range providing the shunts are accurately calibrated. The meter reads up to 1 M/a and must be of the moving coil type.

Rectifier-type instruments have a wide range of application in radio testing, both as regards measuring alternating voltages in mains receivers, and for measuring L.F. voltages both in intermediate L.F. amplifiers and at the output stage of receivers and valve amplifiers.

For these purposes, a high degree of accuracy is not required. Generally, what is needed is an accuracy of the order of 2 per cent., with a simple robust meter capable of being easily read. The rectifier-type instrument fulfils these conditions admirably. It is, moreover, particularly convenient in that the rectifier arrangement can be used as an addition to a general D.C. test set so as to make it a multi-purpose set capable of all measurements which a service man is likely to have to make in checking a modern all-mains receiver.

Power Voltage Measurements in Radio Receivers

For servicing mains receivers, current measurements in A.C. circuits are rarely needed, as continuity of circuit can readily be checked. All that is necessary is to be able to measure that the correct voltage is obtained at various points in the receiver.

A range of 0-10 volts is desirable in checking heater circuits and, for the highest accuracy, it is desirable that a calibration curve should be prepared for this scale, as the effect of the rectifier is to distort the scale to the extent of the first half-volt which is, of course, appreciable in 10 volts.

For the higher voltage heaters used with universal valves, a 0-100-volt scale is useful, while, for checking mains voltages and rectifier input voltages, a range of 0-500 volts is satisfactory.

These ranges will be subject to some modification, depending on the existing figuring of the scale of the instrument to be employed. The most commonly employed instrument for this class of work has a full-scale deflection with 1 ma., as this low current consumption is desirable when using the instrument as a D.C. voltmeter. In order to use the instrument in this way there must be terminals available, brought out direct from the instrument movement as an 0-1 milliammeter. Connections for the A.C. tests can then be arranged as shown in Fig. 1.

If the D.C. milliammeter is fitted with a fuse, it will be necessary to short-circuit this when fitting a rectifier, as blowing of the fuse will cause the rectifier to be destroyed.

If the instrument has ten graduations on its scale, the above suggested ranges can be employed. To provide these scale ranges, non-inductive resistances (either metallised or composition will be found satisfactory, especially if under-rated) will be required having values of about 8,250 ohms, 90,000 ohms and 450,000 ohms respectively.

L.F. Measurements on Radio Receivers (Output Meters)

Modern Westinghouse rectifiers are satisfactory for use even up to frequencies of more than 100 kilocycles. The frequency error over the whole of the audio-frequency band can, therefore, be completely neglected in so far as the rectifier itself is concerned. Suitably designed rectifier instruments can be used, not only as indicators in the audio-frequency portions of a radio receiver, such, for example, as to assist in trimming the tuning circuits of the receiver, but also to enable the frequency characteristics of the whole receiver and amplifier to be measured, provided a suitable variable frequency modulated signal generator or oscillator is available.

The frequency characteristics of an L.F. amplifier and gramophone pickup can similarly be checked if suitable frequency standard records are available.

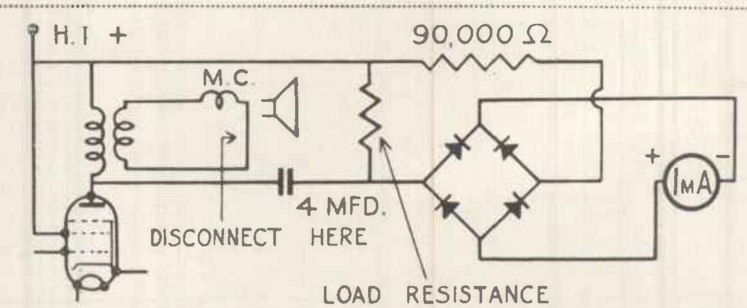


Fig. 2. Any audio frequency can be measured with the meter while it can be used for signal strength checks if wired in parallel with the loudspeaker.

A Direct-Reading Meter for Watts dB.

The most usual requirement is for trimming or ganging a radio receiver with the loud-speaker disconnected. When this is done, it is necessary that the instrument should have incorporated in itself a dummy load of suitable impedance to act as a substitute for the loud-speaker. It is also necessary that such a meter, commonly known as an output meter, should be choke-capacity, or else transformer-coupled so as to avoid any anode current, or even any D.C. voltage drop arising from anode current causing a reading on the meter. This arrangement in its crudest form can be employed for ganging a radio receiver when using some form of simple self-modulated signal generator. The meter shown in Fig. 1 can be readily adapted for this purpose.

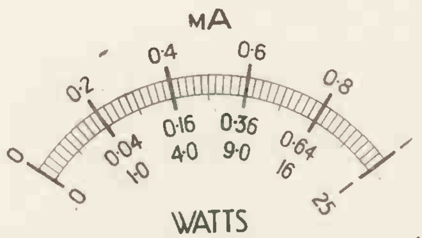


Fig. 3. A typical scale for 100 and 500-volt ranges with 10,000-ohm load resistance. 100-volts is equal to 0.1 watt and 500-volts to 25 watts.

The 100-volt A.C. range should be used, connected through a 4- or 8-microfarad condenser in parallel with the loud-speaker, or, if for the purpose of quietness, it is desired to disconnect the loud-speaker, a load of the same impedance must be connected across the voltmeter terminals. The necessary circuit arrangements are given in Fig. 2.

This circuit is quite safe as regards avoiding risk of damage to the instrument rectifier due to switching-on surges, so long as the output valve is of the indirectly heated type and the H.T. supply is not switched on by means of a delayed action switch. Under these conditions, the anode current flowing through the primary of the output transformer will build up slowly and will not, therefore, generate excess transient voltages in the instrument rectifier circuit.

Where the H.T. circuit can be made or broken with the cathode of the valve hot, there is a grave risk of generating excess voltages across the primary winding of the output transformer which may cause failure of the instrument rectifier. Where it is possible for the H.T. circuit to be made or broken in this way, it is, therefore, wise to see that the instrument rectifier circuit is not connected across the transformer until after the anode current is flowing and to disconnect it before the H.T. circuit is broken. A similar risk occurs where the output meter, instead of being connected across the transformer primary, or across an output choke, is connected between the anode and cathode of the output valve. The use of this form of connection is not recommended.

The majority of radio receivers at the present time use a pentode output valve for which the matching impedance on the primary side of the speech transformer should be 10,000 ohms, and hence a 10,000-ohm resistance should be connected across the voltmeter terminals. The speech transformer must be left in circuit so that its primary winding completes the anode circuit to the valve, thereby acting as a choke coupling, the loud-speaker circuit being disconnected on the secondary side of the output transformer. Alternatively, of course, the loud-speaker may be left in circuit, in which case the 10,000-ohm resistance will not be required.

When the load resistance is made 10,000 ohms, the full scale deflection of 100 volts will correspond to an L.F. output of 1-watt. Using the 500-volt range the corresponding full scale reading is 25 watts.

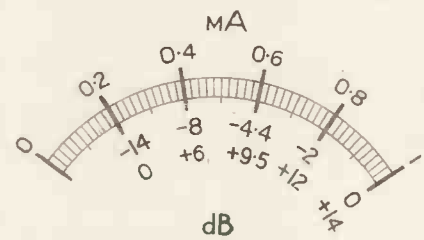


Fig. 4. Direct dB. readings are given with this scale.

For types of output valves other than mains pentodes requiring a load of 10,000 ohms, the load resistance may be readily changed to suit, the value used being obtained from the valve makers' data sheets. If it is desired to have a check on the watts output of the valve, this may be calculated from the formula $\frac{V^2}{R}$, where V is the reading of the voltmeter and R is the value of the load resistance in ohms. It will readily be apparent, therefore, that a reading of 50 volts corresponds to a power output of ¼-watt, when the load resistance is 10,000 ohms.

Output meters of this type are frequently made up complete with a load resistance suited to the valves most commonly being tested, and with the scale calibrated to read direct in milliwatts or watts, the calibration being obtained from the formula $\frac{V^2}{R}$. The scale shape so obtained is of square-law shape, and a typical scale is shown in Fig. 3 for 100-volt and 500-volt ranges with 10,000-ohm load resistance.

Such a meter may have means for switching in different values of series resistances so as to give it more than one range. For example, in Figs. 3 and 4 two scales have been shown, one for 0-1-watt, corresponding to 100 volts and 10,000 ohms load, and the other up to 25 watts, corresponding to 500 volts and 10,000 ohms load. Different values of load resistance can be switched in to suit different output valves. The following table gives the corresponding calibration of the cardinal points of the scale for a range of load resistance values when using the instrument for 100 volts full scale deflection, i.e., as in Fig. 4.

The type of resistance used as a load resistance must be such as to have a power handling capacity capable of dissipating the L.F. output of the valve under test. The condenser shown in the diagram as 4 mfd. capacity is suitable for use with a load resistance of 10,000 ohms, but its value must be increased inversely in proportion as the value of the load resistance is decreased.

Sometimes the scale, instead of being calibrated in milliwatts, is calibrated in decibels, the scale marking being in terms of X or—so many dB. above or below a standard output of, say, 1 watt.

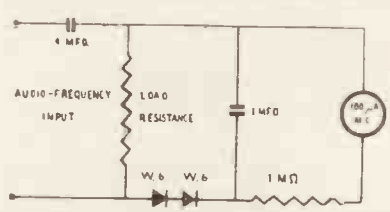


Fig. 5. Peak outputs can be obtained with this type of meter and is suitable for use with low-frequency power amplifiers.

(1 decibel is 10 log 10 $\frac{W_1}{W_2}$, where W_2 is the standard output and W_1 is the power output being measured).

(*Continued on page* 308)

Meter reading. M/a.	10,000	7,500	6,000	5,000	4,000	3,000	2,000
	Watts output.						
0.2	0.04	0.053	0.07	0.08	0.1	0.14	0.2
0.4	0.16	0.213	0.27	0.32	0.4	0.54	0.8
0.6	0.36	0.48	0.6	0.72	0.9	1.2	1.8
0.8	0.64	0.85	1.07	1.28	1.6	2.14	3.2
1.0	1.0	1.33	1.7	2.0	2.5	3.4	5.0

(Load resistance values.)

The Short-wave Radio World

A Review of the Most Important Features of the World's Short-wave Developments

P. M. HONNELL in the February issue of *Communication and Broadcast Engineering*, describes a simple but very effective radio-frequency output meter which amateurs could build and use to advantage.

The R.F. output meter, the circuit of which is shown in Fig. 1, is an instrument which directly reads the amount of power the transmitter can deliver. It consists of a resistance load, indicating wattmeter, and a variable capacity, all connected in series, and the usual artificial aerial. It does, however, give the operator a direct reading meter for calculating the maximum output that the transmitter is capable of giving with 100 per cent. effective loading.

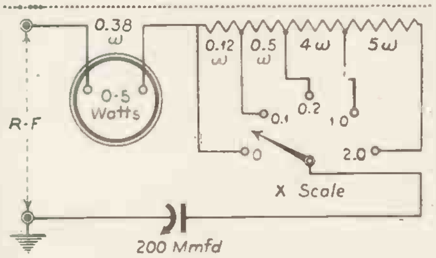


Fig. 1. This output meter will give a true indication of the output a transmitter will give when correctly loaded.

This feature is of great value when tests are being made by amateurs with little experience of this kind of work. The complete meter when made to the circuit in Fig. 1, can be contained in a metal cabinet 5 ins. by 7 ins. by 4 ins., with the wattmeter, load resistance, and variable condenser all mounted on the front panel.

The actual connections are such as to minimise the effect of stray capacities on the accuracy of the meter, and to that end, the tap switch, which is similar to the Bulgin rotary, on which the resistance wire is soldered, is a most important component. Losses in this part of the circuit will decrease the accuracy of the instrument. The direct reading meter is a model 507 Weston thermo-ammeter with the scale removed in favour of one calibrated from 0 to 5.

A linear power scale arises from the fact that the deflection of the thermo-ammeter is proportional to the square of the current, and that the power dissipated in the load resistance is also proportional to the square of the current. So the meter deflection is linearly proportional to the power actually dissipated in the load resistance.

Values of load resistance shown in the theoretical circuit for each multiplying factor were chosen so that the maximum power capacity is 10 watts, although resistances up to 50 ohms with, of course, greater wattage dissipation, can be used.

It will probably be advisable for the constructor to make his own resistances, which should be wound with Manganin or similar resistance wire of the smallest practical diameter to reduce skin-effect to the absolute minimum.

Accuracy of the R.F. meter will vary with frequency, but below 2 megacycles there is less than 2 per cent. error. At higher frequencies there will be a slight increase in error, which is allowable, and due to the skin-effect of the resistance wire load, and shunt capacities reducing the effective resistance of the load; but in any case, the error will be less than that of the average dummy aerial.

When measuring the output of the radio transmitter, the power indicated may be different on the several power scales unless the impedance presented to the output valves is changed to correspond with the change in the resistive component of the power meter input impedance. This can be counteracted by changing the anode tap on the transmitter tank circuit.

Some interesting information can be obtained from the use of this instrument. For instance, the reduction in available output power from a radio transmitter caused by increasing tank circuit losses are immediately apparent.

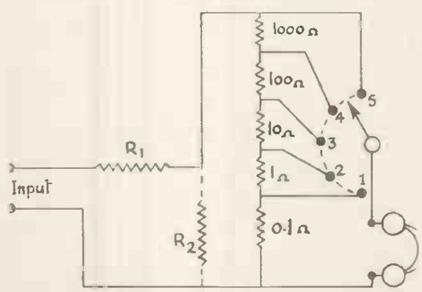


Fig. 2. Listening stations will find this instrument helpful in calculating relative signal strengths.

A Simple Audiometer

While on the topic of measuring instruments, we were interested to see the design of a very simple audiometer in the March issue of the American publication QST. A meter of this kind can be of real practical use to the keen listening amateur who wishes to give as accurately as possible some comparative indication of received signal strength.

It is impossible to retain in the memory the exact strength of a station heard a few days previously and to give an exact comparative report. Also small changes of 10 and 15 per cent. are often unnoticed after the ear becomes used to hearing strong signals. The circuit shown in Fig. 2, is one often used by American amateurs and is now being used commercially. In the commercial form the audiometer has a compensating series resistance which keeps the input impedance constant as the phones are shunted down the scale. With the simplified construction as suggested, however, this impedance is rather unnecessary, because the impedance of the entire shunt resistance is kept low in relation to the impedance of the phones.

As can be seen, the meter has five steps which are obtained by a network of fixed resistances rather than from a calibrated variable resistance. This is an important point, for despite the reliability of modern variable resistances, it is not possible accurately to calibrate the resistance in five definite spots.

As with the previous R.F. meter, we advise constructors to build their own fixed resistors unless they have some means of obtaining guaranteed resistors of the specified value.

The .1-ohm resistor is constructed from an 18-ins. length of 28 gauge wire. It will be noted that each step increases the resistance across the phones by approximately 10 to 1, so that the power ratio is 100 to 1. The common log and the number of bels is 2, and the number of decibels being 10 times this, the steps are each of 20 db.

On two stages of L.F. it rates a fair loud-speaker signal as 5 and a very weak phone signal as 1. In operation a signal is tuned in with the switch to tap 1, where maximum output will be obtained. The switch is then moved up the scale putting the phones across smaller resistances until the signal is reduced to almost zero. If the signal is heard on tap 3, but is lost at 4, it is rated at 3 on the 1 to 5 scale.

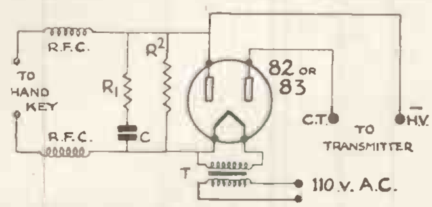


Fig. 3. This clickless keying circuit is suitable for high power circuits for the 82 valve will handle 125 M/a.

The figures have no theoretical value but are merely used as a comparative indication of signal strength. Of course, any number of steps can be embodied, so giving a direct R1 to R9 plus report if 10 steps are used.

If amateurs were to use an instrument of this kind it would make quite sure that listening reports were accurate and of value to the transmitting amateur.

Clickless Keying

Since the Australian authorities have become more strict as to the interference caused by C.W. stations, all new amateurs have been forced to serve a probationary period using C.W. during which time his transmitter has to be adjusted so that it is free from key clicks.

This problem of trouble-free C.W. sending is one that confronts most amateurs, so that this circuit shown in Fig. 3, devised by VK2NO, should be of general interest. According to the designer, the most certain method of clockless keying is to use one or more keying valves, the number according to the load, to serve as a form of keying relay in the centre tap filament return to the buffer or final amplifier. The most common valve recommended is the 45 owing to its low anode resistance.

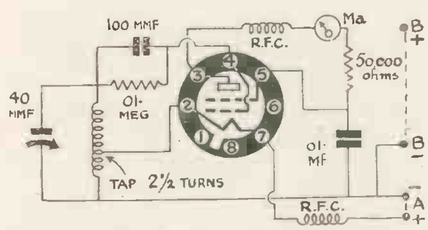


Fig. 4. This oscillator will show when a U.H.F. aerial is in tune and will take into consideration the effect of local objects.

This valve, however, is only suitable for low-power stations as it will not handle a high current.

The type 82 mercury vapour rectifier is ideal for the purpose, for one of these valves will handle up to 125 M/a or by changing to an 83, 250 M/a. Owing to the low anode resistance of these valves the undesirable voltage drop in the anode circuit of the keyed valve is eliminated. The circuit shown using the 82 or the 83 is similar to that for the average triode valve, but in this instance, one anode is used as a grid.

Key clicks are considerably reduced by merely using the keying valve, but if clicks are to be removed even when checked on a monitor, a pair of R.F. chokes and a filter circuit, as indicated in Fig. 3, should be embodied.

A U.H.F. Check Oscillator

Serious experimenters on ultra-short waves are beginning to realise that to obtain any real progressive results a fair amount of equipment is necessary. This applies particularly to aerial design, and in fact, any work where frequency checking is carried out.

The adjustment of a transmitting aerial for use on the 56 to 60 megacycle band is not quite the simple matter generally believed. Amateurs are generally prepared to accept the recommended length for di-pole aerials, etc., and assume it to be correct for the frequency of the transmitter in use. While this may be satisfactory under given conditions, local objects and incorrect feeding can often put the aerial completely out of resonance.

To check this a simple oscillator can be made to indicate exact resonance or frequency. The circuit as published in the *Sydney Bulletin* is shown in Fig. 4. The valve is a conventional tetrode of the 6C6 or VMP4G types. With a 40-mmfd. Eddystone tuning condenser, a coil having 5 turns of 16-gauge copper wire, ½-in. diameter and centre tapped, will cover 4.5 to 7.5 metres.

The R.F. coil consists of 45 turns of 26 D.S.C. wound on a ⅜-in. dowel and used in conjunction with a milliammeter reading from zero to 5 M/a

If a cathode heater type of valve is used, such as the VMP4G, the R.F. choke in A plus will not be needed. Aerial resonance is indicated when there is a sharp rise in anode current as the condenser is tuned through the aerial load. The aerial, of course, is coupled to the oscillator grid in the usual way. Coupling should not be too tight for this gives two indications of resonance. It is suggested that the oscillator be calibrated in the first instance by Lecher wire system or beating up the oscillator against a receiver tuned to stations of known frequency.

"Overhauling S.W. Receivers"

(*Continued from page* 306)

As $W_1 = \frac{V_1^2}{R}$ and $W_2 = \frac{V_2^2}{R}$, the decibel scale can be calculated from $10 \log 10 \frac{V_1^2}{V_2^2}$, or $20 \log 10 \frac{V_1}{V_2}$. A typical scale shape thus obtained is shown in Fig. 4.

For example, the 1-watt and 25-watt scales are obtained by using the 100-volt and 500-volt ranges of the instrument with a load resistance of 10,000 ohms. If the same marking is employed for other values of load resistance, the direct gain or loss in dB. will still be correct, but the zero level, instead of being 1 watt, will become the full scale value given by the bottom figure of the appropriate column of the table above.

For monitoring L.F. amplifiers and similar apparatus, a peak meter is more convenient for the control engineer than a direct reading meter of the type already described. Such a meter should be arranged so that its pointer rapidly swings to the peak voltage generated at the point in the amplifier to which it is connected, but drops back very slowly after the peak voltage has ceased.

The circuit diagram is shown in Fig. 5 from which it will be seen that it is fundamentally a half-wave rectifier circuit in which the alternating voltages applied to it are rectified and charge the reservoir condenser momentarily to the peak of the alternating voltage, the charge on the condenser then being used to maintain the instrument reading through the resistance leak circuit. Obviously, in order to maintain the instrument reading the peak voltage for any considerable period of time, it is desirable to make the value of the condenser large and the resistance high. If the condenser is made very large, however, it may be too big to be charged sufficiently quickly by the alternating voltages of high peak value and short duration. If the value of the resistance is very high, then the instrument movement will have to be extremely sensitive to indicate on the very small current that will flow. A good compromise is obtained with the component values given in the diagram when reading in a portion of an amplifier across which volts up to 100 volts peak are generated. It will be noted, though, that the circuit necessitates the use of an instrument having a full scale deflection with 100 microamperes, and the rectifier employed will consist of two W6 Westectors connected in series.

In the same way as described for the direct reading output meter, the scale can be calibrated either in peak volts, peak watts, or decibels above and below a certain standard value of peak watts.

If comparisons are made with a direct reading output meter, it should be remembered that a sustained note, such as from an oscillator or test record, will produce a peak watts of twice the numerical value of the direct reading wattmeter. At varying audio-quantities, such as are found in speech or music, the ratio between the peak watts and the average watts will naturally be far greater still.

Condenser Testing

High D.C. voltages are in general needed for testing smoothing condensers and the like used in radio receivers, and, for this purpose, a D.C. voltage of 400 volts and upwards is desirable. However, it is important that the circuit employed should be such as to limit the amount of current flowing in the event of the condenser being tested proving faulty. For this purpose, a series resistance, of a value calculated to pass only a limited current on short circuit, should be employed in the H.T. circuit, or, a voltage doubler circuit for the rectifier giving the testing voltage should be used. A suitable value of steep output regulation can be obtained by making the voltage doubler circuit condensers themselves small in value.

Crystal Oscillators —and the Beginner

By Kenneth Jowers

This article on crystal oscillators reviews some of the systems more suitable for the beginner. Providing the C.O. circuit is smooth in operation and provides ample R.F. output, the complete transmitter should be satisfactory on all wavebands.

JUDGING from personal experience, it seems that while the majority of intending transmitters with an A.A. permit in view have a reasonable knowledge of transmitting circuits, quite a number are in doubt as to how one obtains the correct frequency, and what is more, keep the transmitter to that frequency.

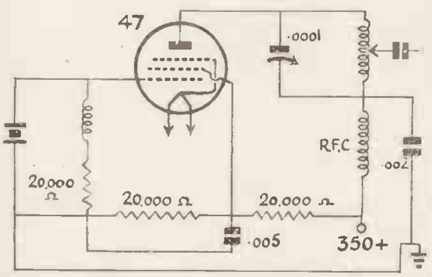


Fig. 1. A pentode 47 is a good crystal oscillator for single wave-band operation. Screen voltage is obtained from a fixed potential divider.

While a coil and condenser will tune to a frequency governed by the inductance of the coil and the capacity of the condenser, the frequency obtained is not sufficiently stable, nor can it be relied upon in transmission circuits, even though a suitable wavemeter is available. This, of course, takes a very broad view of things for there are special circuits and transmitters which are satisfactory without some means of frequency control, but only in the hands of experienced amateurs.

The beginner can take it for granted that his transmitter will require some form of frequency control so that, no matter what type of valve or voltage is used, the frequency to which the transmitter is tuned will remain constant.

In this country the quartz crystal oscillator is invariably used, for it offers

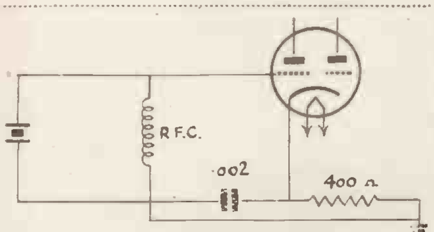


Fig. 2. A 53 or its counterpart the 6A6, is very simple to get going and obtains bias from a fixed cathode resistor.

a means of frequency control that is practically foolproof in the hands of the rawest amateur.

Assuming that a transmitter is to be built for operation on 7,200 kc., a crystal can be purchased that, owing to its physical dimensions, will oscillate at this frequency, and even if it is overrun or not correctly tuned, will only deviate by a kilocycle or so from the original 7,200 kc.

This is a great advantage, for it automatically ensures that the transmitter will be operated within the narrow band allocated by the Post Office. The quartz crystal takes the place of the conventional coil and capacity tuned circuit in the grid of the oscillator valve. In the anode circuit is the normal tuned circuit which should be capable of resonating at the frequency of the crystal, that is, for the purpose of the example, 7,200.

A Pentode Crystal Oscillator

Although triode valves have been used for many years in crystal oscillator circuits, they are being less used at the present time owing to the fact that multi-electrode valves allow for a much larger R.F. output with a lower crystal

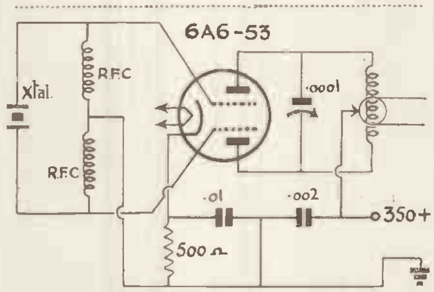


Fig. 3. One of the easiest methods of obtaining high R.F. output at crystal frequency is to use twin triodes in a push-pull circuit as shown. The crystal current is very low.

current and anode voltage. One of the most popular valves is the type 47 pentode shown by Fig. 1. Refer to this circuit and it will be seen that the crystal is connected directly from the control grid to earth and is shunted with a high-frequency choke in series with a fixed resistance.

The purpose of this shunt circuit is to allow for bias to be applied automatically to the 47 by virtue of grid current flow across the resistance. Average values for bias resistance are from 5,000 to 50,000 ohms, according to the type of valve employed, but for the 47, 20,000 ohms is most satisfactory. However, the lower the bias value the greater will be the R.F. output, but it will be more difficult to make the valve oscillate.

When using pentodes it is essential that the voltage on the screen be kept reasonably low, and it is advisable to obtain this voltage through a fixed potential divider. This divider for the 47 valve is made up of two 20,000 ohms resistors across the main H.T. supply

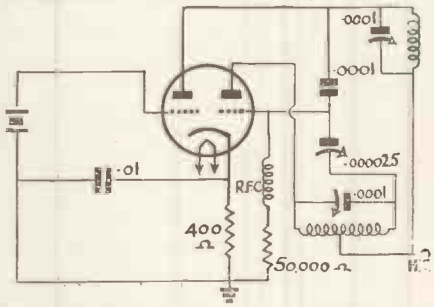


Fig. 4. Twin triodes can also be used as crystal oscillators plus sub-amplifiers or frequency doublers. Regeneration can be obtained quite simply with a circuit such as this.

shunted by a capacity of about .005-mfd.

Assuming the crystal to be of the order of 7,200 kc., that is in the middle of the 40-metre band, the anode circuit should be tuned to the same frequency with, of course, a variable condenser, and as the voltages in this circuit are low, the coil can be wound on a normal 4-pin plug-in former and tuned with a broadcast type of .0001-mfd. condenser. Notice that the H.T. is fed to the 47 through a high-frequency choke. The type of choke is immaterial, providing it does not resonate at 7,200 kc. or the harmonics or overtones of this frequency. The junction of choke and tuned circuit is by-passed by a .002-mfd. condenser, and

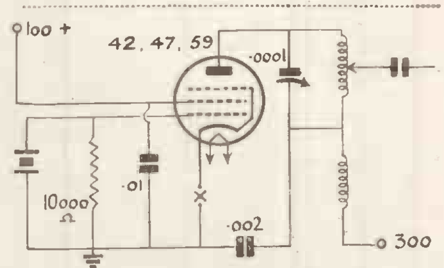


Fig. 5. Providing the screen voltage is kept low, the 42, 47 and 59 pentodes are very satisfactory in a circuit of this type. A meter reads total cathode current at the point marked X.

as with all points where R.F. is being by-passed, the condenser should be of the Mica type.

Twin Triodes :: The 6L6 Tetrode :: RFP 30

Cathode Bias on a 53

It is not always essential to use a leak for bias as in Fig. 1 Refer to Fig. 2, which shows the fundamental circuit of a type 53 valve, a twin triode, of which one half is a conventional oscillator, with the second half suitable for frequency doubling or amplifying at crystal frequency.

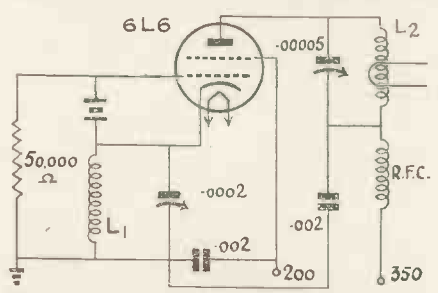


Fig. 6. Experienced amateurs are advised to try the 6L6 tetrode in this tritet circuit. Special care should be taken with the cathode circuit, as mentioned in the text.

The R.F. choke in series with this resistance is essential, for there is always an A.C. voltage present in this circuit caused by the anode grid feedback in the valve. This A.C. voltage exceeds the average bias, so that the grid can periodically be made positive in respect to the filament. The purpose of the choke is to stop the flow of A.C. current without affecting the grid current flow through the bias resistor.

Bias, however, can be obtained automatically by means of a cathode resistance, and as shown in Fig. 2, this has an average value of 400 ohms for type 53 valve. In Fig. 2 the circuit will be completed by the addition of a tuned circuit, by-pass condenser, and high-frequency choke in the same way as in the anode circuit of the type 47.

Push-pull and Push-push

Another way of obtaining greater output from the crystal oscillator circuit is to use push-pull. This has the big advantage of providing very much bigger drive to the succeeding stage, but has the disadvantage that it can never be used as a frequency multiplier and crystal oscillator as the push-pull circuit balances out and does not produce any harmonics of the fundamental frequency.

The split circuit for push-pull operation is shown in Fig. 3 where the two grids are shunted by the crystal plus two R.F. chokes which are connected together and earthed. Bias in this circuit is obtained by means of a 500-ohm cathode resistor. Although the anodes could be strapped, so giving a push-push circuit, the 53's work best with a split anode circuit in which the coil is connected directly across the anodes, the whole being tuned and high-tension applied through a tap at the mid-point. Coupling this circuit to a succeeding stage can be carried out in many ways, but the beginner will find that a single turn link around the centre of the coil is most satisfactory.

In the hands of the beginner the push-pull twin triode circuit gives a maximum R.F. output for a given voltage and crystal current with the minimum possibility of crystal fracture. It must always be remembered that if the anode voltage is too high or the R.F. current in the crystal circuit is allowed to go above 80 to 100 M/a, there is a possibility of the crystal over-heating and fracturing.

A Battery-operated Circuit

The same circuit can be adapted for battery operation and use of a valve such as a Cossor 240B providing bias is obtained in the more conventional way by means of a resistor of 10,000 ohms in series with the connection to the centre of the R.F. chokes.

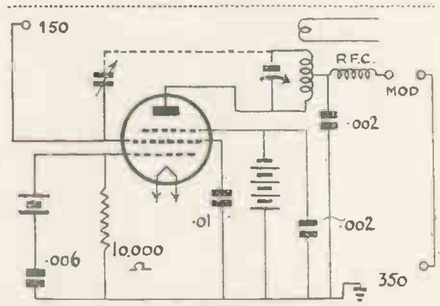


Fig. 7. Complete transmitter for phone with crystal control can be made up by using this single RFP30. The low screen voltage is essential.

Another method of using the twin-triode valve is shown in Fig. 4, in which one half is a crystal oscillator at fundamental frequency, while the second half can be used as sub-amplifier, doubler or quadrupler. When used to provide harmonic operation the coil in the anode circuit of the second triode can be tuned to the first to the eighth harmonic of the crystal. Another feature of this circuit is that owing to the R.F. output decreasing as the frequency is increased, regeneration is included and obtained by means of an R.F. choke in the cathode, so as slightly to counter-balance the decrease in R.F. output.

Fig. 4, with a 160-metre crystal, could provide an appreciable output on 80 metres, and a sufficient output on 40 to drive a sub-amplifier. Of course, if used on one frequency, the neutralising capacity is essential.

One of the most popular valves in recent years has been the 59, which is somewhat similar to the 42 and 47, providing very high output with comparatively low crystal current in a circuit that is simplicity itself. Experienced constructor will probably criticise the low screen voltage recommended, but until beginners have mastered the operation of a pentode crystal oscillator it is advisable to keep this voltage to 100, or slightly lower in order to prevent damage to the crystal. After everything is operating satisfactorily, then the screen voltage can be adjusted for maximum R.F. output.

The circuit in Fig. 5 shows just how the 59 is operated, but this circuit is for fundamental operation only. That is to say, the anode circuit must be tuned to the same frequency as that of the crystal. In order to save expense, and at the same time to simplify the measuring of total screen and anode current, constructors are advised to fit a milliammeter in the cathode circuit rather than to have one meter in the anode and one in the screen feed supply. This point can be seen from Fig. 5.

With this circuit, in order to obtain correct matching, easy oscillation and maximum R.F. transfer to the succeeding stage, capacity coupling is used and the feed line is tapped on to a point on

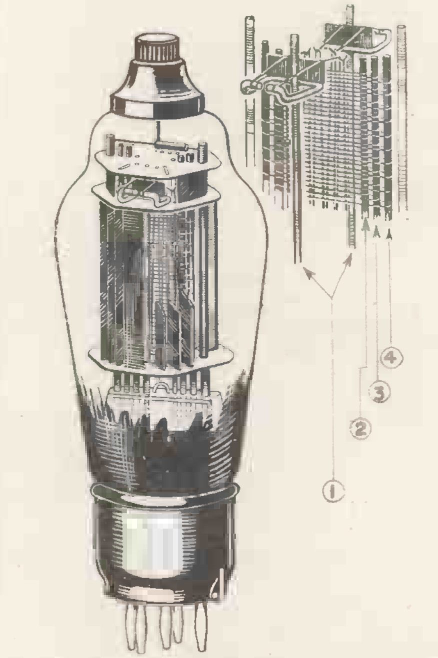


Fig. 8. This is the RFP30 transmitting pentode. The construction can be appreciated from this drawing, but to obtain trouble-free operation, it should be screened so that the grid circuit is entirely isolated from the anode as regards external coupling.

the 59 anode coil, the correct spot to be found by experiment. Most amateurs are inclined to tap on to the anode of the 59 in the belief that that will provide maximum R.F., but this modification is strongly recommended.

(Continued on page 320)

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U.S.A. MIDGET 2-GANG (2 × .0005) CONDENSER with trimmers 3½ in. wide. 2½ in. long, ¼ in. spindle, ⅜ in. long. **3/6** each.

BRITISH MADE ALL-WAVE 8-VALVE SUPER-HET CHASSIS, 11-2,000 metres in 4 wavebands Full A.V.C. and all modern refinements. 8 watts output with 10-in. M.C. speaker. A.C. model 12 gns. A.C./D.C. model, 13 gns. Rola G12 12-in. high-fidelity speaker, 38/- extra.

SHORT-WAVE KITS

NEW 1937 1-VALVE SHORT-WAVE RECEIVER OR ADAPTOR KIT 13 to 86 metres without coil changing. Complete Kit and Circuit, **12/6. VALVE GIVEN FREE! DE LUXE MODEL** 14 to 150 metres, complete Kit with Chassis, 4 Coils and all parts, **17/6. VALVE GIVEN FREE!**

SUPERHET CONVERTER KIT, 13/6.

DE LUXE MODEL, 18/6.

S.W. SUPERHET CONVERTER, for A.C. Mains Receivers, **20/-.** A.C. Valve given **FREE!**

A.C./D.C. S.W. SUPER-HET CONVERTER, 14-50 metres. Completely self-energised. Will operate with **any** Receiver, **30/-. VALVE GIVEN FREE**

NEW 1937 2-VALVE S.W. KIT, 13 to 86 metres without coil changing. Complete Kit and Circuit, **19/6. VALVES GIVEN FREE! DE LUXE MODEL,** 14 to 150 metres. complete Kit and Chassis, 4 Coils and all parts, **25/-. VALVES GIVEN FREE!**

3-VALVE S.W. KIT, S.G., Det. and Pen., **42/-. VALVES GIVEN FREE!**

BAND-PASS TUNING PACK, comprising set of Telsen 3-gang iron-cored coils with switching, mounted on steel chassis with 3-gang condenser, illuminated disc-drive and 4 valve holders. **25/- the lot.** All Mains or Battery circuit. **FREE!**

3-VALVE BAND-PASS KIT, 200-2,000 metres. Complete kit of parts, including chassis, all components, valves, M.C. speaker and wiring diagram. Battery Model, **50/-.** A.C. Mains Model, **70/-.**

LISSEN ALL-WAVE COILS, 12-2,000 metres, complete with switching and wiring diagram. Special Offer, **6/11.**

1936 TELSEN 3-gang iron-cored Band-Pass coils with integral switching, 200-2,000 metres, **12/6** set.

PREMIER HIGH-FIDELITY P.A. AMPLIFIER KITS

3-WATT A.C 2-stage **AMPLIFIER** for Mike or Pick-up. Complete Kit of Parts with 3 valves, **40/-.**

7-WATT A.C./D.C. 3-stage **AMPLIFIER.** High-Gain, Push-Pull output. Complete Kit of Parts with 5 matched valves, **£4 4s.**

10-WATT A.C. 3-stage **AMPLIFIER** incorporating Phase-Inversion and Push-Pull Triodes. Enormous gain and straight line reproduction. Complete Kit of Parts, including 5 matched valves, **£5 5s.**

20-WATT A.C. 3-stage **AMPLIFIER,** suitable for largest dance hall. Employs new Giant Speech Transformer to ensure perfect reproduction. Complete Kit of Parts with 5 matched valves, **£8 8s.**

PREMIER TRANSVERSE-CURRENT MICROPHONE

Reisz pattern. Large output, exceptionally fine frequency response with low hiss level. Frequency range, 45-7,500 cycles, plus or minus 2DB, 30/-. Transformer, 5/-; Table Stand, 7/6; Adjustable Floor Stand, 22/6.

ELECTROLYTICS. U.S.A., 4 or 8 mfd. 530 v. peak, **1/9** each. **Dubilier,** 4 or 8 **mfd.** 500 v., **3/-**; 50 mfd. 50 v., **1/9**; 10 mfd. 50 v., **6d.**; 25 mfd. 25 v., **1/-** T.C.C. 8 mfd. 650 v., **4/-**; 15 mfd. 50 or 100 v., **1/-**; 50 **mfd.** 12 v., **1/-.** Paper Condensers. W. E. 250 v. working 4 mf., **2/-**; 2 mf., **1/-**; 1 mf., **6d.**; 350 v. working **4 mf., 2/6**; 2 mf., **1/6.** Dubilier 500 v. working 4 mf., **4/-**; 800 v. 4 mf. **6/-.** Wego 450 v. working, 2 mf., **1/9,** 4 mf., **3/-**

Dubilier Oil-filled Condensers. Complete range in stock up to 3,000 volts working.

DIALS.—Clarion Illuminated S.W. slow-motion Dial with 2-in. knob, **2/-. Premier** All-Wave 2-speed Dial, full vision straight-line, dual ratios 10-1 and 150-1, **6/6,** with escutcheon.

Potentiometers by well-known makers. All values up to 1 meg., **2/-**; with switch **2/6.**

TRANSFORMERS, latest type Telsen R.G.4 (list 12/6) **2/9** Lissen Hypernik Q.P.P. (list 12/6), **3/6.**

OUTPUT TRANSFORMERS for Power or Pentode, **2/6**; Multi-Ratio, **4/6.**

ELIMINATOR KITS for A.C. mains. 120 v. 20 m.a., or 150 v. 25 m.a., **15/-,** tapped S.G. det. and output. Complete kit with long-life valve rectifier (replacement cost only **2/-**).

PREMIER H.T. KITS, all with Westinghouse rectifiers; tapped transformers and adequate smoothing. All Kits absolutely complete. 120 v. 20 m.a., **20/-**; with ½ a. L.T. Charger, **28/-.** 150 v. 30 m.a., **25/-**; with ½ a. L.T. Charger, **31/6.** 250 v. 60 m.a., with 4 v. 3 a. C.T., **30/-.**

SHORT-WAVE COMPONENTS

SHORT-WAVE COILS, 4- and 6-pin types, 13-26, 22-47, 41-94, 78-170 metres, **1/9** each, with circuit. Special set of 3 4-pin S.W. Coils, 14-150 metres, **4/-** set, with circuit. Premier 3-band S.W. Coil, 11-25, 19-43, 38-86 metres. Simplifies S.W. receiver construction, suitable any type circuit, **2/6.**

COIL FORMERS, in finest plastic material, 1½ in. low-loss ribbed, 4- or 6-pin, **1/-** each.

SUPER CERAMIC CONDENSERS, S.L.F. .00016, .0001, **2/9** each; double-spaced, .00005, .000025 .000015, **3/-** each. All brass with integral slow motion, .00015 tuning, **3/9**; .00015 reaction, **2/9.** British Radiophone 2-gang .00016, **5/6.**

H.F. CHOKES. S.W. 10-200 metres, **9d.**; S.W. screened, **1/6**; standard screened 180-2,000 metres, **1/6.**

CERAMIC S.W. VALVE HOLDERS, 4- 5- or 7-pin. Chassis type, **6d.**; B.B. type, **8d.**

GLASS AERIAL INSULATORS, 4d. each.

BEEHIVE STAND-OFF, 6d. each.

SCREENED FLEX, single, 3d. yd. Twin, 4d. yd.

METERS

MOVING-IRON flush type milliamp meters in 2¼-in. Bakelite Case, to read A.C. or D.C. Ranges, 10, 20, 30, 50, 100, 150, 250 and 500 m.a., also 1, 3, 5 and 10 amps., 6, 16 volts all **5/9** each. 0-250 v., **8/6.**

MOVING COIL METERS, 0-1 m.a., 2¼-in. flush Bakelite Case, resistance, 100 ohms, **18/6.** Super model, 3½-in. case, **22/6.**

VOLTAGE MULTIPLIERS, any value, **1/-** each. Tapped milliamp shunts for 10, 50, 100 and 200 m.a., **4/-** each.

MOVING COIL SPEAKERS

All fitted with Output Transformer's

MAGNAVOX. Mains energised. "154," **7-in.** cone, 2,500 ohms 4 watts, **12/6**; "152," 9-in. cone, 2,500 ohms, **17/6**; "152 Magna," 9-in. cone, 2,500 ohms 6 watts, **37/6.** Magnavox P.M.'s—"254," 7-in. cone, **16/6**; "252," 9-in. cone, **22/6.**

ROLA latest type **P.M.'s, 15/-. GOODMANS'** 8-in. mains energised, 1,000 ohms field, **10/6** each.

JENSEN P.M. Speakers, **10/6. R. and A.** energised Speaker, 7½-in. diameter, 2,500 Ω field. Pentode Transformer, strongly recommended, **11/6.**

ENERGISING UNIT for any above energised speakers, **10/-.**

MAGNAVOX "33," "33 Duodes" and "66" Speakers can always be supplied from stock.

SPECIAL OFFER of large B.T.H. energised Moving Coils. 10½ in. diam., 1650 Ω field. Power or Pentode Transformer (state which required), **14/6.**

W.B. 1936 STENTORIANS, Standard model (list, 32/6), **21/-.** Senior model (list 42/6), **28/6.** Brand new, in sealed cartons.

GRAMOPHONE MOTORS

COLLARO Gramophone Unit, consisting of A.C. motor, 100-250 **v.** high-quality pick-up and volume control, **45/-**; Collaro motor only, **30/-**; Collaro Universal Gramophone Motor, 100-250 v. A.C./D.C., with high quality pick-up and volume control, **67/6**; Collaro Universal Motor only, **49/6**; **EDISON BELL** double-spring motors including turntable and all fittings, **15/-**; **COSMOCORD** Gramo. unit, comprising A.C. motor pick-up and volume control (list 55/-), **35/9.**

COSMOCORD PICK-UPS, with tonearm and volume control, **10/6** each.

PICK-UP HEADS only, **4/6** each.

TUBULAR CONDENSERS, non-inductive, all values up to .5 mfd., **6d.** each.

Wire-end **RESISTORS,** any value, 1 watt, **6d.**; 4 watts, **1/-**; 8 watts, **1/6**; 15 watts, **2/-**; 25 watts, **2/6** each.

Reliable **MORSE KEYS** with Morse Code engraved on bakelite base, **2/-** each.

Bakelite case **BUZZERS, 1/6**; Walnut case "Loud-tone," **2/6** each.

Super Quality lightweight **HEADPHONES, 3/9** pair.

Series-anode Modulation and Speech-controlled Carrier

Don B. Knock has sent us the following details which were evolved by the Australian station, VK2ON. It presents yet another solution to the problem of voice controlled carrier.

ALTHOUGH the circuit to be described embodies valves of American characteristics, they are of types often used by British experimenters so the idea can be embodied in many amateur stations.

Series modulation is more generally used in broadcast stations where high-fidelity is required without the use of a modulation choke or transformer as in the Heising system where it is difficult to design components to give adequate frequency response.

Consider the modulator as a variable resistance, so increasing and decreasing the anode voltage on the P.A. valve. It will be realised that the voltage required for series modulation is considerably higher than that for Heising modulation to obtain the same modulated output with similar valves.

Supply Voltages

As the modulator functions in Class A it is supplied by L.F. voltage and not power. The voltage across the modulator, between anode and cathode, and grid-bias voltage are determined by the normal Class A operating characteristics of the modulator.

For 100 per cent. modulation the D.C. resistance of the P.A. must be about two-thirds of that of the modulator. Consider a type 50 valve modulating a type 10. Normally the 50 operates at 450 volts with 84 volts negative bias and under these conditions takes 55 M/a. The 10 must have a lower resistance than the 50, so the voltage is reduced so that it draws 55 M/a at 350 volts. The two valves are in series so that a total voltage of 800 is required.

The modulated power input is then about 19 watts, and the power dissipated in the modulator about 25 watts. As the type 10 must be operated in Class C remember that the voltage across it is only 350 volts, and that twice cut-off equals 90 volts.

Tuning

In adjusting the P.A. the modulator is shorted out, while the voltage on the 10 is reduced during tuning. Excitation and aerial coupling are adjusted so the P.A. draws 60 to 70 M/a at 400 volts. The switch shorting the modulator is then opened and the voltage raised to approximately 800, giving a modulator current flow of 55 M/a.

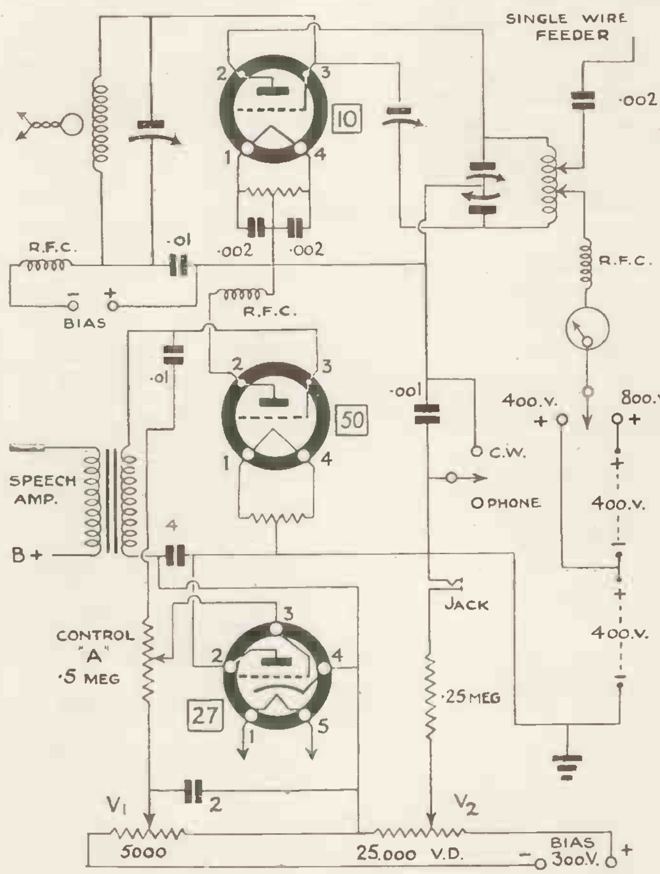
During modulation there should not be any appreciable change in anode current. If the depth of modulation is insufficient, either the D.C. resistance of the P.A. should be decreased, or the drive to the modulator increased. Another point, the modulator and P.A. valves must have a separate filament supply.

Carrier Control

Then there is the problem of carrier control which can be applied in a very simple fashion to series modulation. The circuit for carrier control is shown in this page and has a distinct advantage over the usual arrangement with the control valve in the anode circuit of the buffer. With such a system the modulating P.A. impedance is altered, but with this suggested circuit with the control in the modulator, no variation in excitation to the P.A. is caused.

The extra equipment needed is merely a triode of the 27 or 56 types used as a control valve, a potentiometer and one or two small fixed condensers and resistances.

Without modulation, cut-off bias is supplied to the modulator, so that when fully modulating, bias decreases to normal value. By dividing the total voltage of 800 by the amplification factor of the modulator, which is 3.8, it can be calculated that approximately 210 volts of bias are needed to give complete cut-off. From the same formula it can be deduced that 30 volts have to be applied to the control valve.



As the type 10 valve is one of the most used among amateurs this circuit should be of wide appeal. For those who use different types of power amplifier valves the circuit constants can be adapted without difficulty. As regards the modulator valve any type can be used if the impedance is matched to the P.A. impedance as pointed out in the text.

Voltage Control

Both these bias voltages are obtained from the same supply by means of a 5,000-ohms potentiometer and a 25,000-ohms voltage divider. With the P.A. adjusted for C.W., that is with the modulator shorted out of circuit, the switch is opened and V1 and V2 adjusted to give maximum voltage. If

(*Continued in 1st col. of next page*)

(Continued from preceding page)

there is sufficient bias, the currents through the 10 and 27 valves should be approximately zero. Then decrease the voltage at V2 until the anode current of the 10 begins to rise. V1 should also be adjusted until current begins to flow in the 27 circuit. V1 and V2 should then be left as adjusted, but if constant carrier is required, V1 should be decreased until the anode current of the 10 is around 55 M/a. In this position the bias on the modulator should be approximately 84 volts.

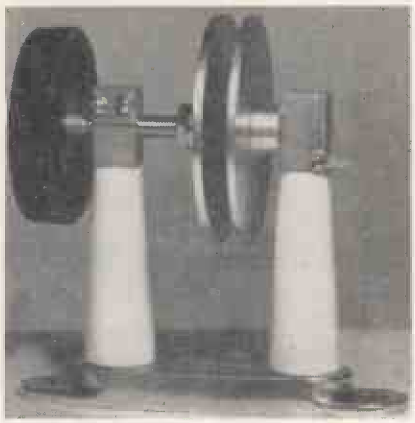
With the control A at minimum, modulation is adjusted on constant carrier to a 100 per cent. V1 is then increased to give cut-off on the control valve, after which, with the L.F. drive the same as before, the control A should be again adjusted until the anode current of the P.A. rises to 60 M/a.

If the control A is set too high undermodulation may result, and if too low, there may be distortion due to overmodulation.

Carrier cut-off is complete and on the average is approximately R3 rising to R8 on modulation. We cannot stress too highly the advantages of speech controlled modulation, particularly on the lower-frequency bands where congestion is very marked. Interference is reduced very considerably by this system of control, while duplex working is rendered more simple.

New Components for Constructors

NEUTRALISING large valves of the 150T or ESW204 types has until just recently meant that the constructor would have to build his own condenser of the correct capacity and gap. To meet the demands of such constructors, Messrs. Stratton & Co., who are responsible for Eddystone components, have introduced a small capacity neutralising condenser which has been given the type No. 1067.



This condenser is made up of two solid turned brass plates well polished to prevent flash-over, and mounted on glazed Frequentite insulating pillars. The maximum capacity is 12-mmfd. with the low minimum of 3-mmfd., so being suitable for most of the modern low-capacity transmitting valves.

Only one plate is movable and this is supported in a split bearing designed to be entirely free from backlash. The whole condenser is mounted on an aluminium base so that it can be bolted to the chassis, and is of such dimensions that with the average valve the grid and anode connections are kept reasonably short. The price of this condenser is 12s. 6d.

Another Eddystone product which is very useful to transmitting and receiving set constructors is the slow-motion driving head that has single hole fixing

and can be connected to any quarter-spindle by the usual flexible coupler. The slow-motion head has a 9.1 reduction gear and is fitted with a pointer and 1½ in. engraved scale.

Owing to its small dimensions it is particularly useful on transceivers where a slow-motion drive is required, but lack of space prevents the use of the normal slow-motion dial. This driving head, type 1012, is priced at 3s., and it can be recommended for use with any components mounted back from the panel.

Condensers primarily intended for use in receiving sets or for low power transmitters, are being marketed by Messrs. Webb's Stores, of 133 New Street, Birmingham, and 14 Soho Street, London.

This new range of condensers, designated the "Apex," are available in three ranges of 15, 50 and 100-mfd., and priced at 1s. 6d., 1s. 9d., and 2s. respectively. They are of extremely low-loss construction with brass vanes, ceramic end plate and extended spindle for ganging. Also, owing to the omission of ball-bearings, the condenser is absolutely noiseless in operation.

A feature of these condensers is their low-minimum capacity which for the 15-mmfd. is approximately 7-mmfd.; for the 50-mmfd., 7.7 mmfd.; and for the 100-mmfd., 9.2 mmfd. The maximum capacities conform very consistently to rating.

Transmitting amateurs will appreciate that these condensers can be double or even triple spaced, so providing a cheap neutralising or tuning condenser that will stand reasonably high voltages.

Messrs. Belling and Lee, Ltd., have produced some 2 and 3 pin plugs and sockets made to the B.S.S.666 specification. This specification applies to plugs and sockets for radio speech circuits up to 50 watts, with a maximum steady current of 5 amps. R.M.S. and a steady speech voltage of 80 R.M.S. It is intended that these plugs be used for loudspeaker extension circuits, for as they are non-reversible it is impossible to confuse the loudspeaker line with the mains supply.

2 pin plug and socket type 302 is priced at 2s. 4d., and 3 pin type 303 at 2s. 8d., both can be used for surface or flush mounting.

More Programme Criticisms

(Continued from page 292)

substitute travel films. Through the medium of films comes our best pictures, therefore, I suggest the programmes department should collect a number of short cabaret films and use them as Broadcasting House would use gramophone records.

My ideal programme would be :—

An O.B. topical event.
News reel.
Variety act, or one act play.
Travel film.
Picture Page.

J. J. Smith (Eltham).

THE TASK OF THE B.B.C.

One could advance the following reasons for public apathy towards television. *Firstly*, the television programmes from Alexandra Palace have proved comparatively dull and uninteresting. This should not be taken as implying criticism of Gerald Cock and his assistants, who are doing their very best to provide real television entertainment. One cannot however forget that it is an entirely new medium of entertainment, which requires the development of a technique of its own. Moreover, any really interesting television entertainment is bound to be costly and from the point of view of the B.B.C. unremunerative for a good few years to come.

A considerable increase in the financial appropriation for television in the B.B.C. budget will have to be made. One cannot feed lookers for very long on such items as how to carve a turkey, how to mend a window-pane, or on bird-life at the Zoo, and the like.

Secondly, a shortage of viewing hours. At present there are only twelve viewing hours a week, half of which come between three and four in the afternoon, when the master of the house must be somewhere at his business, and when the mistress of the house is likely to be either out shopping or attending a tea-party. Since for some unfathomable reason Sunday television is considered to be sacrilegeous, the consumer is at present offered a television programme for only *six hours* a week, out of which he may have real entertainment value for about *ten minutes* every hour.

Thirdly, whatever programme is offered, the looker has to view it on a *small screen*, average size 8 in. by 10 in., there being only one firm whose screen is somewhat larger, i.e., 9 in. by 12 in. After all, our standards for pictures are set by the cinemas and the home ciné.

Last. A step in the right direction was made by the reduction, after the abolition of the second standard, of receiver prices to about 55 to 60 guineas. Of course, one may say that £55 to £60 is still rather a high price. Remembering, however, that there was quite a good market for radio-gramophones in the first years at a similar price, and also for home cinema equipment (comprising camera and projector), where, apart from the initial outlay, there is a constant recurring expenditure, and for high-class cameras such as Leica, Zeiss-Contex, etc., one would be inclined to think that *even at the price of 55 to 60 guineas there should be room for many thousands of television receivers.*

If that is not the case to-day, the reason can only be two-fold : (1) the *inadequate entertainment value* of the B.B.C. programmes, coupled with a shortage of viewing hours, and (2) *the inadequacy of the size of the viewing screen.*

The first is a matter for the B.B.C. and one can definitely look forward to a gradual improvement in the programme, and to an increase in the number of viewing hours.

S.C. (London).

Sir,

The real problem, obviously, is to provide the non-technical masses with a television receiver giving a good, clear picture and costing not more than £25 in its cheapest form. This, I believe, can be done, but not with the present system. I have *not* followed the progress of television for the past eight years, except to pick up the scraps of information(?) broadcast from time to time in the lay press. Nevertheless, these scraps have been sufficient to give me a fairly good idea of what I should see on the screen of a receiver. They have also told me that line scanning is still in use, and as I have a ten year-old theory that line scanning is an unnecessary complication, I was not particularly interested. On Monday of this week I happened to see your January publication of "Television" and purchased a copy (I have, of course, obtained the February edition). A brief perusal of these two papers confirms my original views that *it is possible to pick up, transmit and reproduce a complete picture*, instead of a series of spots, as is now the case. The amount of skill and ingenuity which has been, and is being, put into the perfection of line scanning, reflects great credit on the people who have brought the science to its present stage ; but I am bound to say that I believe the research has been directed into the wrong channel.

I do not propose to deal here with the technical side of complete picture transmission, except to say that a mere glance at the Philco and Marconi-E.M.I. camera diagrams convinces me that my original theory is correct and that we may hear at any moment that someone has put the idea into practice. The consequent discarding of the time-base and its attendant evils, will simplify and cheapen the receiver considerably. The type of cathode-ray tube I have in mind should certainly be retailed at not more than £5 if it could be produced in sufficient quantities. I do not think there is much doubt about the sale of quantity if the price is right.

In conclusion I would reiterate that the "flaws" in the programme will automatically be righted when there are sufficient "ordinary people" with satisfactory apparatus. Until then let the B.B.C. concentrate on transmission and reception of a high standard and within reach of the general public.

Leonard Seaborn (London, N.).

Short-wave Programmes from Australia

The following schedules have been arranged for the Australian stations, Sydney and Melbourne, for the month of May.

Sydney, VK2ME.
Sundays—06.00-08.00 G.M.T.
Sundays—10.00-14.00 G.M.T.
Mondays—14.30-16.30 G.M.T.

Melbourne, VK3ME.
Monday to Saturday—09.00-12.00 G.M.T.

The wavelength of Sydney is 31.28 metres, and that of Melbourne, 31.5 metres.

How To Get A Transmitting Licence

ANY short-wave experimenter who is technically interested can, after serving a probationary period, generally obtain a Post Office permit to transmit on the short-wave amateur wavebands. Naturally these permits are only given to genuine experimenters and not merely to enable amateurs to send messages across the world, as seems to be the impression amongst some of our readers.

The Application Form

The first step towards getting the full transmitting permit is to apply for the artificial aerial licence, which can be obtained for a fee of 10s. per year. Take as an example, any short-wave listener. First a request is sent to the Office-of-the-Engineer-in-Chief, Radio Division, General Post Office, Armour House, Aldersgate Street, E.C.1, for an application form for a transmitting licence.

This form needs very careful filling in. References have to be supplied to prove the identity of the applicant and British nationality. Any past experience with transmitting apparatus must be carefully stated, while two sections are devoted to the type of experiments to be undertaken and the circuits that will be used.

It is most important that full details be given regarding possible experiments, while the theoretical circuit of the proposed transmitter should be clearly given.

No Morse Test

As an artificial aerial licence is being asked for there is no need to fill in the spaces left for knowledge of morse code, unless a speed of more than 12 words per minute for both sending and receiving can be attained. In such circumstances there should be no objection to a full radiating licence being immediately granted.

Where a commercial receiver is in use the G.P.O. will generally accept the type number of the receiver in lieu of a circuit, but where the receiver is home constructed, full information must be given.

The power supply should also be stated, whether A.C. or D.C. mains, and it should also be remembered that the maximum input to the transmitter allowed is 10 watts. This input is the actual D.C. wattage of the final valve, as for example, 300 volts with a current flow of 30 M/a would be equal to an input of 9 watts, or 400 volts at 20 M/a 10 watts.

This A.A. permit allows the experimenter to build a complete transmitter and modulator for speech transmissions and to obtain some experience in handling transmitting gear.

A dummy aerial consisting of inductance, resistance and capacity is permanently coupled to the transmitter and as this dummy has similar constants to the conventional elevated aerial all kinds of tests can be made without actually radiating signals.

The dummy aerial is usually made up of a coil and condenser similar to that used in the final stage of the transmitter plus a non-inductive resistance to make up for the normal resistance of the elevated aerial. If required a current meter can also be included to read the actual R.F. current obtained.

After the A.A. permit has been obtained in addition to building the transmitter progress can be made in learning the morse code so that the test can be passed.

When sufficient experience has been obtained in working the transmitter, and no further tests can be made with the dummy aerial, application should be made for the full radiating permit.

"A 6D5 Push-pull Transmitter"

(*Continued from page 295*)

consists of one turn of 14-gauge about 1 in. diameter, soldered to a flash lamp bulb. Hold this coil up against the anode coil and retune. The lamp will light up at resonance without any connection being made to it, and if there is only one tuning point, then the double hump in the aerial light is due to too tight a coupling. If, however, the double hump still persists, then the centre tap made by the high-frequency choke should be shifted until the correct electrical centre is found and the bulb only lights in one condenser position.

Once the tuning has been perfected there is no need to couple up the aerial until the transmitter is finally completed and ready to go on the air. Next wire up the speech amplifier and modulator. When the currents and voltages have been checked as against the previous details, check the quality by connecting a pick-up in the grid circuit, not, of course, through the microphone transformer, and have a loudspeaker in the anode circuit of the 6F6.

Adjust to give best quality and total absence of hum, after which the amplifier can be connected in circuit with the transmitter with a microphone in the grid of the 6C5.

With the small modulator suggested, the microphone must have a reasonably high output. So for that reason it is suggested that one of the transverse type A, made by Leslie Dixon, be used. This gives a reasonably high output with good quality and low noise level. A suitable transformer is the Midget Bulgin which has twin ratios of 35 or 70-1. The 35-1 ratio should be sufficient, but if the modulation percentage is too low, then it is a simple matter to use the higher ratio. A small Ever Ready 3-volt bias cell is bolted to the lip of the chassis. Actually a small strip of aluminium is bent to form a bracket. The idea can be seen in the illustration of the underside of the chassis.

Simple Switching

No switch is connected in the microphone circuit, so it must be remembered that there will be a continuous drain on the energising battery as long as the microphone is plugged into circuit. However, as the plug and jack system is used, when the transmitter is off the air the microphone plug has to be withdrawn.

While on the subject of switching, it will be noticed that there are two switches on the front lip of the chassis. The one to the left is the main on-off switch in the primary of the power transformer. This switches on the mains supply and also the heater voltage to all valves. When the valves are warmed up, H.T. can be applied by means of the second switch. During transmissions this H.T. switch is used for cutting the carrier, and allowing for the transmitter to be switched on without time delay.

Hum can be introduced through the microphone transformer, so for that reason one side of it only has been fixed to the chassis. As the connections are fairly long, the microphone transformer can be rotated until a position is found where there is no hum pickup.

A Licence Needed

It must be clearly realised by intending constructors that before this transmitter can be built, an artificial aerial permit must be obtained from the Postmaster-General. A full radiating licence can ultimately be obtained when the equipment is ready for connecting to the aerial. Full information can be obtained from the Engineer-in-Chief, Radio Division, General Post Office, Armour House, Aldersgate Street, E.C.1.

The metal valves specified in this apparatus are all American R.C.A. metal types obtainable through Messrs. Eves Radio.

"Crystal Oscillators —and the Beginner"

(*Continued from page* 310)

After some of these pentode circuits have been tried, experimenters can try using the new 6L6 valve which is so popular in America, and which is being more and more used in this country. The circuit is shown in Fig. 6, where a fundamental crystal on 40 metres can provide ample excitation on 20 metres.

The tri-tet circuit is used which is far more effective than the regenerative 59 oscillator doubler arrangements and, providing the constants are followed, this type of valve is most satisfactory. Assuming the crystal to have a frequency of 7,100, the anode of the 6L6 should be tuned to 14,200. L1 in the cathode circuit should be tuned to approximately 10,650 kc., that is approximately 50 per cent. higher than the crystal frequency. This enables a fair amount of regeneration to be set up in the grid, cathode and screen circuit, which is essential when the valve is being used as a tri-tet. It should also be remembered at this point that the variable capacity across L1 should have a minimum of .0002-mfd. in order to prevent crystal fracture.

In the anode circuit of the 6L6 only a small capacity is needed, and with the constants shown 10 watts output can be obtained at 20 metres when using a 40-metre crystal.

Constructors checking this circuit will find that the valves given will provide a crystal current of 75 M/a and a total D.C. cathode current of about 70 M/a. The crystal current rises to just over 100 M/a when the screen is increased to 275 volts, but the R.F. output also rises to approximately 17 watts.

For 40-metre operation, L1 should consist of 8 turns on a standard Eddystone former of 20-gauge enamelled, wound to a total length of $1\frac{1}{2}$ ins. L2 is of similar construction, but with 20 turns wound to $1\frac{1}{2}$ ins. total length.

The 6L6 valve is very popular owing to the high R.F. output it provides, but experience has shown that it is not suitable for beginners who should keep to the more simple 59 or 53 circuits.

Many readers will probably have heard the transmissions of the Dutch station PAOFB, which uses a single-valve, crystal-controlled transmitter with an input of about 20 watts. Such a circuit is very simple to construct and provides an easy means of getting on the air with the minimum of equipment and trouble.

A circuit for such a receiver is shown in Fig. 7 which uses a 362 pentode valve as a modulated crystal oscillator.

On 160 metres a crystal that will resonate within the amateur bands is required, and it should be isolated from direct earth by .006-mfd. condenser. Bias is obtained in the conventional way by the 10,000-ohm grid-to-earth resistance.

A maximum of 150 volts should be applied to the screen, and although this is much below the makers rated figure, it should not be exceeded in this particular arrangement. Negative bias is applied to the third grid from a small H.T. battery shunted by a capacity of .002-mfd. This transmitter is only suitable for one-band operation, so that the anode circuit must be tuned to the frequency of the crystal.

Assuming again that the crystal is in the 160-metre band, the anode coil should be wound on a 3-in. former with approximately 70 turns of 20-gauge enamelled-covered wire, and tuned with a reasonably high capacity of .0003-mfd. This condenser can be of the ordinary single spacing type.

The coil is centre tapped, and at the junction of coil and choke, shown in Fig. 7, is a by-pass condenser of .002-mfd. With correct design, these three components can be connected together without any additional wiring, so increasing efficiency. Modulation is applied in series with the choke and H.T. supply, and it is suggested that the modulator valve be coupled to a 1-1 transformer, the secondary being connected to the two points marked "Mod." To obtain maximum output, a suitable Marconi aerial and coupling should be effected.

The RFP30 used in Fig. 7 is shown in Fig. 8. It must be screened to prevent external anode-to-grid coupling.

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