AN EASY GUIDE TO TELEVISION

TELEVISION

THE FIRST TELEVISION JOURNAL IN THE WORLD

and SHORT-WAVE WORLD

G. E. Davis

MONTHLY 1/-

MARCH, 1935

BERNARD JONES PUBLICATIONS LTD.,
58-61 FETTER LANE, LONDON, E.C 4

TELEVISION

A High-definition Service Ready in London

Review of Current Events

The Large Screen in Television

Picture Units, Scanning Lines and Frequencies

SHORT WAVES

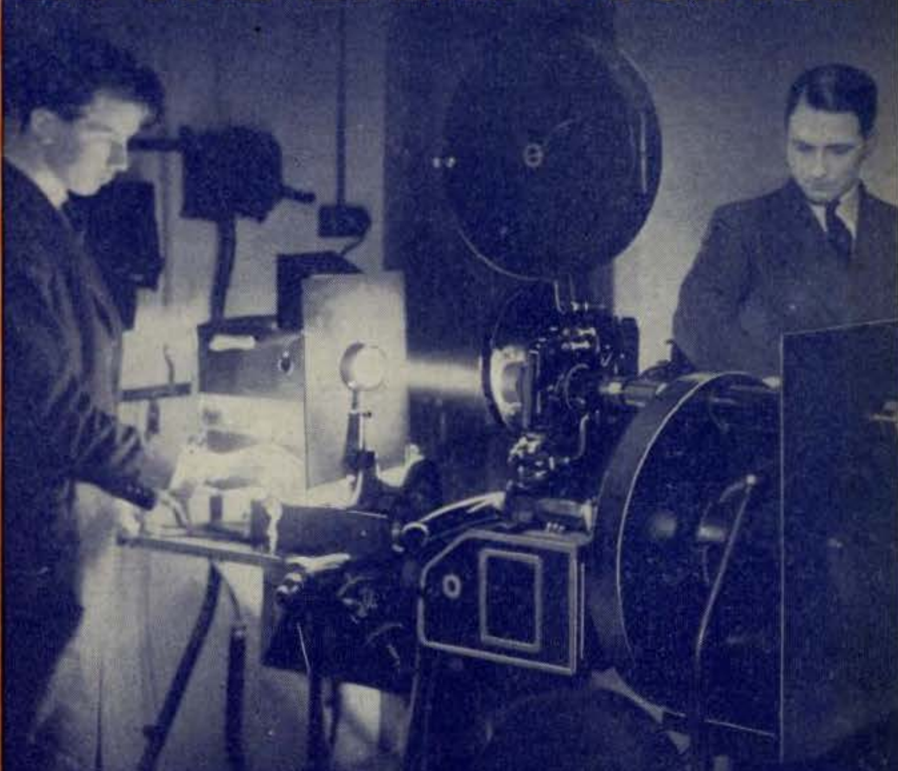
An 18-watt Power Amplifier

Interference-reducing Aerials

A Multi-purpose 10-watt Transmitter

All the Short-wave News

IN THE BAIRD STUDIOS



HIGH-DEFINITION TELECINE TRANSMITTER

SEE PAGE 117

No. 85 VOL. VIII MARCH, 1935.

TELEVISION and SHORT-WAVE WORLD

Special Features in this Issue

TELEVISION AND SHORT-WAVE WORLD

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COMMENT OF THE MONTH

180 or 240 Lines?

SINCE the publication of the Television Committee's Report we have been at pains to ascertain the opinions of many well-known authorities on the various recommendations. These we had hoped to publish fully, but in several cases there are politic reasons why personal views should not be given in detail; we are able, however, to give a general outline of what may be described as an average opinion.

Commendation of the report is general and the only criticism that can be considered in any way adverse is upon the somewhat high scanning frequency recommended. Many people point out that the desirability, or otherwise, of this high scanning frequency can rationally be argued from two points of view. In favour of it are the facts that it is immediately possible, and that it provides a standard which will dispose once and for all of any suggestions of lack of entertainment value in television.

On the other hand such a high scanning frequency as 240 lines places some very difficult obstacles in the way of those who have pinned their faith to mechanical systems; there are several of these at the present time which with a slightly lower frequency are giving wonderful promise of simple methods of reception. Most of these were calculated to go to 180 lines and the additional 60 lines will mean a considerable revision of ideas. We do not for a moment imagine that this extra handicap will rule mechanical systems out, but it is likely to have the effect of retarding development in this direction.

It can, of course, be contended that nothing but the best possible is good enough, and as a 240-line standard is possible with cathode-rays, any system which cannot reach this standard is not worth while. There is, however, another aspect of this matter. At the present time it seems that larger pictures are more likely to be obtained by mechanical methods than by cathode-rays and this everyone will admit is desirable. Within the past twelve months remarkable developments have been made in light modulation and it will be unfortunate if this progress is retarded. The whole point is that it would be desirable to give both systems equal chances of development, for either has advantages that are not present in the other —in other words, definition at this stage should not be regarded as the only criterion of the value of a system. Some of the mechanical systems are now simple and at the same time remarkably efficient, and it would be a pity therefore if consideration is not given to their special features. Those who have made comparisons of 180- and 240-line pictures will be aware that there is not a great deal of difference in the quality, whereas the production of the latter increases the difficulties very considerably.

The figure of 240 lines is, of course, only a recommendation, and the final decision will rest with the Advisory Committee to which we understand strong representations are being made on the matter.

ULTRA-SHORT WAVE TELEVISION TESTS

Here are some interesting details of experiments carried out in California over a distance of 56 miles.

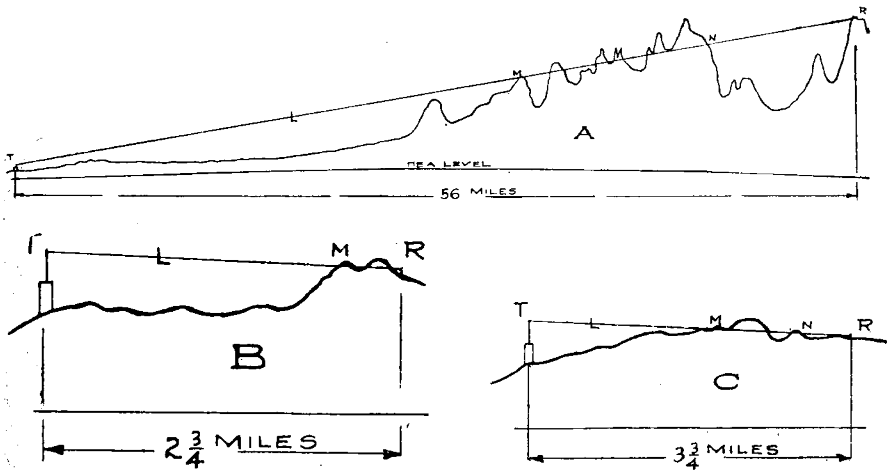
WE have just received the first details of some ultra-short wave television transmissions sent out from the American station W6XAO, in Los Angeles, of the Don Lee Broadcasting System. It appears that this station has been able to keep up a regular service over a distance of 56 miles even though the intervening country is of a hilly nature.

Actually the 6.7 metre-wave had to pass through 7½ miles of rock before it reached the receiving station at Lake Arrowhead.

Harry R. Lubcke, the television director for the W6XAO Station, points out that the waves passed around the intervening mountains, and recombined to eliminate the radio shadow that would otherwise have existed. The profile A of the accompanying diagram, constructed from official data of the United States Geological Survey, shows the mountains in the direct line of sight, L, from M to N. Recombination was possible because of the considerable distance of eight miles between the last of the mountains at N and the receiver location R.

The signal strength at Valley View was surprisingly strong. The distance to the transmitter was greater than the forty to forty-five miles generally set as the limit of the service area of an ultra-high frequency transmitter. It was over half as great as at a representative location in the city, only four miles from the station.

Measurements in Los Angeles have shown similar results. Profile B shows a local condition to a scale four times larger than that of A. The receiver was located at R, three miles away from the transmitter on a considerable hill, but just over the top on the side *away* from the transmitter. This was an inferior location. On the side toward the transmitter, at M, the field strength was five times greater.



Three diagrams showing the profile of the country over which the ultra-short wave television tests were made.

Profile C shows another location, four miles from the transmitter, where the path M N, through hills along the direct line of sight, was several times greater. Still the field strength was only slightly less than for a clear line of sight path which obtained for another.

This is interesting in view of the guesses that are being made as to the service of the proposed B.B.C. transmitters. It looks as if a few hills in the way will not have a very detrimental effect after all.

There is little doubt as to the genuineness of the reception for Donald Stephens and John W. Newkirk, San Bernardino business men, witnessed the reception, and in spite of a strong, cold wind blowing at the time, heard the call letters, frequency, and time of transmission of the station, regularly made to identify the transmissions.

One point which we in this country can verify is the fact that very often ultra-short waves are stronger or at least as strong behind a hill or mountain.

This point has been stressed by the American experimenters. For they say that in one location where the transmitter was shielded from the receiver by a high hill the field strength was only slightly less than for pure quasi-optical reception.

A feature of the short-waves is, however, that the receiver must not be just behind the hill otherwise the field strength drops right off. There must be a slight gap between the receiver and the hill for the waves appear to bend sufficiently to meet, and so fill up the gap.

It must not be assumed that location will not have any effect on the transmissions for those on the fringe of the service area will find the higher the location the greater will be the field strength.

Reception at Arrowhead was accomplished with an aerial consisting of 8-foot metal rod mounted on to a tree trunk. Later a directional aerial tuned to 6.7 metres was found greatly to increase the pick-up.

It is suggested that the future television aerial will be a number of wires spread in a fan-shape manner. Directional aerials normally receive only in two directions, but as the television programmes will come from several directions (referring to Los Angeles.—Ed.) this type of aerial array will be essential.

With ultra-high frequency television, it will be the exception rather than the rule, to "fish for distance" or to receive from more than one "cluster" of stations. Each major city will have its television station or stations which will serve a local audience. Chain broadcasting features may be relayed by special relay stations or special wire lines, but the programme will always come to the receptionist from his local station.

A HIGH-DEFINITION SERVICE READY IN LONDON

TRANSMITTER, STUDIOS AND LABORATORIES AT THE CRYSTAL PALACE

A FULL ACCOUNT OF THE BAIRD CO's WONDERFUL DEVELOPMENTS

It will come as a surprise to most readers to learn that at the Crystal Palace there is ready a complete television transmitting station with studios, transmitters, laboratories and workshops. In this remarkable development of the Baird Company every phase of modern high-definition television is represented.

BAIRD TELEVISION, LTD., have ready for immediate use studios and radio transmitters, suitable to commence a service of high-definition television and synchronised sound on ultra-short wavelengths for reception throughout the Greater London area. These are at the Crystal Palace and cover an area of 40,000 sq. ft., all on one open ground floor.

This site was chosen by the Baird Company because it is the highest point in London and modern high-definition television transmission technique demands the use of ultra-short wave radio transmitters, which have a range limited by the height of the transmission point. Ultra-short waves travel effectively only a little further than the eye can see. The top of the South Tower of the Crystal Palace is 680 ft. above sea level, and the Baird aerials on top of that tower give the maximum possible range of any site in the Greater London area—a radius of 30 to 35 miles in all directions.

The crystal Palace offers unlimited scope for expansion of studios and laboratories and the 200 acres of grounds are eminently suitable for the televising of outdoor scenes of all types.

The premises comprise the following:—Studios and radio transmitters; offices and laboratories; workshops and stores.

Television Studios and Radio Transmitters

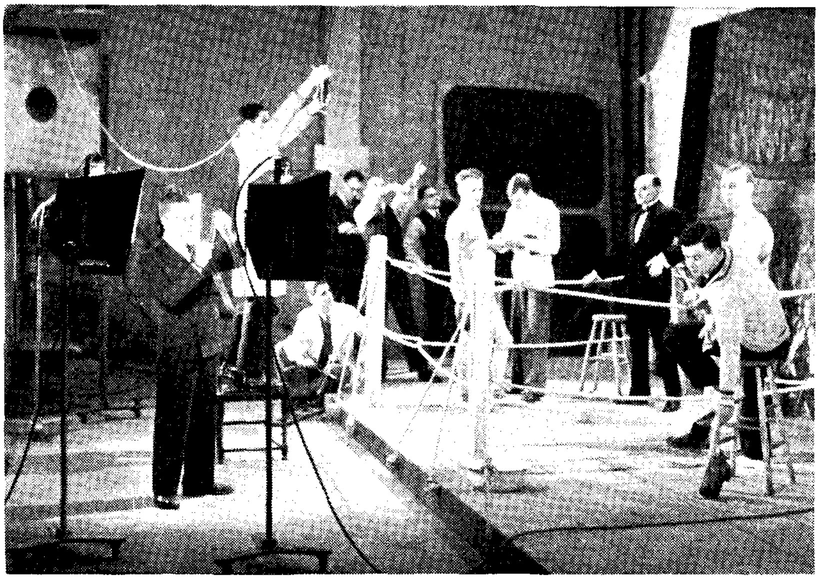
The studios and transmitters are all together in one block, known as the Studio Block.

Studio No. 1.—This measures 60 ft. by 40 ft. and is utilised for large scenes containing up to 40 actors.

Studio No. 2.—This studio is slightly smaller (50 ft. by 30 ft.) and is for dramatic and musical performances up to 10 actors, and has provision for back projection of any still or moving scene, as a backing to the performance taking place in the studio.

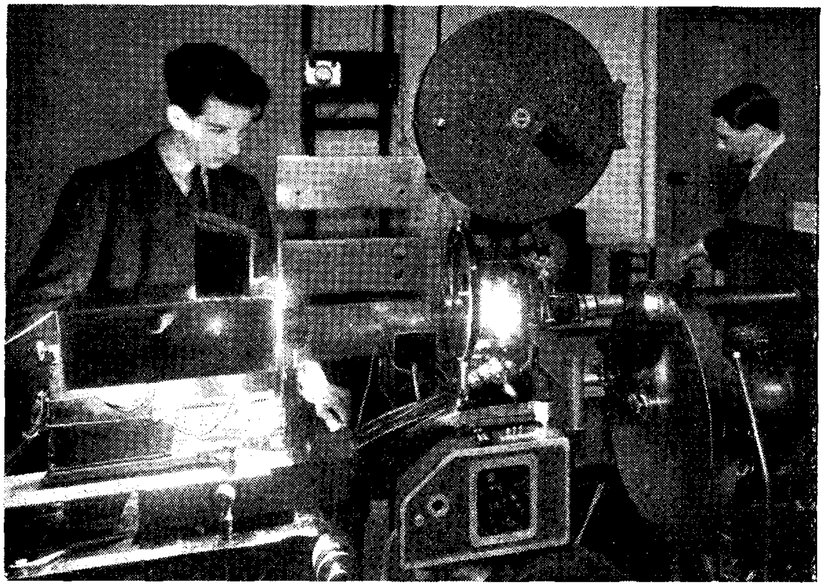
Studio No. 3.—This studio is designed for performances having up to four or five actors. It measures 40 ft. by 20 ft.

All these three studios are acoustically isolated and treated inside for correct sound recording results. They are overlooked by one large central camera room with large glass windows into each studio. Above the camera room is situated a central control room which has access from each individual studio by separate stairs. The three studios are equipped with full com-



Direct television of a boxing contest in No. 1 studio by the intermediate-film system.

Use of the cathode-ray tube for recording pictures on film for television reproduction in cinemas.



180-line Telenecine ***disc*** *scanner* ***for transmitting*** *talking films.*

The television scanners used in the camera room are of two kinds:—

1.—An intermediate-film scanner, which uses cinematograph film, on which is recorded the picture of the scene and its corresponding sound in a special cinematograph camera. On leaving the camera the film is immediately developed, fixed, washed and dried, and a complete negative made in a time interval of 30 seconds. The film is then scanned by a disc scanner and the corresponding television signal passed to the control room, and thence to the radio transmitter. This apparatus can be used for any indoor or exterior scene under all conditions of time, weather, and space. For instance, it can be taken out into the grounds to pick up scenes of football matches, fireworks, etc.

2.—An Electron camera, which is an all-electric device, having no

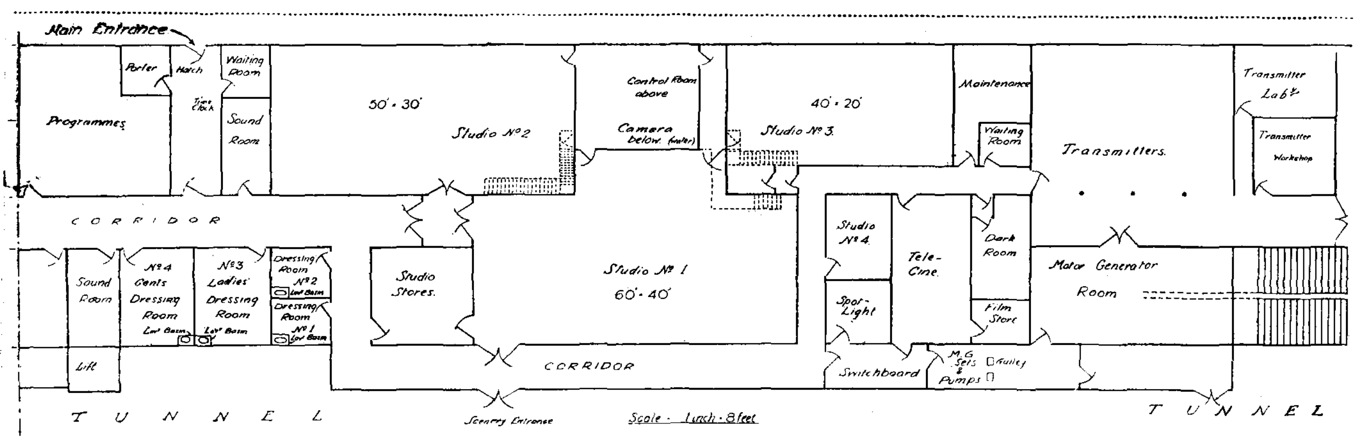
plement of electric power and lighting with the necessary ventilation and scenery tackle. It is possible for transmissions to take place in one studio while a rehearsal is going on in the next studio, and therefore by utilising all three studios, a continuous programme can be maintained throughout the day, if necessary.

Camera Room

The camera room contains apparatus for televising actual scenes in Studios 1, 2 or 3. A window also opens from the camera room on to the extensive terraces of the Crystal Palace grounds, enabling outdoor scenes of all types to be transmitted.

A large platform has been built in the open air outside the camera room with an area of 80 ft. by 40 ft., where sets can be built for portraying exterior scenes.

Spanish scene in No. 1 studio being taken by intermediate film process.



Plan of the Baird television studios and laboratories at the Crystal Palace.

moving parts, capable of taking indoor or outdoor scenes with any degree of definition from 100 to 500 lines.

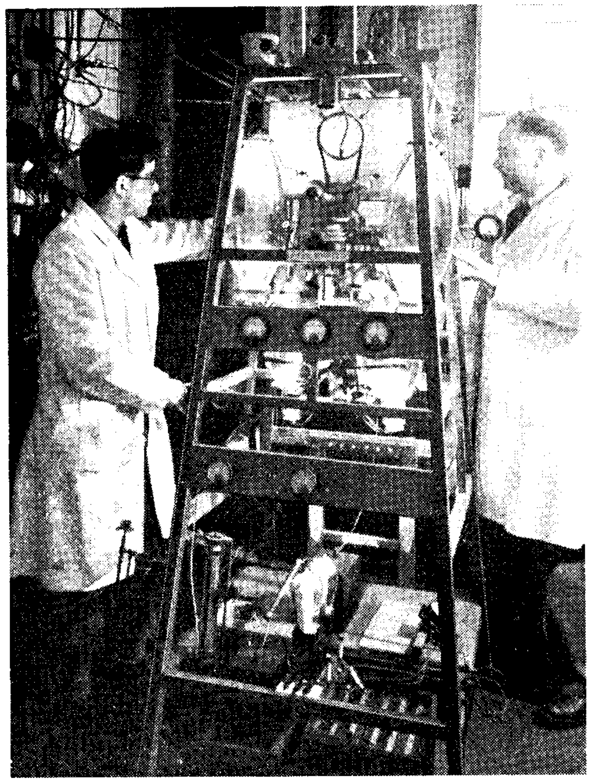
Either of these types of scanners can be transported to exterior events, as for instance, the Derby or Boat Race, or even in an aeroplane, the relaying to the Crystal Palace for retransmission from there being by microwave radio link.

Studio No. 4 is a spotlight studio using the original Baird method of the flying spot of light. This is provided by a huge automatic arc taking a current of 200 amperes, which projects light through the holes of a rapidly rotating scanning disc. Definition of 180 lines, with 25 pictures per second, is used at present for this.

This scanner, of course, employs the well-known principle of a spot of light passing through into the spotlight studio falling on the object to be televised, the light being reflected back into photo-electric cells. The electric currents so produced are then passed to the control room.

The photo-electric cells used in this studio are the largest in the world. This studio is capable of transmitting from large head close-ups to three-quarter lengths of two or three artists. Normally, it is used, however, for announcing and educational talks and the presentation of objects of art, still pictures, solo artists and lecturers.

Telecine Room.—The telecine room contains two projectors for the transmission of talking films. One of these is a disc scanner giving 180-line definition. This has been in continuous use for the last twelve months sending out daily programmes of films for experimental purposes.

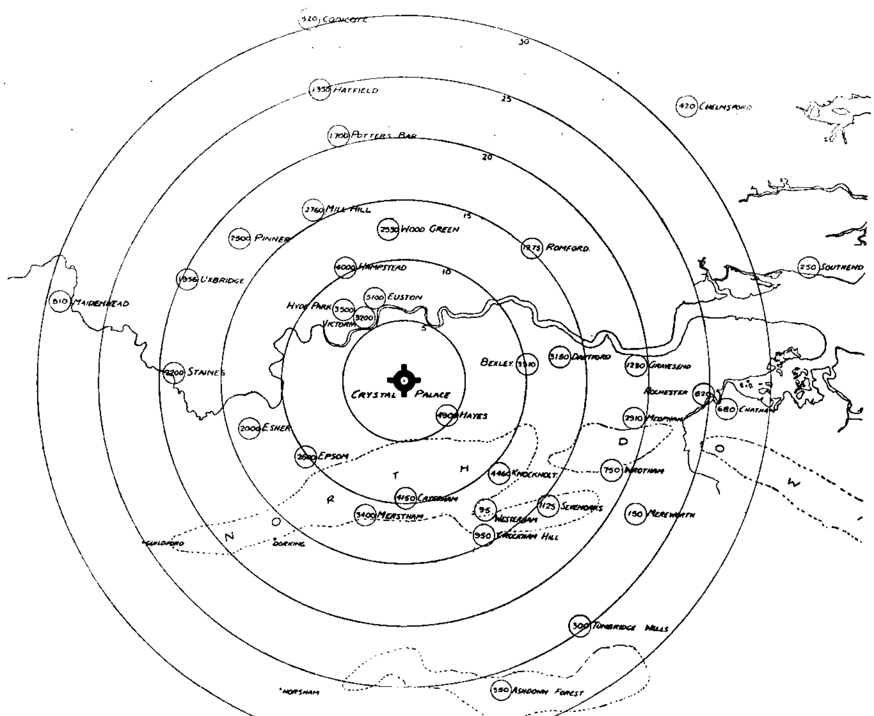


Ultra-short wave sound radio transmitter to operate in conjunction with the high-power vision radio transmitter.

The other is an electron scanner which, as mentioned before, has no moving parts (except the projector mechanism itself). This scanner is capable of televising with from 100 to 500 lines definition at 25 pictures per second. The degree of definition is controlled as required by the turning of a knob.

This electron scanner represents the latest stage of development of the art of the transmission of talking films by radio and is capable of giving results better than those obtained in the average home cinema, and equivalent in definition and tone quality to pictures seen on the full-sized cinema theatre screen.

The use of electron scanning for the transmission of real scenes and of talking pictures is a major development which the Baird Company believe has put them in a leading position.



Map of Signal Strengths received from Baird Television, Crystal Palace, 7 metre, 10 kw., transmitter, December 4th, 1934. (The figures represent microvolts picked up by a vertical dipole at ground level.) Schedule: Above 1,000 *microvolts—A good picture under all conditions.* 250-1,000 *microvolts—A good picture when the receiving aerial is not within* 50 *yards of a main or arterial road.* 100-250 *microvolts—A good picture in quiet locations.*

Control Room

The control room, situated above the camera room, takes the television signal outputs, sound outputs, and synchronising outputs from all four studios and the two telecine scanners, and passes them on to the radio transmitter, selecting them as and when required to provide a programme for radio transmission.

With sound broadcasting it is only necessary to transmit one thing, that is, the sound. In television three things must be transmitted, the picture signal, the synchronising control (which keeps the picture received in the television set in the home in frame with the picture sent out from the transmitter), and the sound signal. Normally, the synchronising control is sent out with the vision signal on the vision radio transmitter, and sound is sent out on the sound transmitter. These signals must be switched in and out as required in accordance with the programme, and they must be controlled for relative volume and phase in modulating the radio transmitter.

The control room is the nerve centre of all studios and it is here that the control-room engineers see not only the actual performance from their point of vantage, but they see also on a home receiver exactly what is being received in the home, and they make their adjustments accordingly.

It is in this control room that the producer of plays or musical performances can see the result he is getting in the home, on the home receiver, and can modify his production to the best advantage to give the best impression to the audience in the home. To arrange a successful transmission programme, items of all types, including talking films, must be provided, and the necessary control and operating system for quick changeover from item to item has been fully worked out in the Crystal Palace studios.

The High-power Radio Transmitter

The vision transmitter operates on a wavelength of 7.0 metres and delivers 5 kilowatts mean power to the aerial on top of the tower. There is no other transmitter like this in the world.

Ultra-short wavelengths of the above order are essential to handle the very high modulation frequency band necessary for high-definition television. Whereas the transmission of good sound needs only from 50 cycles to 80,000 cycles modulation frequencies (which can easily be accommodated by any transmitter on the normal broadcasting wavelength of 200 to 2,000 metres), high-definition television of from 180 lines upwards needs a modulation frequency range of from 10 cycles to 2 million cycles. All the studio, control, and modulation amplifiers must handle this range of frequencies without distortion or phase change for a satisfactory picture to be transmitted.

The only type of radio transmitter which will handle this frequency range is an ultra-short wave transmitter operating on a wavelength between 5 metres (6 million cycles) and 8 metres (40 million cycles). The design of this transmitter and its successful modulation by high-definition television signals has been accomplished by Baird engineers, and the success which has been achieved in radiating these ultra-short waves to considerable distances for satisfactory reception has been confirmed by demonstrations.

The Sound Radio Transmitter

The sound transmitter is situated on the lowest floor of the South Tower, and operates on 8½ metres, with a power of ½ kW. This transmitter was the one first made by the Baird Company for transmitting high-definition television from the South Tower of the Crystal Palace; it was used for many successful demonstrations of 180-line transmission during the first few months of 1934. It is capable of sending out sound of very high quality, in fact, of very much better quality than is possible with broadcasting stations with their present wavelength limitations.

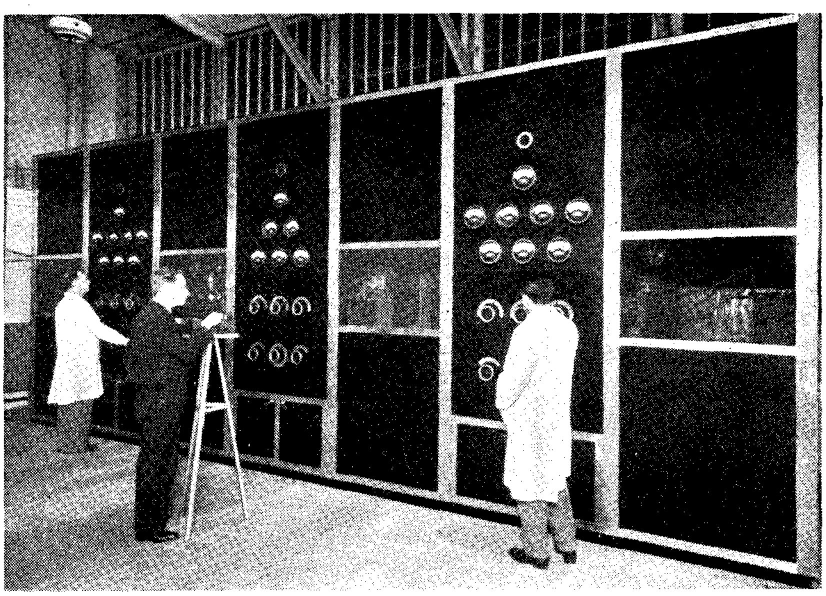
The sound transmitted is, of course, synchronised with the vision sent out by the high-power vision transmitter.

A film-cutting room is provided for editing the various films used on the telecine scanners. The films transmitted during the past year have included most of the Gaumont British super films released in that period. Further editing is necessary to make them more suitable for television transmission.

Four dressing rooms are available for artists, two of these are for "stars," and the other two larger ones are for accommodating crowd artists. All are fully equipped.

Back Projection Room

Back projection is available for use in conjunction with Studio No. 2. This room contains a projector which operates in synchronism with the cameras in the camera room and projects on to a screen in Studio No. 2 a scene suitable as a backing for what is taking place in that studio. Thus it is possible to have artists in a gondola in that studio and project as a background



10-kilowatt, 7-metre transmitter for radiating television signals to Greater London and the Home Counties.

a view of the canals of Venice, the whole being photographed together in a realistic manner by the camera in the camera room.

Power Supply and Motor Generator Room

A high-voltage, high-power transformer feeds the studios direct from the South Metropolitan Electric Supply Power Station. This feeds the necessary motor generators and motor converters for the lighting of the arc lamps and studios and for the various motors operating the television and synchronising equipment throughout the building.

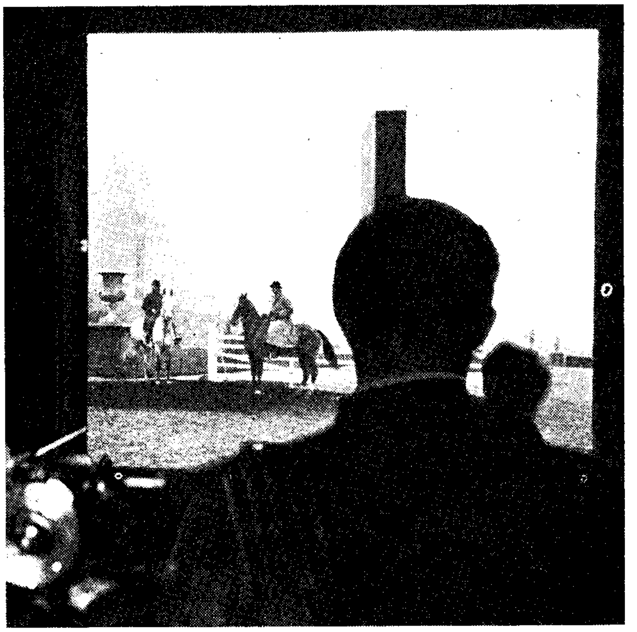
Offices and Laboratories

Every possible aspect of television transmission and reception is subject to the most intensive research in the laboratories. Experiments are continuously being carried out with a view to improving the degree of definition and the efficiency and the quality of the various scanners and the radio transmitters. Also, continuous experimental work is taking place with a view to improving the size, brilliancy, clearness, definition and simplicity of the working of the Baird home television receivers. A large staff of highly-trained physicists and engineers, many of them experts of international reputation on such highly specialised subjects as photo-electric cells, valve amplifiers, photographic emulsions and processes, scanning discs, electron tubes, fluorescent screens, are constantly engaged in research.

Workshops and Stores

Ninety-eight per cent. of the apparatus used at the Crystal Palace for transmission and reception of television is manufactured by the Baird Company. Furthermore, the design of home receivers has arrived at such a point that models can be put immediately into quantity production if necessary, and the workshops are so designed as to be able to produce any number of sets at the inauguration of a high-definition television service.

Miss Alma Taylor before the 180-line spotlight television transmitter giving hints on hairdressing and hat styles.



Televising horse-jumping scenes in the Crystal Palace grounds, by means of the intermediate-film-high-definition process.

"Sponsored" Television

A BRIEF statement by Major Gladstone Murray, of the B.B.C., recently appeared in the *Publicity World*. In this Major Murray says:—

"A good deal of misleading information has been published in various quarters about 'sponsored' television, and I am glad of the opportunity, through the columns of *The Newspaper World*, of correcting the mistaken impressions that seem so generally prevalent.

"The simple facts are that, according to our Charter and licence, we are entitled to accept 'provided' programmes, that is to say, appropriate programme material paid for by outside organisations.

"These, of course, do not contain advertising matter, but we are at liberty to give a courtesy acknowledgment to the 'providers.' The dance music from hotels and restaurants is a case in point.

"In the early days more advantage was taken of this than recently. There were programmes provided by newspapers and journals, *The Daily Express*, *The Evening Standard*, *Tit-Bits*, and so on. But, with increasing resources, we considerably restricted the practice. The liberty still remains, however.

"No doubt, it was in the minds of the Postmaster-General's Committee on Television that this method might be used to surmount the difficulty of finance. Of course, it remains to be seen to what extent the method will be employed.

"I do not think it probable that there will be any change of policy with respect to television programmes."

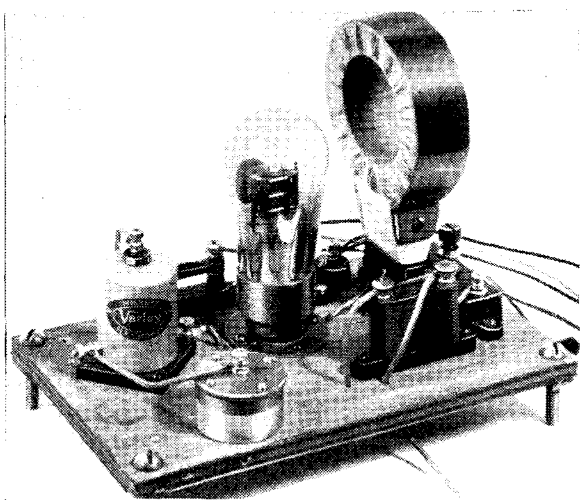
A Crystal Frequency Monitor

By 2BHN.

Every amateur should possess some means of frequency measurement. If you intend to possess a transmitting station of your own this piece of apparatus is essential.

IF you intend to do any serious short-wave experimenting, the first piece of apparatus required is a really accurate wavemeter. On the broadcast band, where a slight change in condenser capacity does not have very much effect, a wavemeter can be constructed and calibrated from some of the more reliable broadcast stations.

Amongst the best stations for this purpose are the commercials, which send out regular programmes for ships at sea. The exact frequencies these stations use can be found in the Call Book.



Construction is quite simple and there is nothing below the baseboard except valve holder connections. Make a special note of the supporting brackets—simply large bolts.

On the short-wave band things are not quite so simple, for the amateur may not always be able to identify four or five stations on each wave-range so as to carry out the necessary calibration. I do not have to tell you how unreliable are some of the commercial stations, which change their frequency two or three times a day.

Heterodyne wavemeters are reasonably good and simple to construct, but if you change the valve or vary the anode or filament potentials, the calibrations immediately change.

Most of you probably know that every transmitting station is equipped with a quartz crystal. With this crystal in circuit, no matter what change you make, the frequency to which the transmitter is tuned always remains constant. Until just recently quartz crystals have been rather expensive so that the average listener has not thought it worth while to go to the expense of building an oscillator with a high degree of accuracy.

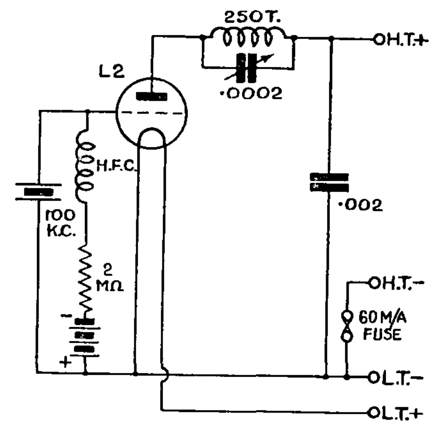
The Brookes Measuring Tool Company have now available a remarkably fine crystal, already mounted, ground to a frequency of 100 kilocycles and accurate to one part in 50,000. For transmitting work, such a crystal is invaluable. This crystal, in the grid circuit of a suitable oscillating arrangement, will produce harmonics that are easily receivable in an oscillating short-wave receiver provided that the coupling between them is sufficient.

Actually a 100-kilocycle crystal will generate harmonics in all the amateur bands up to and including 20 metres. Two harmonics are detectable on the 1.7 mc., 3.5 mc. and 7 mc, and 3 points on the 14 mc. band. The scope of the meter can be extended to cover other bands so that harmonics can be picked up on 1,700 kilocycles, 3,400 kilocycles, 3,800 kilocycles, 6,900 kilocycles, etc.

With these 100-kilocycle harmonics a very accurate curve can be drawn so that your short-wave oscillator can be calibrated from it. It is not intended that B.R.S. listeners use this frequency monitor as a wavemeter, but that you calibrate your own meter from it.

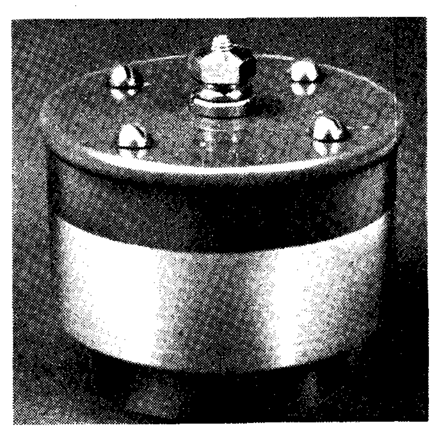
Calibration should not cause any trouble, but you must use a common supply for the oscillator and the receiver or unit under test. Take for example the 20-metre band. Tune your receiver to approximately the centre of the band, and tune in a known station that you can rely upon to be on its correct frequency. Then switch on the oscillator and the first harmonic picked up will be the 136th, giving a frequency of 13,600 kilocycles. If you tune to the top band with the larger coil in circuit, the 17th harmonic on 1,700 kilocycles can be identified without any trouble. You can go on in this way picking up as many points as you wish until you obtain enough points to make a really accurate curve. The harmonic following the 17,000-kilocycle note is, of course, 13,700 kilocycles, and further harmonics can be picked out down to 20 metres.

The valve in the frequency monitor should be of the low-impedance type, and operated from a 120 or 150 volt high-tension battery. It is not always necessary to employ grid bias, in which case the negative tapping can be connected to earth. The Ferranti L2 that I have used oscillates very freely and is particularly suitable for the purpose. The coil is of the ordinary pin-and-socket plug-in type of 250 turns, and, while the preset condenser across it is not particularly necessary it does help to take up any variations there may be in your coil.



You can see that the circuit is quite conventional. The .0002 condenser across the 250 turns coil is a preset.

With this unit, wavemeters and receivers can be calibrated in a highly effective manner.



Without a Brookes 100 K.C. crystal this Monitor would not have been constructed. It is accurate to one part in 50,000.

Occasionally some of the harmonics on the higher frequency bands are rather too weak to be useful, in which case additional coupling is required.

Scannings and Reflections

By THE LOOKER

The Iconoscope

READING through the Television Report I was interested to see special mention made of the possibilities of the cathode-ray tube with the " mosaic " electrode. This, I take it, must refer to the Iconoscope type of transmitter, in which the scene to be televised is focused directly on to a photo-sensitive surface mounted inside the glass bulb of the tube.

The surface is made up of a multitude of tiny silver-caesium globules, and its action is not unlike that of an ordinary photographic plate, except that an " electric " image is produced instead of a chemical one. Actually the picture is first transformed—automatically—into a series of electric charges, the distribution of which represents the varying light-and-shade values. These are then scanned or discharged by the cathode-ray stream from the other end of the tube.

Transmitting Outdoor Scenes

THE advantages of this type of transmitter seem to be two-fold. In the first place the " mosaic " surface is said to be practically as sensitive as the ordinary camera film or plate, which means that any scene which can be photographed can be televised. In the second place the image focused on the mosaic electrode " stays put " between one scanning period and the next—so that it has lots of time to make its presence felt, and to generate a stronger photo-electric current than that obtained, say, with a rotating-disc scanner.

So far as one can gather, the only alternative at present available for handling outdoor scenes on a large scale is what is known as "delayed" television, where the picture is first taken on a camera film and afterwards scanned. For topical events the scene is recorded " on the spot " with a movie camera, and the film at once passed through an extra-rapid developing bath. As it emerges it is scanned whilst still wet, and so sent straight into the ether. As the total time for developing and scanning is less than half a minute, there is hardly room for much complaint on the ground of delay.

After the first transmission the film can be more thoroughly washed and permanently fixed, and dried at leisure, so as to bottle-up the programme for the benefit of those who prefer to follow, say, the " finish of the Derby " some hours after the actual event, preferably about 9 p.m., after a comfortable dinner.

Future Lines of Development

ON one point the Report is not perhaps quite so explicit as it might be. Whilst insisting, on the one hand, that the promotion of television must not be allowed to prevent the continued development of sound broadcasting, it rather covers up the fact that the present type of broadcast receiver is totally unsuited to deal with high-definition picture signals.

I know that existing 30-line transmissions can readily be handled on a standard broadcast receiver. But that is because the corresponding side-band frequencies are only slightly wider than those required to reproduce high-grade music.

When we come to 240-line scanning and 25 pictures a second, the side-band frequencies increase to something of the order of 500 kilocycles, which at once puts the ordinary tuned circuits, as used for broadcast reception, completely out of court. In other words, the idea of adding a short-wave adaptor to an existing wireless set, and then hoping to receive high-definition pictures simply won't hold water.

Semi-aperiodic couplings and special types of amplifying valves are required to handle a band of half a million different frequencies, without introducing distortion, and for this reason alone I do not think we shall find very much in common between the present type of broadcast receiver and the high-definition television set of the future.

Where do they go to?

INCIDENTALLY the extensive use of six- and seven-metre radiation for television programmes is likely to revive a rather interesting problem. Such waves are supposed to have only an optical range—that is to say, reception is said to be limited to the distance over which one can see from the level of the transmitting aerial. But this is largely speculation. Are we to take it for granted that the waves are all absorbed, as and when they reach the ground—and if not, what happens to them?

Assuming they behave like other short waves, say of the 10-metre variety, they will be diverted upwards towards the Heaviside layer, possibly in the hope of getting reflected back from there towards earth again. Here, however, their fate is uncertain.

According to the experts, waves below 10 metres are not reflected from any of the layers. They are supposed to pass clean through them all —even the highest or Appleton layer. But, I must repeat, the point is not definitely settled, because there are instances on record of six- and seven-metre waves skipping from earth and sky and back again, and covering quite long distances in this fashion.

This may possibly give rise to television " interference " at long range. It also opens up the prospect of receiving pictures direct from Paris or Vienna, or even New York—which may prove a blessing in disguise if the new Director of Television develops a gloomy outlook on what is suitable for our Sunday entertainment.

On the other hand, if both the Heaviside and Appleton layers turn out to be truly transparent to all waves below 10 metres, the new high-definition programmes may give the Martians their first chance of finding out what we humans really look like.

What's in the News?

THERE has been television " news " enough and to spare in the newspapers ever since the Television Report was presented to the Postmaster-General. Amazing and quite unfounded claims have been made with every air of authenticity, but what do they amount to when boiled down to hard facts?

In his own special broadcast the P.M.G. emphasised the fact that "the art of television is still in its infancy and that television broadcasting will not immediately spring into being as a general nation-wide service." It is just as well for us to keep that statement in mind when we read claims that every cinema in the country will be televising news events in the course of a few months, and so on. Newspapers have made much of such extravagant stories during the past month and most of them have but scanty foundation in fact.

"Television Is Here" screamed one contents bill on the day of the publication of the Television Committee's Report. But readers of TELEVISION AND SHORT-WAVE WORLD know that television—real television in the form of an entertainment—is only just beginning.

First Steps

NO time is being lost by the Television Advisory Committee, which has already had more than one meeting.

The first point to be decided is that of the location of the first television transmitter. The Crystal Palace has much to recommend it; it is high above sea level and signals radiated from one of the towers can be relied upon to produce a good service area (that is, within the limitations of the wavelength employed). There are obvious advantages in using this location for the first experiments. But a complication is introduced by the fact that the Committee recommended that both the Baird and E.M.I. processes should be given a trial at the same time (alternately and not simultaneously). It is not likely that either the Baird or E.M.I. interests will want rival gear to be installed in the same experimental station.

A way out of this difficulty has been suggested. That is to send the Baird transmissions out from the Crystal Palace and install the E.M.I. gear at Alexandra Palace, in North London. But the difficulty, then, would be to make directly comparable tests. This television simply bristles with problems that need careful, and certainly not hasty, solution!

Aerial Experiments

WHAT is quite certain is that the aerial for high-definition television transmission must be high and unobstructed so that the "optical" range is as great as possible. This means the use of a high tower, certainly of the order of 400 ft., although a height of 600 ft. has been discussed as being more likely to give the desired results.

It has been suggested that captive balloons might be used to support the aerial. In this way the aerial could be put up when it was needed; the cost of erecting a high permanent tower would be saved; and there would be less danger to aircraft.

One of the greatest snags on the transmitting side will be to link up studios with transmitting stations. The cost of suitable cable is enormous. As a solution to this problem—and also the general problem of transmitting—Marchese Marconi has announced that he is experimenting with micro-waves for this purpose.

Unlike waves of the order of 5 metres, micro-waves have a range greatly in excess of 25 miles.

The Future of Receiver Design

ON the receiving side nothing much can be done until designers have technical details of the transmissions that will actually be put out. Nearly every set maker is looking round to see how he can come into the new field at the appropriate time, and when the service gets going there will be no lack of television receiving gear.

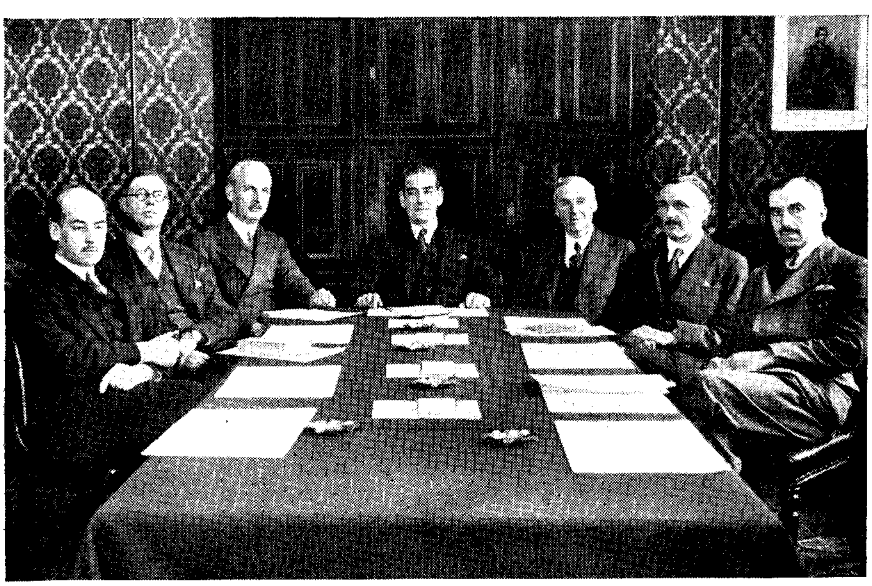
Edison Bell, in particular, claim to have developed a method of cathode-ray reception that will enable them to put on the market very reasonably-priced "televiewers."

The New Television Director

MR. GERALD A. COCK has been appointed Television Director of the B.B.C. Mr. Cock joined the Corporation in 1925 and has since had several years' experience of outside broadcasting (he is director of the department concerned) to his credit. It is understood that he will not take up his television activities until after the Royal Jubilee celebrations have been brought to a successful conclusion.

As soon as Mr. Cock begins his new duties TELEVISION AND SHORT-WAVE WORLD will keep its readers informed of his views on the general question of programmes. Already he is collecting many schemes and ideas—but there are many considerations, both practical and political, to be taken into consideration.

At a recent meeting of the West Herts Radio Retailers' Association it was stated that the recent television developments had adversely affected the sale of wireless receivers.



Television Advisory Committee meets at G.P.O.

The photograph shows: Left to right—Mr. Noel Ashbridge of the B.B.C.; Mr. O. F. Browne; Sir Frank Smith; Lord Selsdon (Chairman of the Committee); Mr. F. W. Phillips (Assistant Secretary of G.P.O.); Colonel Angwin (Assistant Engineering Chief of G.P.O.) and Mr. V. Roberts (Secretary of Committee).

GENERATING CATHODE-RAY SWEEP VOLTAGES MECHANICALLY

By S. T. Roberts.

This article describes an interesting experiment in the production of cathode-ray sweep voltages by means of a light-mechanical system. The possible combination of the cathode-ray tube with mechanical systems is a line of investigation worth following up.

MOST TELEVISION AND SHORT-WAVE WORLD readers are now familiar in theory with the general principle of cathode-ray reception. This system requires but little power in the output stage of the receiving amplifier, but this advantage is offset by the somewhat complex time-bases required.

These time-bases are nearly always some form of relaxed oscillators which are definitely "tricky" to handle. Actually two circuits have to be synchronised with this form of receiver. Also they must be carefully adjusted to produce pictures of the correct ratio.

Some years ago, before the modern mercury relay valves were obtainable, the writer, wishing to reproduce a television signal on a cathode-ray tube, was at first a little perturbed over the generation of the two necessary saw-tooth waves to produce the scanning sweep; being, shall we say, photo-cell minded, it was decided to produce them from a light interruptor.

The two wave-forms required were of the frequency to produce a 30-line picture; that is to say, one 30 cycle and one 1 cycle saw-tooth wave in a unit of time, such as shown in the diagram, Fig. 1.

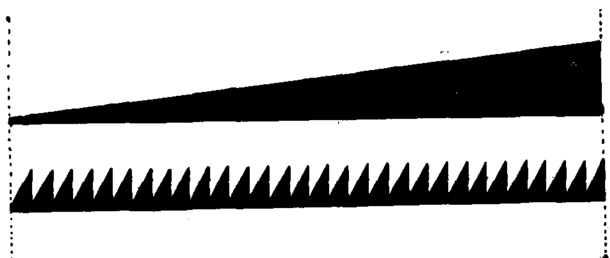


Fig. 1.—The type of wave forms required.

It should be noted that the saw-tooth waves of the figure are perfect inasmuch as the fall from maximum to zero is instantaneous. Turning to Fig. 2, A represents one-and-a-bit of a saw-tooth wave. Now if a slit of light SS were passed across this pattern, the light reflected would vary in value as B, and one obtains a very similar light impression of the original pattern.

There is, however, a slight change from the original, as the fall from maximum to minimum has a definite time value; also the amplitude has been somewhat reduced. This is due to the finite size of the slit of light. In the position drawn in A, Fig 2 (the dotted vertical lines representing the slit) the value of the light would be 50-50, this is not in any way harmful as the spot on the cathode-ray tube's screen must take a certain time to "fly back."

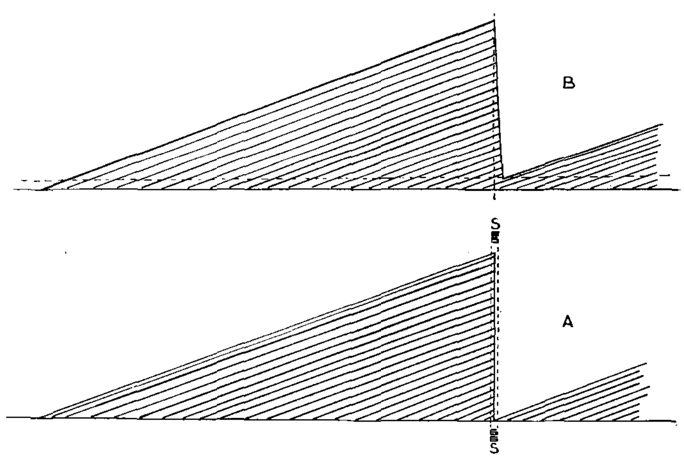


Fig. 2. Diagrams showing how the saw-tooth wave is produced.

"Fly-Back"

Obviously this "fly-back" time can be controlled by the width of the slit of light, the wider this is, the longer the time. Converting these light variations to volts (or amperes) is, of course, done by aid of a photo-cell. Fig. 3 shows the two saw-tooth waves of Fig. 1 converted into two circles or discs which can be rotated past a stationary slit of light SS, the speed of rotation controlling the frequency.

In practice one does not use reflected light as previously described, but arranges the rotating pattern to interrupt a beam of light, which, of course, gives a better maximum and minimum for a given light source, as with reflected light some is always lost from the whitest of materials, while some is always reflected from the blackest.

The practical arrangement used by the writer consisted of two sheet-aluminium discs some 8 ins. in diameter, whose peripheries were cut as shown in Fig. 3. These discs D, D_1, were mounted on the same shaft (Fig. 4). The light source was a low-voltage motor-car type of lamp with a straight filament F, which was arranged evenly to illuminate two slits in a sheet of metal M and M1 by the aid of condensers LC and LC_1.

The lens LP and LP_1 each projected an image of the illuminated slits in M and M_1 on to the discs D and D_1, while the lens L and L_1 collected the resulting light on to a fixed area of

MECHANICALLY-PRODUCED SWEEP VOLTAGES

the photo-cells. The motor in the writer's case was a synchronous type driven off the same A.C. mains as the transmitter.

The valve amplifier after each of the photo-cells was resistance-capacity coupled of a type suitable for 30-line television signals. No peaking at the fundamental frequencies can be satisfactorily achieved as a saw-tooth wave requires a large number of harmonics to be satisfactorily produced.

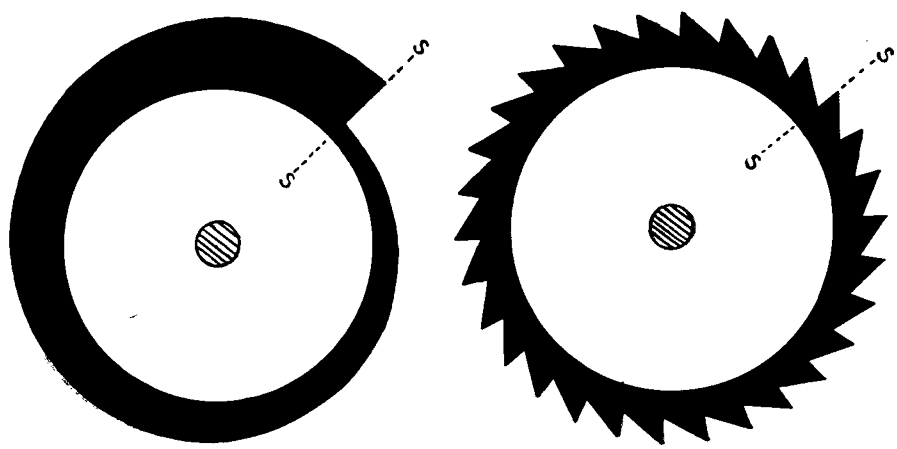


Fig. 3.—Design of rotating discs to produce a saw-tooth wave.

The amplifiers used had four stages using triodes. With modern valves probably two would be sufficient. In the actual construction of the discs, it was found worth while to calculate the amplification of the amplifiers at the two frequencies concerned, bearing in mind the ratio of the two sweeps, and cutting the depth of saw-tooths accordingly.

It must, of course, be understood that such apparatus is not less costly to construct than the usual relaxed oscillators type of sweep circuits, but it has the advantage of being more convenient to handle, especially for the amateur, who has his own transmitter driven from A.C. mains, or is on the same A.C. mains which control the transmitter of a broadcast television signal.

The system, of course, is suitable for any number of lines, though for anything above 60 it would be best to construct the "line" disc, as apart from the "picture" one, photographically, in which case the two discs could be made quite conveniently about 3 ins. in diameter on the usual commercial flat film.

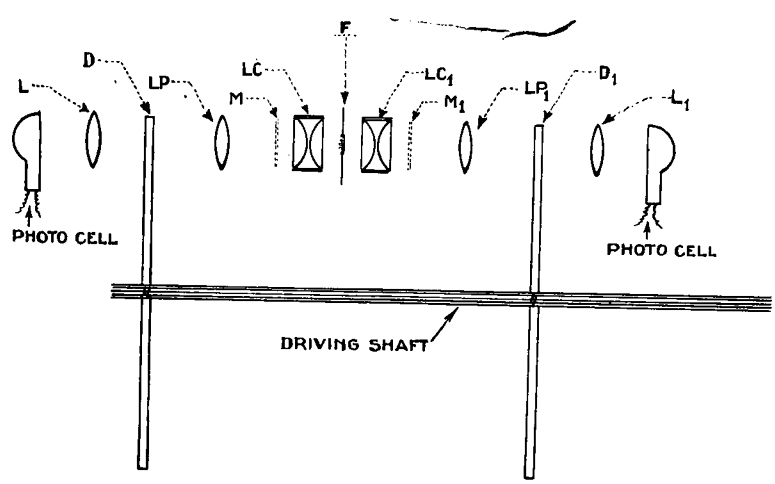


Fig. 4.—Schematic arrangement of the device for producing the sweep voltages.

Ultra High-Frequency Cables

Bell Laboratories announce that they have succeeded in designing a " wire within a wire " type of cable capable of carrying very high frequencies. It is stated that the new transmission line will conduct, without appreciable loss, frequency-bandwidths of 1,000,000 cycles or more. The new wire is less than half an inch in diameter and can be bent around corners.

Up to the present it has been thought that it would be necessary to employ micro-waves for linking stations. The main disadvantage in micro-waves is that they do not travel much further than the horizon.

The new cable, it is stated, consists of a small conductor carried on spacing insulators inside a larger metallic tube. The assembly has the unique property of excluding extraneous interference, as well as being able to conduct electrical pulsations of an exceptionally wide range of frequencies.

" The development of this cable changes the complexion of the idea of carrying television images from a central studio to television transmitting stations," said Dr. Frank B. Jewett, president of the Bell Laboratories. " It is the only structure, as far as we know, that will convey the wide frequency-band that television requires. The cable will be comparatively cheap, although we have not made any practical application to discover the actual cost.

A centrally-located television studio, say, in a large city where talent is easily available, can now be linked with television broadcasting stations at any distance, by employing the proper wide-band repeating stations at the required intervals in the line. At junction points lines can be made to branch off to stations along the way."

Our February Issue

The February issue of Television and Short-wave World was completely sold out and it was found necessary to reprint. This second printing was also sold out and only a very few copies are now available.

THE LARGE SCREEN IN TELEVISION

By Telecon

Owing to the lack of an adequate amount of light, the projection of television pictures upon large screens has necessitated the problem being attacked in an indirect manner. This article describes the systems which have been the most successful.

THERE is no doubt that large screen television is a branch of the subject which is very attractive and great developments may be expected in the very near future. The temporary lull in screen activities is undoubtedly due to the fact that firms engaged in the race for television are concentrating their activities on the production of home receivers as it is in this direction that they hope to reap financial reward.

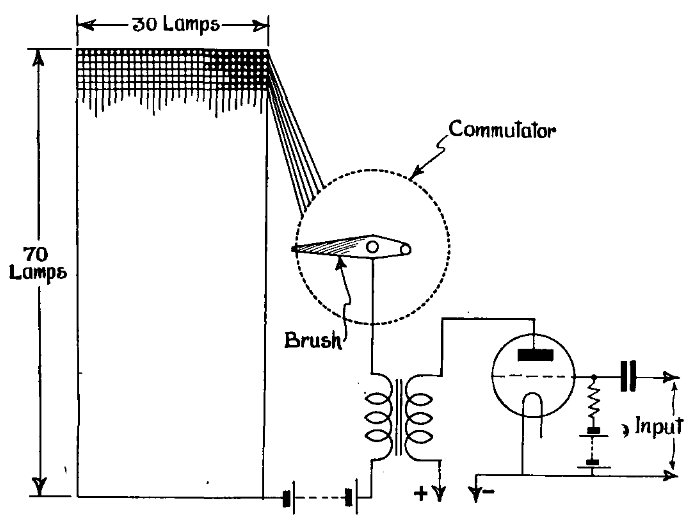
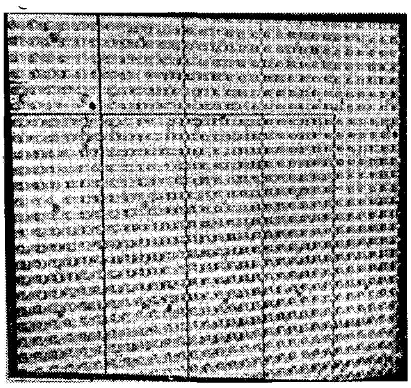


Fig. 1.—Schematic arrangement of the "bank-of-lamps" system. This was successful but it is not sufficiently good for modern requirements.



A close-up view of the lamp screen in the "bank-of-lamps" system; the honeycomb has been removed.

Early Efforts

It is over six years ago, when visiting the Baird laboratories, that the writer first saw a large television screen. Mr. Baird was using a huge *wooden* disc containing about twenty 6-in. lenses and as one side of the disc was used for transmitting and the other side for receiving, the effect was extraordinary. The picture, which was projected from a crater neon lamp on to a screen about 4 ft. by 2 ft. was upside down and split in half, having the ears in the middle and half the nose at each edge of the picture!

About this time, Karolus, working in Germany, perfected his modification of the Kerr cell and was able to project quite large images using 30-line definition.

The Modulated Arc

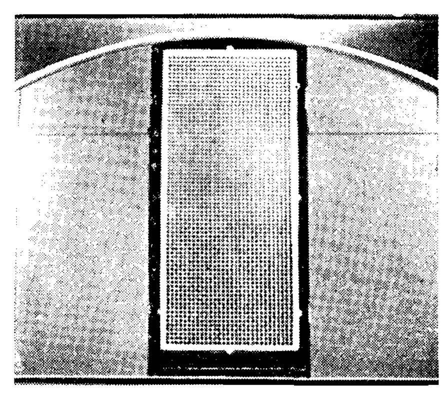
A great stride in the development of large picture projection was accomplished when Baird engineers evolved a successful form of modulated arc lamp. The intensity of this new light source was far greater than that of any source of modulated light hitherto available and 30-line pictures 6 ft. by 3 ft. were easily obtained. This device was demonstrated with considerable success at the B.A. meeting in 1931.

The "Bank of Lamps"

By far the most successful large screen televisor, however, was the "bank of lamps" in which the picture was not projected, the screen itself—consisting of 2,100 small electric bulbs—being self-luminous. Each of these lamps was connected to a segment of a huge commutator and as the brushgear revolved the lamps were lit up in turn, the complete bank being scanned $12\frac{1}{2}$ times per second. Fig. 1 illustrates the principle of the scheme. This screen was shown to a paying public in many of the larger Continental theatres as well as the London Coliseum.

Multi-zone Screens

For various reasons screens of the type described were limited as far as scope and detail were concerned and many efforts were made to increase the definition by dividing the screen into a number of "zones" using a separate transmission channel for each zone. Practically every television organisation produced something on these lines, the most successful being the H.M.V. 5-zone screen, the Baird 3-zone screen (on which the Derby race was shown at the Victoria Palace), and the intercallated multi-zone apparatus of Alexanderson in America, and Baird in England, in which the zones were not side by side but actually mixed together by dividing the scanning spot itself into separately controlled areas.



This photograph shows the screen with the honeycomb in position.

The Intermediate-Film Projector

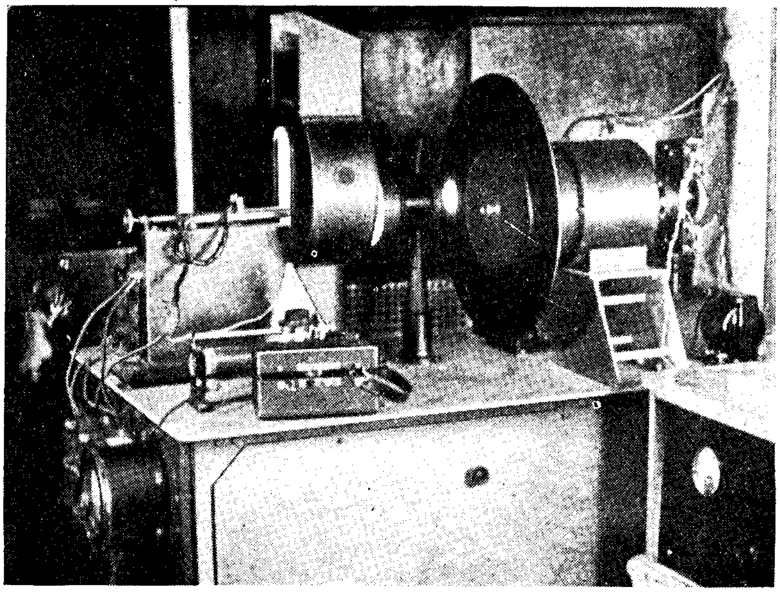
During the past year, the application of the intermediate photographic film to the problem has resulted in great improvements in big screen television. It is now possible to project pictures which will bear comparison with the cinema as regards size and definition.

Fig. 2 shows how the process is carried out by the Fernseh Company in Germany. The signals from a high-definition receiver are fed to a Kerr cell which serves to modulate the light from a high-intensity arc lamp. This modulated light is caused to scan a photographic film by means of a disc of lenses. The film is then subjected to chemical processing and after drying is passed through a standard cinema projector and the image thrown on to a screen.

Reducing Flicker

Owing to the fact that in the last operation the picture is projected as a whole, it is possible to use flicker blades as in motion picture practice. The whole process can be carried out in less than a minute, and in order to keep the sound and vision synchronised the former is recorded on the film at the same time as the picture.

As a result of these new developments it will soon be a common occurrence to see events on cinema screens a few seconds after they have actually happened.



The 30-line transmitter used with the bank of lamps system.

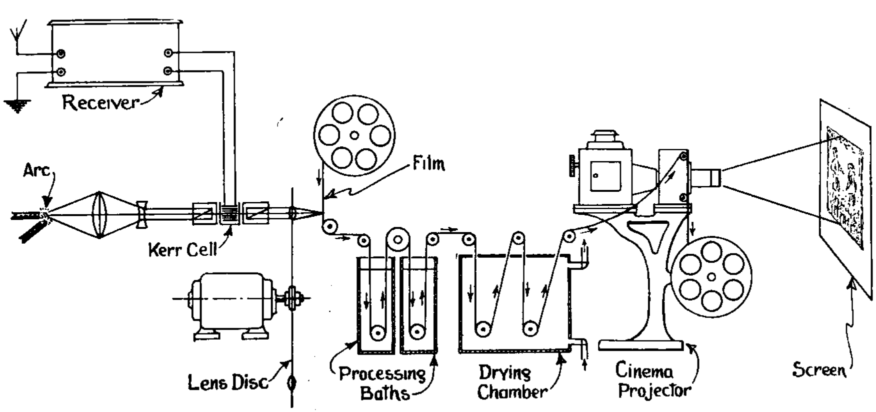


Fig. 2.—Schematic diagram showing the principle of the intermediate-film receiver. The Baird Co. obtain very fine results with an intermediate-film transmitting system.

Amplifier Noise

Background noise in amplifiers is of two main types (leaving out leakage and similar effects which arise from defective construction or workmanship). First there is the " shot noise " in the valves. This arises from uneven electron emission. The electrons are not emitted regularly and uniformly, but tend to come off in groups or clumps so that the anode current is not steady, but varies very slightly the whole time.

When the signal to be amplified is very small the anode current variations are comparable with those produced by the shot effect and thus a limit is placed on the amplification possible.

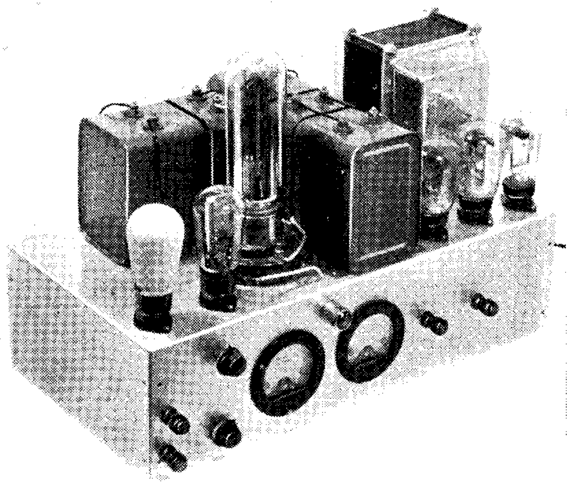
The second effect is known as " Johnson noise." It arises from thermal agitation of the electrons in the material of the impedances and resistances used in the amplifier. This effect increases as the value of the impedance increases and also depends on the temperature being greater at high temperatures.

Generally speaking, an amplification of between 10,000 and 50,000 is the maximum possible in a photo-cell amplifier and the gain is often less than this.—J.H.R.

Television Transmission Technique

The Baird Company stress the point that modern high-definition television is closely akin in technique to the production of talking pictures and has no relation whatever to the methods in common use for broadcasting. The broadcast technician, it is contended, is completely lost when he enters a modern television studio; a talking picture technician, however, is able to appreciate the duties and values of the camera man, the sound recording engineer, the lighting expert, the studio designer or art director, the make-up man, the projectionist, the film editor, the photographic developing and printing expert, who correspond to their respective technicians in the film industry.

In addition the television engineer has an art and experience of his own, mingling with the research expert on electron tubes, the photo-electric cell specialist, and the photographic research chemist. Not a single one of these types is to be found in the broadcasting studio or station. Furthermore, the ultra-short wave radio transmission engineer has worked and solved the problems of an entirely new radio technique, not yet touched in any other radio field.



This amplifier is a high-class instrument. The first meter is in the grid of the ES75H and is used to check distortion. In the output of the ES75H is the second meter.

A Speech Amplifier with 18 Watts Output

This amplifier was designed by **Kenneth Jowers** *for general laboratory purposes. It is a high-class instrument and can be used for a variety of purposes, among which may be mentioned the modulation of a transmitter, the amplification of the output from a radio receiver for mirror-drum television and as a powerful amplifier for public-address work.*

A POWERFUL amplifier should not in any circumstances give bad quality or overload. It has many uses. Generally, power amplifiers are rather difficult to get going in a satisfactory way. The input valve may overload, unless it has a wide enough grid base and then, perhaps, the output is insufficient.

Rarely is a large enough output valve used. I have often seen pentode valves used after two low-frequency stages, while it is quite a common occurrence for valves of the DO24 type to be used after two low-frequency stages when the driver valve is of the power type. Consequently, it is not surprising that distortion is set up when the amplifier is being run at full volume.

18 Watts Output

With this speech amplifier the undistorted output can be increased up to 18 watts, and with the output valve taking 75 milliamps at a thousand volts there is not the slightest trace of flicker on either the grid or anode meters.

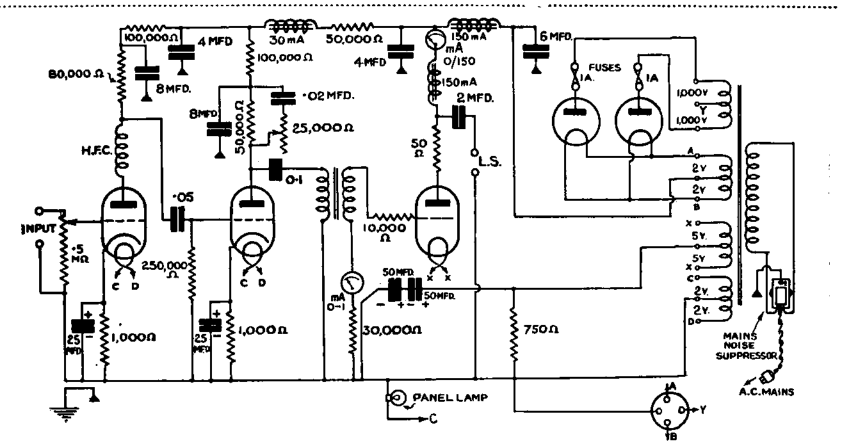
With an input of .75 volt R.M.S. each stage is fully loaded, but not overloaded, and when it is being used to modulate the transmitter there is no need to worry about distortion on well-modulated records.

A microphone fed into the first valve through a 25-1 transformer gives about 80 per cent. loading of the output valve.

This amplifier consists of two low-gain stages, resistance-capacity coupled in the first stage, with parallel-fed transformer following. Across the anode resistance in the second stage is a tone-correction circuit consisting of a .02-microfarad condenser and a 25,000-ohm variable resistance.

.02 is not a very big capacity for the condenser, but I did not wish to cut off all the top notes but only to remove needle scratch.

The mains transformer is specially designed for use with this amplifier and has a secondary giving 800 volts. This voltage is high enough, because I am using mercury-vapour rectifying valves which only drop 15 volts, while the D.C. output is fed into a 6-microfarad oil-immersed condenser. The actual voltage applied to the ES75H after allowing for voltage drop through free bias and choke resistance is approximately 1,050 volts. This voltage is then reduced still further to 200 volts and applied to the first two indirectly-heated valves.



Three valves are used in the low-frequency section and three in the mains section. One of the latter valves is actually a delay switch.

Delayed Switching

With the gaseous type of rectifier it is essential that some reliable means of delayed switching be employed, otherwise the valves are inclined to arc over. After trying various systems of mechanical switching, I finally decided to use the Mazda DSL/1 thermal-delay switch. This switch, mounted in vacuum in a similar way to a valve, is connected in the negative return to the high tension. With four volts applied to it the actual delayed time is approximately 50 seconds, sufficient to allow the first two indirectly-heated valves time to warm up.

Care must be taken, however, when making alterations to remember that this switch also takes 50 seconds to cool, so that if you make a slight alteration and switch on again immediately you will put an undue strain on the fixed condensers and rectifying valves.

Talking about fixed condensers, the new Dubilier oil-immersed type will stand considerably more than the average voltage that will be applied to them in this amplifier. In fact, every component will stand an overload of 30 or 40 per cent.

When using over 500 volts, several precautions have to be taken to prevent any flash-over to the chassis. As an example of what I mean, the lead-out wires from the mains transformer come through the chassis. Even though you

:: :: A General-purpose Power Amplifier :: ::

COMPONENTS FOR 18-WATT AMPLIFIER.

CHASSIS.
1—Aluminium, 20 × 10 × 5½ ins. (Peto-Scott.)

CONDENSERS, FIXED.
1—.05-mfd., type B770. (Dubilier.)
1—.0002-mfd., type 670. (Dubilier.)
1—.1-mfd., type B770. (Dubilier.)
2—25-mfd., type 3001. (Dubilier.)
2—50-mfd., type 3003. (Dubilier.)
3—4-mfd., type 951. (Dubilier.)
2—2-mfd., type 951. (Dubilier.)
1—8-plus-8 mfd., type BE 362. (Dubilier.)
1—.02-mfd., type tubular. (Dubilier.)

CHOKE, HIGH FREQUENCY.
1—Screened choke, type H.F.P. (Wearite.)

CHOKES, LOW-FREQUENCY.
2—Set-makers' type 150 milliamperes. (Savage.)
1—Set-makers' type 30 milliamperes. (Savage.)

HOLDER, FUSE.
1—Twin holder, type F10. (Bulgin.)

HOLDERS, VALVE.
5—5-pin chassis type. (Ferranti.)
1—Johnson 50-watt Isolantite power socket. (Lyons.)

INTERFERENCE SUPPRESSOR.
1—type 1118. (Belling-Lee.)

METERS.
1—0/1 milliampere, type 27F. (Ferranti.)
1—0/150 milliampere, type 4F. (Ferranti.)

TERMINALS.
4—Insulated type B, marked 2 input, L.S. plus, L.S. — (Belling-Lee.)

RESISTANCES, FIXED.
2—1,000-ohm, 1-watt, type. (Franklin.)
1—250,000-ohm, 1-watt, type. (Franklin.)

RESISTANCES, FIXED (Continued).
1—30,000-ohm, 1-watt, type. (Franklin.)
1—10,000-ohm, 1-watt, type. (Franklin.)
1—50-ohm ohmite, 1.5-watt, type. (Graham Farish.)
2—50,000-ohm, 3-watt, type. (Erie.)
1—30,000-ohm, 3-watt, type. (Erie.)
1—100,000-ohm, 3-watt, type. (Erie.)
1—80,000-ohm 3-watt, type. (Erie.)
1—750-ohm type PR4. (Bulgin.)

RESISTANCES, VARIABLE.
1—500,000-ohm potentiometer. (Erie.)
1—25,000-ohm potentiometer. (Erie.)

TRANSFORMER, LOW FREQUENCY.
1—1-1.75, type AF7. (Ferranti.)

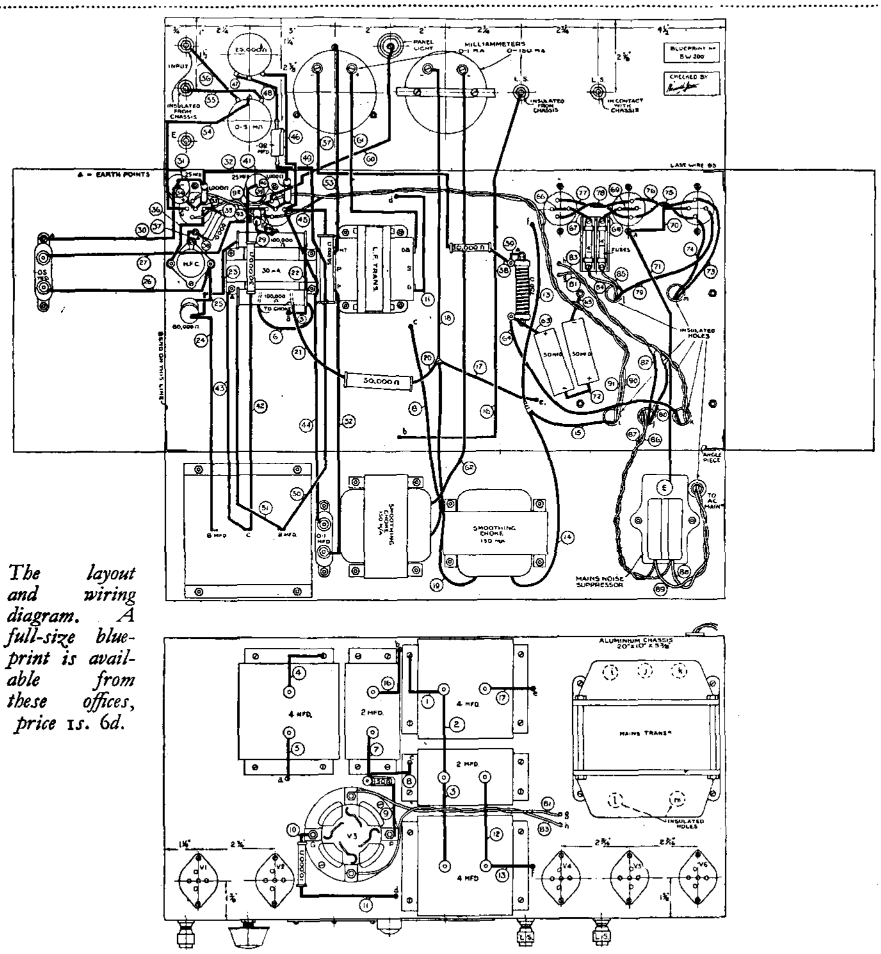
TRANSFORMER, MAINS.
1—type T125. (Vortexion.)

PICK-UP.
1—Piezo Electric. (Rothermel.)

VALVES.
1—ES75H with carbon anode. (Mazda.)
1—41MHL met. (Cossor.)
1—ML4. (Marconi.)
2—MU1. (Mazda.)
1—DSL/1. (Mazda.)

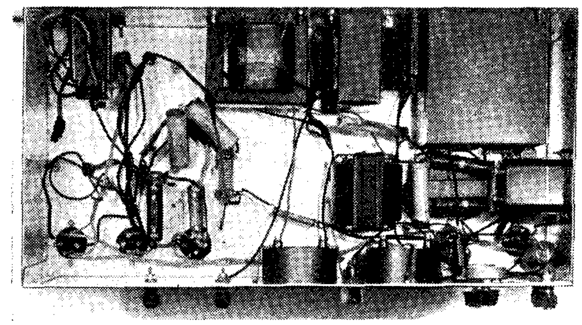
SUNDRIES.
1—dial light, type D9. (Bulgin.)
5 dozen locking washers. (Bulgin.)
6—¼-in. bushes. (Bulgin.)
1—6-volt bulb. (Bulgin.)
6 dozen 6BA nuts and bolts. (Peto-Scott.)
2,000 volt tested sleeving. (Goltone.)
18-gauge tinned copper wire. (Goltone.)
4—2BA nuts with bolts. (Peto-Scott.)

A complete kit of parts can be obtained from Peto-Scott, Ltd.



The layout and wiring diagram. A full-size blueprint is available from these offices, price 1s. 6d.

use a hole of about half an inch diameter, the high-tension wires will flash over to the chassis. To obviate this, these holes must be bushed with ebonite and care should be taken to see that the high-potential wires are kept clear from the chassis.



An underside view of the chassis showing how most of the heavy components are bolted to the rear side.

In series with the anodes of the rectifying valves is a twin fuse holder. You will find it a distinct advantage to suspend this fuse holder in the wiring and not to bolt it in the chassis. The first time that the amplifier was tested there was an immediate short-circuit owing to one side of the fuse flashing over to the chassis, via one of the fixing bolts. It is essential that every nut should be kept in place by means of a shakeproof washer. If you do not do this, after the amplifier has been in use for a few weeks all the nuts come loose.

Hum is negligible, but only if you use the amplifier in a sensible way. The pick-up leads must be screened, earthed and be relatively short, while the loud-speaker leads must be kept away from the grid side of the amplifier.

If you intend to amplify the output from a radio receiver then independent earths must be used for both units. When used as a modulator for a transmitting circuit a single lead from the positive side of the output stage has to be taken to the oscillator, again through a screened earth lead.

Simple Assembly

Construction should not present any difficulties. The chassis is of heavy-gauge aluminium and even the largest holes, for the valve holders, can be cut out by means of a woodworker's brace and a 1¼-in. centre bit. With the exception of four, all of the fixing bolts are 6BA.

It is advisable to wire up the valve holders before the low-frequency chokes and the 8-plus-8 decoupling condenser are mounted.

Remember to mount the AF7 low-frequency transformer before the power-type valve holder, otherwise as the valve holder is directly above the

(*Continued at foot of next page.*)

Directional Aerials for Short-wave Transmission and Reception

From Lloyd G. Morse, W1CAA, Boston, Mass.

Here are some interesting details about special aerials used in America by go-ahead amateurs. These details were part of a letter received from W1CAA telling us how he makes sure of his long-distance contacts

INTERESTING experiments with directive or beam aerials on the higher frequencies have resulted in some useful data being obtained. An aerial that will appeal to many listening stations is the twin flat top arrangement shown in Fig. 1.

How many readers have found that by using two aerials placed at an angle to one another the amount of fading is decreased?

Both for receiving and transmitting I suggest that two receiving aerials are

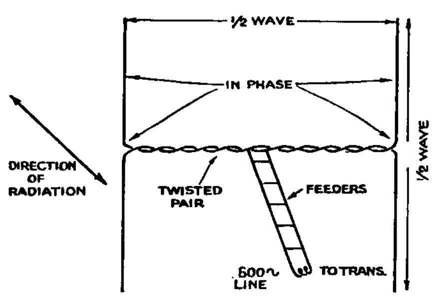


Fig. 2.—This transmitting aerial can be used on any wavelength. The interesting feature is the angle of radiation.

quite effective, when the two aerials are at right angles to one another. You will find that when a signal received on one aerial begins to fade it will invariably be received at good strength on the second aerial.

This theory works out well in nine cases out of ten and I have proved that it results in a much greater amount of D.X. being worked.

Over here we are using a single-pole double-throw switch located near the receiver so that we can switch from one aerial to the other with the minimum amount of trouble. The system does not appear to be very effective on the broadcast bands; in fact, the higher the

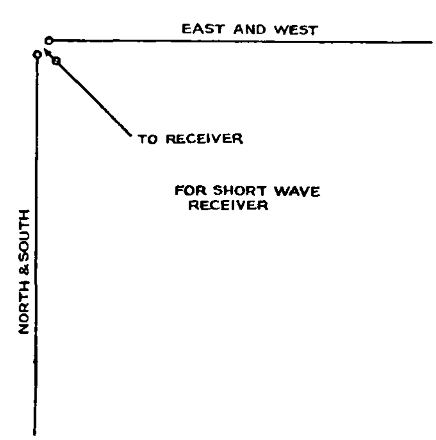


Fig. 1.—One of the most interesting American ideas for a receiving aerial. A single pole double-pole switch is used, so either aerial can be switched into circuit without trouble.

frequency the greater the noticeable gain.

Now as regards transmitting aerials there are several arrangements being used with great success, but generally the final array chosen depends on the amount of room available. An aerial we have taken from the Dutch PAOLL is about the simplest type of radiator that puts the signal across. You can see from the diagram in Fig. 2 that it consists of a 600-ohm transmission line coupled to half-wave radiators. Make particular note of the angle of radiation, a point which you Britishers seem to forget.

Have you ever tried the aerial shown in Fig. 3? Here you have one live and one dead feeder usually half wavelength. The angle of radiation is again an interesting point as it is almost opposite to the half-wave radiator.

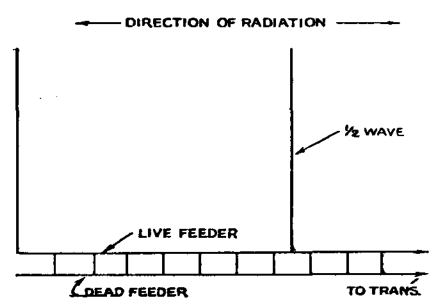


Fig. 3.—With this aerial the angle of radiation is between the two half wave radiators. The feeders are of the conventional spaced type.

For five metres the same systems are being used with wonderful success, but, of course, they must be cut to the frequency required. We are satisfied over here that the aerial is 90 per cent. of the station. Fellows with ten watts and directive aerials are doing much better work than the big fellows with 1,000 watts and any old kind of aerial roughly erected.

"A Speech Amplifier with 18 Watts Output" *(Continued from preceding page.)*

transformer you will have some difficulty in mounting it.

The two variable resistances, one used in the tone-correction circuit and the other as a volume control, need not be insulated from the chassis providing you use the specified resistances, for these have isolated spindles.

There are four type B Belling-Lee terminals. These are supplied with special insulating bushes, and, before the amplifier is tested, try these terminals for insulation between spindle and case. You will notice that two of them should show a continuous circuit, while the remaining two should be isolated.

Across the 750-ohm bias resistance for the ES75H are two 50-microfarad electrolytic condensers. These are joined in series so as to halve the capacity and double the effective working voltage.

Although on the surface you might feel that the thermal-delay switch can be heated from any of the heater supplies, this is not so. You might be tempted to parallel the delay switch with the heaters of the rectifying valves, in which case there will be a short-circuit across the H.T. The delay switch must be in parallel with the two IDH low-frequency amplifiers.

A final word on the operation of the ES75H. It should be of the carbon-anode type, in which case it will keep perfectly cool, but if you are using one having a molybdenum anode this will be comparatively hot and the anode will go cherry red. You must make sure that the anode current does not rise above 75 milliamps. You can control this by merely varying the value of the bias resistance. The resistance specified is supplied with an adjustable clip.

PICTURE UNITS, SCANNING LINES AND FREQUENCIES

SOME BRIEF NOTES EXPLAINING THE REQUIREMENTS OF HIGH-DEFINITION TELEVISION.

TWO hundred and forty lines—twenty-five pictures per second, are two of the standards laid down for television by the Television Committee—that is to say, eight times the number of lines and twice as many pictures per second than the present 30-line low-definition television broadcast. Some people think this is too much of a jump into the future; they say a hundred and eighty perhaps, but the extra sixty they never considered—quite forgetting that in the television laboratories the world over 400-line pictures are being experimented with.

Obviously, the more advanced low-definition television experimenter has got to turn to and handle something rather different. The mechanical scanner seems about to give way to the cathode-ray tube.

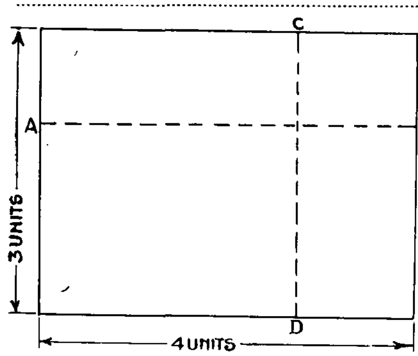


Fig. 1.—Diagram showing the unit area of the 4×3 picture.

Picture Shape

Other standards for the new service, such as shape of picture, horizontal or vertical scanning, and methods of synchronising, have not been published. The shape of the picture will undoubtedly be the same as the cinema picture, namely, four units wide and three units high. This 3:4 ratio is that of the old silent films; the advent of "talkies" produced a more square picture, which has again given place to the original 3:4 picture. There is also little doubt that horizontal scanning will be employed, for two reasons. First, more definition is transmitted for a given number of lines if the spot traverses along the greatest dimension, and secondly, it is very much easier to televise cinema films with horizontal scanning, than with vertical scanning.

It is interesting to note that though most high-definition pictures from the living object are produced by electronic devices, that those from films use mechanical ones, and in this respect the writer suggests that it is perhaps not impossible to use a sort of converse arrangement at the receiving end—anyway mechanical televisionists can turn it over in their minds.

High-definition Frequencies

Now let us see what frequency band this new service is likely to require, assuming a 3:4 picture horizontally scanned. Such a picture will have 240 elements along CO, Fig. 1, and $\frac{4}{3} \times 240 = 320$ elements along AB, that is to say, the scanning spot area is contained 76,800 times in the area scanned, which is 36.6 times more than in the present 30-line picture. Therefore the definition will be some 36 times better than at present, provided every link in the chain is at the same degree of "goodness." Had the same picture shape as at present used on 30 lines been retained the improvement would have been 64 times.

As to the actual maximum frequency required for satisfactory results in a television picture, various workers are not quite in agreement. Some say the first zero frequency, others half that amount. The first zero frequency is given by the number of picture elements in the width and height of the scanned area by the pictures per second. For example: $240 \times 320 \times 25 = 1{,}920{,}000$ for the probable picture of the new service, as against $30 \times 70 \times 12.5 = 26{,}250$ of the present picture radiated.

Actually the first zero frequency never exists as a fundamental. In low-definition television it has always been considered desirable to use up to the first zero frequency. Pictures so produced always have better definition in one direction, that of spot traverse, than the other, so much so in fact that the writer has heard it criticised as a form of distortion, though on the other hand reduce the frequency band to half the zero frequency and the resulting picture noticeably looses crispness.

With high-definition, however, it does not appear to be so important and most workers work to half the zero frequency. The reason for this is really quite obvious. In low-definition an area 1/1,000 of the whole area of view is about all you can expect to see reproduced, while in high-definition about 1/36,000 will be the limit, which will be sufficient for most purposes one would imagine for viewing by a television link.

For example, 13 lines of TELEVISION AND SHORT-WAVE WORLD print would

Lines.	Pictures per sec.	Picture shape.	Elements along 1 line.	Total No. of elements.	Maximum frequency.	Approx. max. frequency.
120	25	5 : 6	144	17,280	216,000	220 kc.
120	25	3 : 4	160	19,200	240,000	240 kc.
180	25	5 : 6	216	38,880	486,000	490 kc.
180	25	3 : 4	240	43,200	540,000	540 kc.
240	25	5 : 6	288	69,120	814,000	820 kc.
240	25	3 : 4	320	76,800	960,000	1,000 kc.

$$\frac{\text{lines}^2 \times \text{width} \times \text{pictures per second}}{\text{height} \times 2} = \text{maximum frequency.}$$

Fig. 2.—Table showing the frequencies required for various scanning line frequencies.

(Continued at foot of next page.)

A Test of The 1-V-1 Band-Spread Short-wave Receiver

B.R.S. 1374, Jack Wilson the Secretary of the Wishaw and District Radio Society, has tested our Band-spread Receiver described last month. He comments on the exceptional performance on the 20-metre band.

BEFORE giving a brief outline on the performance of the 1-V-1 Band-Spread Short Waver, I would like to congratulate Mr. Jowers on giving something worth while for the needs of the short-wave enthusiast. This is a receiver capable of providing world-wide reception and being very simple to operate is free from the usual run of snags one generally encounters in a short-wave receiver.

One point worthy of note is that whatever adjustment is required on the aerial series condenser, no variation of the reading of the tuning condensers take place. This enables one to have the dial readings taken and the set permantly graphed out, and is a great advantage. The set was also very stable and free from hand capacity effects on all three aerial systems which I used, viz., 40-ft. high 66-ft. Hertz with Eddystone crossfeeder blocks, 30-ft. high 33-ft. Hertz with doublet and an inverted L type 66-ft. long.

I took a rough plot of the dial readings, and with the band spreader set at 90 degrees the following wavebands were found :—

Coil No.	Metres.	Degrees on tuning condenser.
1	25	85
1	20	42
1	19	30
2	50	150
2	40	100
2	31	12
3	80	100
3	75	80
4	80	30
4	160	100

On trying out the receiver my expectations were exceeded, the band spreading being easily one of the finest points I have discovered. Operation is smooth and silent. The all-metal cabinet, while adding to appearance, assists in cutting out local interference. This cabinet, although compact, houses the L.T. and H.T. batteries. The H.T. battery, by the way, only gave a reading of 110 volts.

On Saturday afternoon, the 9th instant, on my invitation, some members of Wishaw and District Radio Society, which included G2DI, called and heard the 1-V-1. The 19-metre broadcast and 20-metre amateur bands were explored and some very fine American transmissions were heard up to 18.00 G.M.T. All agreed that it was truly a very fine set and, given good conditions, would pull in anything.

G.M.T.	Station.	M/c.	R.
00.30	G5VL	3.5	8
00.35	PAOHJ	3.5	6
10.15	PAOUV	7	6
10.20	PAODK	7	7
10.24	F8WY	7	6
10.30	G5PP	7	7
10.35	G5KA	7	4
10.45	G2XO	7	8
10.50	G2MV	7	8
13.00	W8GYY	14	4
13.05	K4SA	14	5
13.10	W1CRW	14	5
13.45	WQP	13	8
14.45	W3BPP	14	5
14.50	W2GOQ	14	6
15.55	W3MD	14	5
16.00	W1GPE	14	8
16.15	W1AHI	14	8
16.25	W3TV	14	4
19.15	W2ADE	14	4
19.17	CT1BY	14	7
19.20	W2DC	14	8
19.30	W2EDW	14	6
19.45	K4SA	14	7
19.50	W2ZC	14	7
19.55	W3MD	14	6
20.05	K4SA	14	8
20.20	K4SA	14	8
20.21	W1CMD	14	4
21.45	G2MG	14	7
21.50	K4SA ?	14	1
23.25	VE1EI	3.5	6/7
23.30	G6LL	3.5	7
23.32	G5VL	3.5	7/8
23.33	PAOGA	3.5	8/9
23.40	PAOPCM	3.5	8/9

My log, which is all telephony stations, covers various times on Sunday and does not include the many broadcast stations which I heard. At 15.15 G.M.T. I went over to the 31-metre band and found VK2ME Sydney coming in a nice R7. He was playing gramophone records.

At 21.45 G.M.T. I tried the 20-metre band and all was dead, except for a very weak carrier which was just on K4SA's frequency. I turned the band-spreader a few degrees and against the very silent background I heard a strong carrier and an announcement: "This is G2MG testing," he was R7 and a perfect signal.

"Picture Units, Scanning Lines and Frequencies"

(*Continued from preceding page.*)

fit into a 3:4 ratio picture, which would allow over 9 lines per row of type, which would be ample for reproduction.

Fig. 2 is a table, which shows the maximum frequency for 120, 180 and 240-line pictures of 3:4 and 5:6 picture-shape, horizontally scanned. The maximum frequency being based on half the first zero frequency. Such a frequency standard is set by a scene composed of alternate black and white vertical lines each one spot's width. Similar black and white horizontal lines might, however, not be reproduced at all, if it should so happen that the spot travelled along half of one and half of the other; in this case the receiver screen would go to a uniform tone between maximum and minimum intensity. This, of course, would be true of any number of scanning lines and maximum frequencies, so even with super high-definition, certain "scanning distortion" must take place. But who wants to televise horizontal black and white lines of one spot width?

Matched-impedance Feeders

By Malcolm Harvey.

This method of coupling the transmitter to the feeders is generally used in America. Amateurs in this country have received the idea with mixed feelings.

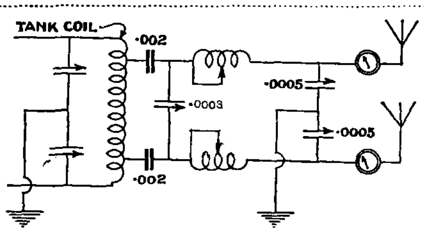
MANY short-wave amateurs are experimenting with the matched-impedance arrangements, as shown in the diagram, and in some cases have met with marked success. It will be seen from the circuit that the arrangement consists of a completely tuned aerial system which is indirectly coupled to the tank coil.

In one instance where I saw the arrangement demonstrated there was a marked increase in radiation on both the 3.5 and 1.7 mc. bands. On the top band radiation increased from .5A to .8A, quite a healthy increase.

Radiation v. Feeder Current

In talking of radiation I am rather misleading you for aerial current was really meant, a very different matter. Even so, the station in question is receiving reports showing that the signals are getting out with an increase in strength of up to 20 per cent.

The tapped inductances in series with the feeders are easily made up on 2.5 in. formers with 16 gauge wire



A matched-impedance feeder circuit.

Here are the turns for the various bands :—

160 metres	30 turns.
80 metres	20 turns.
40 metres	15 turns.
20 metres	10 turns.
10 metres	5 turns.

One big point in favour of matched impedance, not counting the almost certain increase in radiation, is the claim that interference to B.C.L.'s is greatly decreased.

5UK tells me that his broadcast receiver working in a room below the transmitter is not affected by key clicks.

The arrangement is quite easy to operate. The tank coil should be tuned to give maximum dip with the feeders removed. Next, connect the the feeders when the current in the tank coil will rise and must be corrected by tuning the .0003 mfd. condenser across the feeders.

All that is left to do is to adjust the tapping on the inductances in series with the feeders and tune the aerial series condensers to give maximum radiation.

Suppressor Grid Modulation

WE have been hearing quite a lot lately about the wonderful characteristics of the Raytheon RK-20 R.F. power pentode. Although there are very few of these valves in use in this country they are in use in G5UK's new rig and are giving excellent results.

In this new transmitter G5UK has suppressive-grid-modulation using two of these RK-20's in push-pull. The first QSO was with Spain and Algiers on 7-megacycles R9 phone.

The RK-20 is of the filament type R.F. pentode for use as a suppresser grid-modulated-oscillator or R.F. amplifier. Owing to the low control grid-plate capacitance it is possible to use a plate load circuit tuned to the fundamental in crystal or electron-coupled oscillator circuits, such as the Tri-Tet.

Using crystal control, 50 watts R.F. can be taken from the plate-load circuit without overloading the crystal. The great advantage is that only 1-watt R.F. is required for excitation of the RK-20 operating as an R.F. amplifier and less than 1-watt low-frequency input is sufficient for 100 per cent. modulation using the suppresser-grid method.

These valves are supplied with five-pin bases and a top cap, this being the anode connection. The overall height from pins to cap is 8¾ inches with a maximum diameter of 2 1/16 inches.

The general characteristics are approximately as follows :

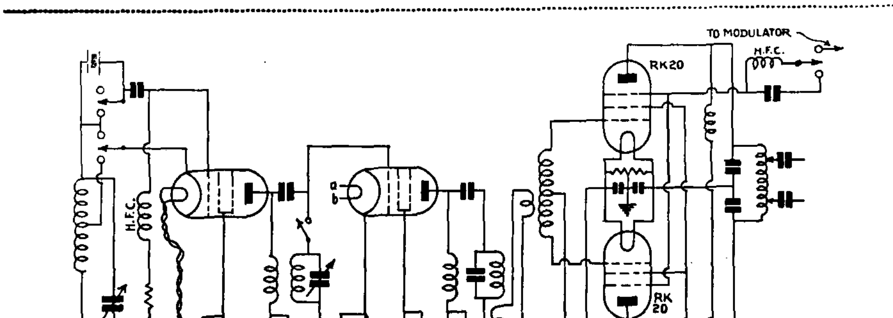
Filament voltage,	7.5 volts.
Filament current,	3 amperes.
Anode current,	28 milliamperes.
A.C. resistance,	500,000 ohms.
Amplification factor,	1,500
Grid to plate trans-conductance,	3,000 micro-ohms.

When used as a radio-frequency power amplifier, class-B or suppresser-grid modulated amplifier or oscillator, the maximum anode potential is 1,250 volts with a maximum screen potential of 300 volts. This gives an anode current of 65 milliamperes with a maximum anode dissipation of 35 watts. The maximum radio-frequency grid current is 5 amperes.

Other details which are worth noting are that the carrier output is 16.5 watts while the peak power output is 66 watts. The peak low-frequency voltage for 100 per cent. modulation is 90 volts.

In operation either as an oscillator or a radio-frequency amplifier the circuit has to be adjusted so as to give the lowest D.C. current possible with sufficient excitation to provide the rated output. Usually, a value of between 5 and 10 milliamperes will give maximum power output with highest screened grid efficiency.

In Fig. 1 you will see just how these RK-20's are used. This is the circuit at present in use at 5UK.



The best way to use the RK20's is in push-pull. G5UK suggests this arrangement which he has found to be especially good.

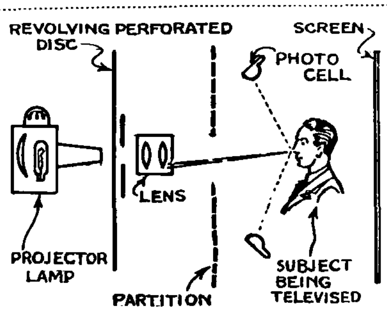
FOR THE BEGINNER

THE BASIC PRINCIPLES OF TELEVISION

AS EXPLAINED IN THE TELEVISION COMMITTEE'S REPORT

As a preliminary to the Television Committee's Report a simple outline of television principles was given. This was a clear exposition of the art as it is to-day and we reproduce it almost verbatim below. The diagrams shown are our own and have been included with the object of making the explanation more easily understood.

TELEVISION may be defined as the transmission by telegraphy and reproduction in transitory visible form of images of objects in movement or at rest. The equipment utilised usually consists of combinations of optical and electrical apparatus which at the transmitting or "pick up" end of the system convert the image of the object into electric currents, and of similar combinations at the receiving end of the system which resolve the electric currents into visible forms.



This diagram shows the elements of spot-light scanning at the transmitter in its simplest form.

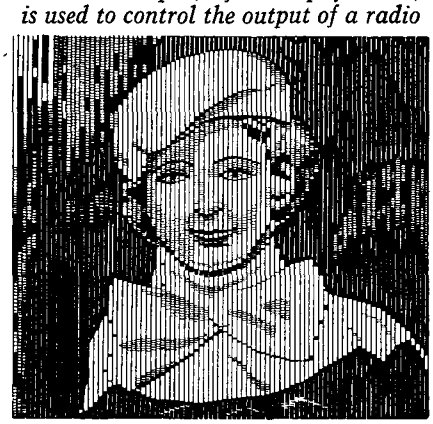
When an object is viewed by direct vision, light reflected from the object under observation impinges on the eye and is focused by the lens on to the retina where it stimulates nerve cells.

Each cell communicates with the brain, and the sensation of sight and the perception of any scene result from the relative stimulation applied to the brain by the cells in the retina. As the light-sensitive cells of the retina have finite dimensions, details in an object which produce an image on the retina smaller than a single cell cannot be individually perceived. The eye, therefore, really sees a large number of infinitely small objects, which in the aggregate form the image.

How the Picture is Built up

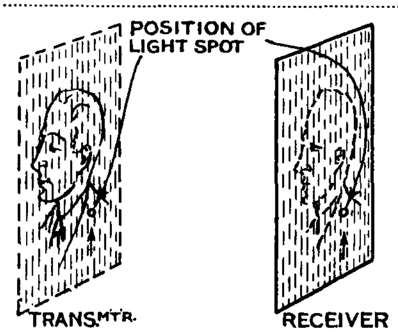
Thus all vision is of a granular structure, as is also pictorial reproduction, and, in order to transmit pictures or images over electric circuits, a suitable granular structure is adopted, the relative brilliancy of each grain or elementary area of the picture being transmitted telegraphically to the distant point, where by suitable means an equivalent brilliancy is given to a corresponding area on the receiving screen.

The transmission of the relative brilliancy of each grain or elementary area of the picture must be effected in some ordered sequence, and the process by which this is achieved is termed "scanning." The usual method employed is to allow light from a selected area of the subject to impinge on a device known as a photo-electric cell, which delivers an electrical output proportional to the light stimulation it receives. This electrical output, after amplification, is used to control the output of a radio transmitter by methods similar to those in use for the transmission of speech and music.



The composition of a televised picture.

The position of the selected area of the subject is varied in a definite path so that the whole of the subject is covered in a period which should be less than the time of persistence of vision. The path of selection is usually a series of horizontal or vertical parallel lines, and the process somewhat resembles the action of the human eye in reading a page of printed matter, letter by letter and line by line.



This diagram shows that it is essential that the spot position at the receiver corresponds with that at the transmitter.

A further refinement consists in making the path of selection run first along every alternate line and then, as a second process, along the lines omitted in the first process. This is known as interlaced scanning, and it appears to be successful in reducing "flicker."

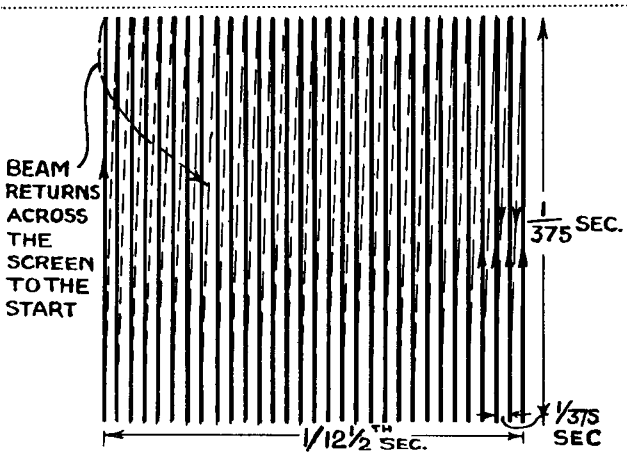
At the receiver, the radio signal is detected and amplified by methods similar to those used for radio-telephony. The electrical signal from the receiver thus resembles the signal from the photo-electric cell or cells at the transmitter, and is used to control the brilliancy of illumination of an elementary area of the screen on which the received picture is to be displayed.

It is essential to arrange that the area illuminated on the viewing screen at any given instant shall

AN EASY GUIDE TO TELEVISION

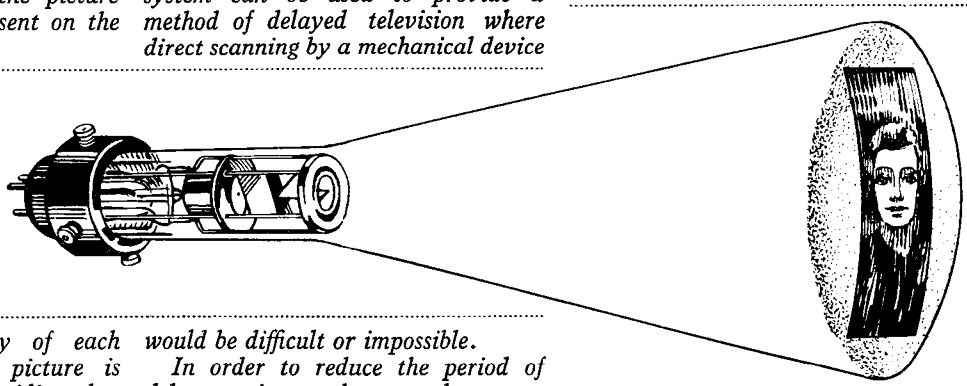
correspond in position with the area of which the illumination is then being determined by the scanning device. In other words, precise synchronism is necessary between the movements of the scanning device and the receiving device.

Various methods have been proposed for achieving this synchronism; it can, for instance, be accomplished



This diagram shows the spot traverse on the screen of a cathode-ray tube; the return traverse is so fast that it is not discernible; in the diagram it is shown dotted. Thirty-line scanning is represented by this drawing.

by the sending of two series of special synchronising signals by the transmitter—one series to ensure the correct motion of the picture spot along each line and the second series to signal the instant of termination of one picture and the commencement of the next. As these series of signals occur respectively between successive lines of the picture and between successive pictures, their transmission need not interfere with the picture signals, and they can be sent on the same radio transmitter.



Sketch showing the electrode assembly of a cathode-ray tube. The picture is produced on the end by the impact of a moving beam of electrons on the special fluorescent coating on the inside of the end of the tube.

The relative brilliancy of each successive grain of the picture is transmitted with such rapidity that persistence of vision produces the effect at the receiving end of a complete picture, the degree of definition and steadiness of which is dependent upon the fineness of the individual grains composing the picture, i.e., the number of lines used for scanning it, and the speed at which complete pictures are successively transmitted.

Intermediate Film System

One of the difficulties which has been encountered in direct scanning is the small amount of light available to actuate the photo-electric cell obtained by reflection from objects which are being televised.

Accordingly, considerable experimental development has taken place upon a technique whereby the scene to be televised is first photographed on ordinary cinematograph film which, after being developed, is scanned by light transmitted through it. This system can be used to provide a method of delayed television where direct scanning by a mechanical device would be difficult or impossible.

In order to reduce the period of delay, equipment has now been produced in which the cinematograph camera is associated with the film scanner, and the film, after exposure, is immediately developed, fixed, washed and partially dried. It then passes through the scanner, and after further drying is stored for future use if required. In this way, the advances which have been made in photographic processes in the production of rapid and sensitive emulsions can be utilised to overcome the difficulties which are at present encountered due to the comparatively feeble sensitivity of photo-electric cells.

The Iconoscope

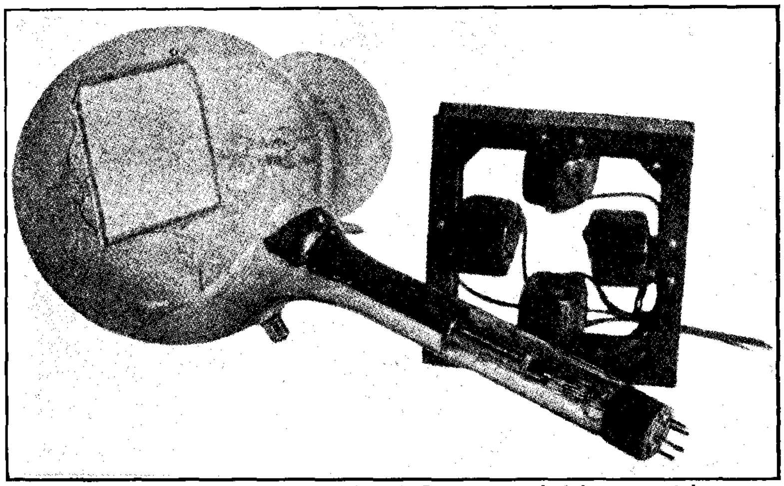
The direct scanning of open-air scenes and studio subjects without abnormally powerful illuminating devices has also been made possible by the use of cathode rays in combination with photo-sensitive surfaces or minute photo-electric cells. For instance, in one such device which is being developed in America, Germany and this country, the image to be televised is focused by means of lenses on to a photo-electric mosaic contained in a cathode-ray tube. The cathode-ray beam is directed on the surface of the mosaic and by a method of magnetic control the image is scanned repeatedly. Electrical energy is thus drawn off from the photo-electric mosaic by the cathode ray which is proportional to the light intensity of the picture and can be transmitted to operate the distant television receiver.

This system of "direct pick-up" has already attained a considerable degree of effectiveness, and satisfactory reproduction of outdoor moving scenes can now be attained by this method in conditions of light, etc., approximating to those under which satisfactory cinematograph pictures can be taken, provided that the recording apparatus can be located *reasonably close to and at a moderately constant distance from the scene to be televised. It is probable that satisfactory reproduction could, even at this stage of development, be obtained of such scenes as a procession, a lawn-tennis match, or the actual finish of a horse race, though the transmission of a view of the whole course of a race, a cricket match, or a football match, would present much greater difficulty.*

Frequencies for High-definition

For high degrees of definition and picture frequency, very high modulation frequencies are required, which in practice can only be handled by radio transmitters working on ultra-short waves, the effective range of which is much more restricted than the range of the medium waves used for ordinary sound broadcasting.

For the reception of high-definition pictures the cathode-ray tube is now usually employed. The cathode-ray tube receiver involves no moving parts, and the picture is presented as a fluorescence at the end of the tube. A stream of electrons (particles of negative electricity) is projected along the tube, and impinges on a coating of fluorescent material at the end of the tube, the impact of the electrons on the fluorescent material causing illumination. The amount of illumination can be controlled by varying the flow of electrons, and the point of impact can be changed by deflecting the jet by means of electric or magnetic forces. The jet is modulated or controlled in amount by the received signal, and suitable electrical circuits are provided to move the point of impact in exact synchronism with the transmitter.



A special type of cathode-ray tube—the Iconoscope—which has a special mozaic screen. This tube is used for direct scanning at the transmitting end in some systems of transmission.

THE ELECTRON MULTIPLIER

ONE of the difficulties in television transmission is that of obtaining sufficient response from the photo-cell. The amplification which can be used following the cell itself is limited by the incidental noise which is set up in the valves and the components themselves. At a relatively early stage these noise currents equal the photo-cell currents and make satisfactory working impossible.

To overcome this defect Farnsworth, in America, has devised a new form of valve called an electron multiplier. This device has two disc cathodes, one at each end of the tube. In between the two is a cylindrical anode, while around the tube is a coil producing a magnetic field.

The operation is as follows: Light falls on one of the cathodes which is coated with photo-electric material. Electrons are emitted and attracted to the anode. The magnetic field of the coil, however, prevents them from reaching the anode. It repels them from the outside of the tube and forces them to remain in the centre. Consequently the electrons move towards the middle of the tube with increasing velocity, shoot right through the anode and eventually hit the second cathode.

Here they cause secondary emission, releasing four or five times as many electrons and these secondary electrons start to travel back to the first cathode by an exactly similar process. In turn they liberate more electrons and the process goes on building up in this way. The time taken to travel across the tube is very small so that we may have ten successive actions in the space of one-ten-millionth of a second.

If with each stage we get a five-fold increase, this corresponds to a magnification of about 10 million. In some of the early tubes the current obtained was so large that the electrodes burnt out!

The action is usually assisted by connecting an oscillatory circuit across the two cathodes. This is tuned to about 50 megacycles and the effect is to aid the oscillating action of the electrons inside the tube. The cathodes are of special material designed to emit secondary electrons very easily.

Television, To-day and To-morrow, by Sydney A. Moseley and H. J. Barton Chapple. Price 7s. 6d. net (Sir Isaac Pitman and Sons, Ltd.). The fourth edition of this interesting book brings the reader right up to date regarding current television practice. All angles are simply dealt with including vision receivers of the disc, mirror-drum, and cathode-ray types. Several interesting chapters are devoted to ultra-short wave activities which are particularly interesting in view of the current trend of design.

One cannot realise how much television has progressed since the early days of the original Baird transmissions from Long Acre until the first chapters have been read. Much space has been devoted to the disc receiver, which is still being used for low-definition work. The beginner will be able to obtain valuable information on the fundamental principles of disc reception and will be able to gauge the advantages of the various systems.

There are 208 pages fully illustrated so the amateur will be able to grasp a working knowledge of how to construct or operate simple television equipment.

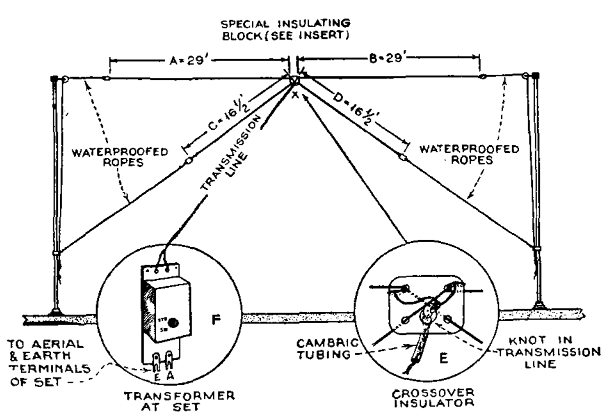
Interference-reducing Aerials

By G. V. Colle.

The growing use of short-wave receivers and the lack of legislation to prevent the generation of electrical interference makes the use of special aerials almost essential. The different systems are discussed in this article in a practical manner.

If local electrical devices radiate interfering H.F. waves more powerful than the prevailing static level, this static is received and little or nothing of the weak transmission. In consequence, the horizontal section of the aerial must be erected where possible above the level of surrounding objects, which means in effect a height of 20 to 30 feet above the roof level. It is certain that very few listeners provide such an efficient aerial unless absolutely forced to by interferences.

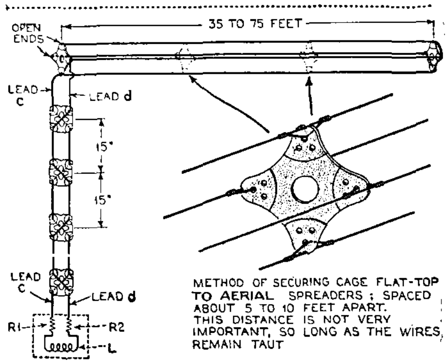
Applying the principles to short-wave reception, a feature of most of the systems now in force is to provide one or more single-wire aerials having natural wavelengths resonant about the middle of each band to be covered, and joining them together with a low-loss twisted or cross-over downlead (unscreened) of considerable length, so that the horizontal sections can be erected as high as possible and as far away from the source of interference and buildings as space will permit. Other systems make use of two equal horizontal aerials separated electrically but joined by insulators as a single length; the downleads are taken from the ends nearest the centre and twisted together or the now well-known cross-over insulators are employed.



The inverted V-type of aerial in addition to reducing noise-level acts, to a certain extent, as a directional aerial. In this way maximum strength can be obtained from any desired locality.

Tuned Aerials

Although various claims are made as to the ultimate effects, yet the fact remains that in all cases the aerials are so arranged as to provide the double downlead which, it is claimed, cancels out the interfering waves which impinge on it. By making the aerials also resonant in the range of frequencies covered, the long downleads (the inevitable result of raising the horizontal sections) do not cause excessive losses.



This type of aerial with a transposed down lead is very effective in reducing heavy locally-generated static. The loss in signal strength is slight.

These short-wave aerials give surprisingly good results as regards signal strength, but it is suggested here that the static-eliminating downleads are only effective if the interference is not too close and also provided the coupling to the aerial coil, via a small coupling winding connected to the ends of the transposed or twisted downlead, is purely inductive and in no sense capacitative.

Where the two aerials are unequal, and especially a single aerial with twisted downleads (one end being unconnected) is employed, some means of balancing the system must be effected. In such instances it is not uncommon to find small value resistances 40 to 100 ohms in series with the coupling coil.

Some makers employ a receiver impedance matching device, consisting of primary and secondary aperiodic windings, partly to match the aerial system to the receiver and partly to avoid the possibility of the user spoiling the effect by a capacitative coupling. The latter objective is achieved by inserting an earthed metallic shield between the windings on the impedance matching device.

According to the propounded theory of such a transformer, in-phase signals are eliminated, while out-of-phase signals are passed. In-phase denotes that the voltages of the two sides of the downleads go positive together and then negative together, corresponding to the interfering currents which are a direct pick up on both downleads. Such currents do not produce potential in the primary but are passed on to the grid of the valve only, where capacity exists.

Out-of-phase signals, corresponding to the aerial pick up are those causing one downlead to go negative when the other goes positive and vice versa, the alternating current then producing a primary current. For medium- and long-wave reception the transformer is short-circuited, which, of course, no longer renders the system static-free.

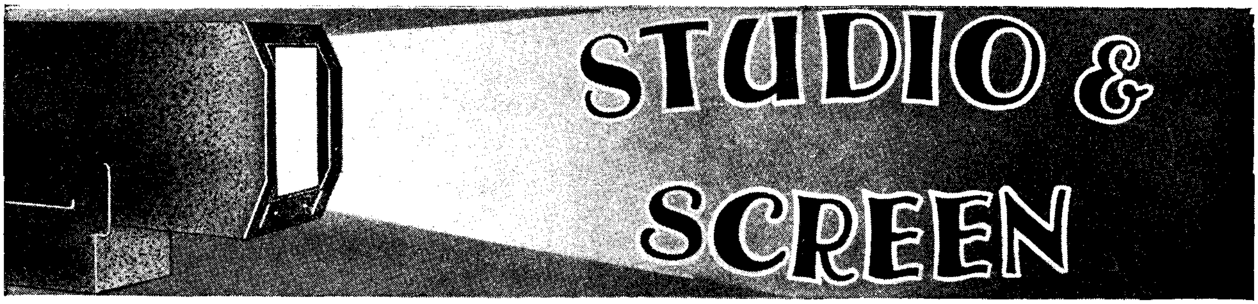
Use Transposed Downleads

It is not claimed that the aerial and downlead system are static-free without the screened transformer, which, if correct, would lead one to suppose that most claims in this respect for transposed downleads cannot be substantiated as there is little or no difference between the various types. From the point of signal efficiency they are unquestionably good.

The most effective device for aerials operating on normal wavebands is a low-loss ½ in. dia. screened downlead. This screened lead will completely eliminate most types of static picked up in the aerial system. There is, however, no reason to suppose that it would be other than effective on short wavelengths provided it is not used in unreasonable lengths, say, in excess of 20 feet. It is known to function effectively down to 100 metres and obviously if it can be employed on lower waves it renders a short-wave aerial unnecessary.

Car ignition systems are probably the worst offenders on short waves and

(*Continued at foot of page* 140.)



REVIEWS OF THE PROGRAMMES AND RECEPTION REPORTS

" Things are looking up,
Television's come to stay,
And its getting better,
Better, better every day "

(A parody of the popular number). Words by Eustace Robb, music by Noel Gay, of the theme song which has opened the programme each Saturday since the publication of the Television Report.

* * *

Gerald Cock, newly-appointed Television Director, has had a remarkably varied experience. When the war interrupted his roaming, he had been in the Western States of North America for six years, mining in Utah, cattle farming in California, and for a time acting as an explosive consultant. His travels took him from Mexico to Alaska. In 1915, he sailed for home and within five weeks of landing at Liverpool was in the front line in France as a sapper. After the war he became director of a film company and ten years ago joined the staff at Savoy Hill as assistant to Roger Eckersley, soon becoming Director of Outside Broadcasts.

A vigorous Englishman and a bachelor, it was chance that sent him overseas in the first place. Returning from a city luncheon, Gerald Cock happened to pause by the offices of a steamship company, and when he came out there was a ticket to New York in his pocket. Returning to the United States for a holiday last year, he discovered skyscrapers along Sunset Boulevard in Hollywood where his ranch used to be.

Outside scenes will eventually take an important place in television and Gerald Cock, with initiative and ingenuity, has already made O.B.'s one of the most popular features of sound broadcasting. It was he who planned and produced the first relay from the sound-track of a film.

* * *

For thirty months Eustace Robb has worked enthusiastically to produce programmes of the greatest possible interest within the limitations of a thirty-line picture. That he has succeeded in presenting programmes of distinction and variety, every looker who has followed developments will agree. Imagination, unremitting effort and a catholic taste have combined to produce this result and experience acquired in this pioneering effort should be invaluable in the future direction of television.

* * *

I do not claim to have invented the word " looker," which the Television Committee adopts in its report. Such a claim would be challenegd at once. All that I did two and a half years ago was to discard the suffix " in " from the term " looker-in," which was current at the time. This feature started when B.B.C. television programmes began and a simple word was needed to describe a user of a television set. From many alternatives I chose looker, and now that the Television Committee have used it it is certain to be standardised. Maybe it is not the best word, but no one has yet thought of a better. Anyway, it is simple, descriptive and alliterative when used in conjunction with listener, as it is bound to be in the future. Of other suggestions, viewer is a difficult word, scanner is ambiguous, watcher is unsatisfactory, and " televisionary " was always a poor joke as events are proving.

* * *

The test cards have been used several times during the month, not inartistically between scenes, but for a few minutes before close-down, whenever programmes have run short. Lookers find these queer designs useful in adjusting their sets, and the producer assures me that they will be seen at short intervals.

* * *

Two new receivers will be needed when high-definition transmissions start, as both sound and vision will be broadcast on ultra-short waves. Some observers had expected a

A television star at home —— Reita Nugent in her South Kensington flat.

medium wavelengths to be used for sound, and the addition of vision on an ultra-short wavelength to a programme broadcast for listeners on a medium wavelength is a possibility for the future which should not be excluded. Such an arrangement has obvious advantages, but for many years to come any programmes on the medium-waves must be produced primarily for listeners. A programme designed to please both lookers and listeners at once would probably end by satisfying neither.

On the ultra-short wavelengths transmitters and receivers will be developed freed from the frequency restrictions of a wavelength plan and if sets can be built to reproduce all the overtones of a symphony orchestra, Sir Thomas Beecham may yet become a wireless fan.

* * *

I liked the unrehearsed effect in the programme of February 13, when the piano was pushed into the picture from behind the curtain at the side of the studio. Figures strayed across my screen in an aimless way that was quite intriguing—so demonstrating the appeal of the unexpected. Whether intentional or not, the lapse was refreshing. Cyril Smith then appeared to give a short recital to fill up time and I was reminded of the early days of broadcasting when Cecil Dixon used to play the piano in any unexpected interval.

In the same programme La Taiga trilled like a bird while plucking the lyre, and Chief Os-Ke-Non-Ton appeared in a most elaborate costume. Did you spot the bears' teeth and ermine skins? These were visible in my visor.

Leslie Goossens, seen before her marriage as Leslie Burrows, gave an excellent interpretation of the clever "rush hour" dance. Masked as an insignificant male with a bowler hat and attaché case, she missed train after train in the crush and finally expired from exhaustion.

A spirited song by Gerald Kassen, as a drunken monk, was a feature of the programme on February 6. On the same evening Walter Gore was seen well in a comedy dance depicting the fate of men if women struck and left their husbands to hold the babies. He danced with several infants in his arms and possibly with tears in his eyes; but my set will not reproduce a detail like that in a distant shot.

For his song, "The Prisoners," Gerald Kassen wore chains, which were seen clearly on my screen as they clanked around, and Semenova, making her first appearance, and a charming picture, danced delicately about the studio.

And I must just mention a remarkable exhibition in an earlier programme—the "Continental"—which was given so adroitly by Ray and Geoffrey Espinosa in the style of Fred Astaire and Ginger Rogers in the film *Gay Divorce*.

The days of Cavaliers and their fair Ladyes portrayed by Patrova and Jules. Here they are showing an old English dance.

"Interference-reducing Aerials"

(*Continued from page* 138).

generally give out vertically polarised radiation. The vulnerable point is obviously the downlead so that if it can be screened a screened downlead should prove more satisfactory than complicated short-wave aerial systems. However, to make a short-wave set completely immune to man-made static, it should be completely enclosed in an earthed metal box, care being taken to keep the tuning coils small and away from the metal so that their fields are not affected.

H.F. Filters Useless

Normal mains H.F. filters are useless, but, if already fitted, must be augmented with heavy-duty short-wave chokes consisting of 4 to 12 turns of heavy gauge wire in series with each lead from the master switch. Condensers are not usually necessary, but, if used, should be of low capacity, say, .1 mfd. non-inductive and of the requisite working voltage.

Television for the Amateur Constructor, by H. J. Barton Chapple, Wh.Sch., B.Sc.(Hons.), A.C.G.I., D.I.C., A.M.I.E.E. (Sir Isaac Pitman and Sons, Ltd., price 12s. 6d.). The home constructor with little knowledge of the principles of television receiver construction and operation will be well-advised to consider this work of Mr. Barton Chapple. Starting off in simple manner it goes on to deal very fully with all aspects of television.

THE AMATEUR TELEVISION EXPERIMENTER

CATHODE-RAY TUBE EQUIPMENT

This article is one of a series which provides a complete guide for the amateur television experimenter. The information given will cover every phase of television.

WITH the advent of high-definition television, every experimenter should invest in a cathode-ray tube. The cost is, unfortunately, still high, but there is no piece of apparatus which will be found so useful in the laboratory or so adaptable for measurements or television reproduction on any number of lines. In order to make the fullest use of the tube it should be designed to be available for any measurement or for television with the minimum of trouble in changing connections. For this reason, some of the associated equipment described in this article is duplicated with minor alterations. This may seem extravagant, but is of great convenience in practice and reduces the possibility of mistakes that may occur when the apparatus is being re-wired for a different purpose.

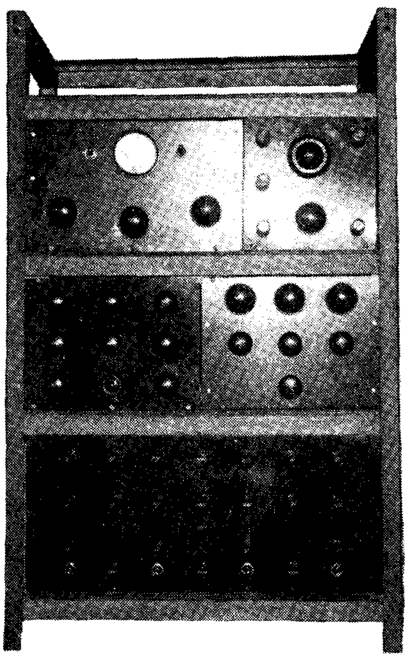


Fig. 2.—Front view of an experimental cathode-ray tube equipment adapted for television and various radio measurements. The rack is on the "unit" principle.

It is not proposed to give a list of all the uses to which the tube may be put—it would take a page at least! Some of these were outlined in the October issue, 1934, on p. 447, and others will be mentioned later in this series of articles under the appropriate subject. In the meantime the apparatus may be designed to be as flexible as possible, and to permit of the following measurements to be taken when desired:

(1) Peak value of A.C. volts with calibration.
(2) Ordinary audio-frequency waveform observations.
(3) Phase displacement in A.F. circuits.
(4) Frequency measurement.
(5) Television reproduction at any definition standard.

Since all these are to be done with the minimum of trouble in changing connections it is essential to provide an "exchange board" for the connections to the tube, and make these with flexible links between terminals on the front of the board. Such a panel is shown in the diagram of Fig. 1 and forms the lower panel on the complete rack shown in the photograph of Fig. 2.

The circuits illustrated are intended for use with a high-vacuum tube as it is certain that this will supersede the gas-focused type before very long. The accuracy obtainable with the high-vacuum tube is greater, and although the voltage required to operate it is higher, it is definitely of advantage in high-definition and radio-frequency work.

Exciter Unit

Commencing with the exciter unit, this is at the top left of the rack, and has a circuit similar to that given in last month's issue in connection with the simplest cathode-ray receiver. It is reproduced for convenience in Fig. 3. A layout is not given here, since the assembly is straightforward, but the principal sizes are: Baseboard 10 ins. square, panel 10 ins. wide by 6 ins. deep. This will be found roomy enough to accommodate the mains H.T. transformer and oil-filled condensers. The meter on the front was a Weston model 0-1.5 amps. A meter in the cathode circuit of the tube is not absolutely essential, but is very desirable if the life of the tube is to be considered, as it precludes the risk of overrunning. The controls on the front of the panel are: first accelerator, cathode, and shield, with switches for the cathode and mains.

At the back of the baseboard is mounted a terminal strip having the following connection points: L.T.+ and – for the cathode; two terminals in the shield circuit of the tube for introducing modulation, and a terminal connected to the H.T. max., for earthing purposes. These are all shown in the diagram of Fig. 3. Connection to the mains transformer is made by a Belling-Lee twin fuse plug and socket mounted on the left of the baseboard.

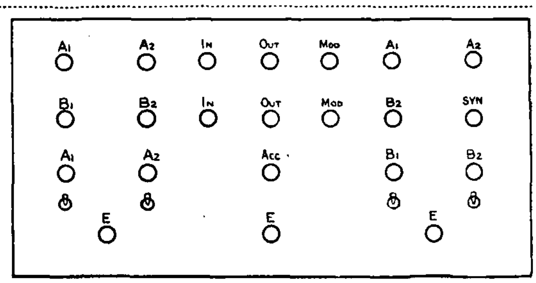


Fig. 1.—Layout of "exchange panel" for making connections to the tube. The use of the various terminals is shown in the text.

Current Supplies

Next to the exciter unit on the top row is a calibration and general "handy" unit for supplying D.C. or A.C. of low voltage.

The diagram of this is shown in Fig. 4, and it will be seen that the supply to the rectifier anodes is tapped off to a high-resistance potentiometer which provides some 150 volts A.C. on the terminals marked.

HOW YOU CAN EXPERIMENT WITH CATHODE RAYS

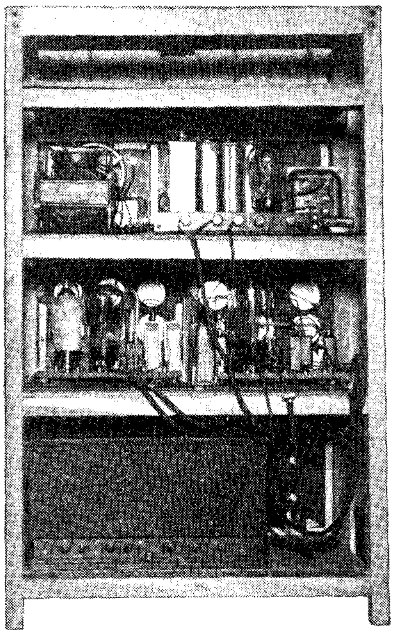


Fig. 7.—Back view of the complete rack showing the H.T. supply for the time base in its case at the bottom of the rack. The relays for the time bases are also clearly seen.

The rectified D.C. is brought out to a separate pair of terminals at the right of the panel, and is available for connection to a potentiometer for calibration of the tube deflections.

Across the A.C. terminals is connected a resistance and condenser with their junction brought out to a terminal marked C.T. (centre tap). The potential across the top terminal and the tap differs in phase by 90° from that between the tap and the lower terminal, and if the deflector plates of the tube are connected across the three terminals the beam will trace a circular path.

Strictly speaking, the trace will only be a perfect circle if the impedance of the condenser C is made equal to the resistance at the frequency of the supply. For 50,000 ohms, therefore, the value of capacity should be .063 mfd., but 0.1 is the nearest practical size. The figure on the screen can then be altered by varying the resistance. The elliptical figure produced by this method is of use in checking low-frequency oscillators, particularly if the frequency of the supply mains is controlled. Further details of its use will be given when the question of beat-frequency oscillators is discussed.

The Time-Bases

For experimental television work a double time-base is provided on the lines of that described in the issue for May, 1934 (p. 219). To make the scanning adjustments as elastic as possible the two condensers in the charging circuit (shown in the diagram as 0.5 and 0.01 mfd.) should be made adjustable. This would mean the provision of two more knobs on the front panel with multi-contact switch connections, but as the panel already has eight knobs, it is better to fit the condensers on some form of terminal strip with plugs to enable them to be changed rapidly by inserting from the side.

In passing, do not forget that these condensers are charged to several hundred volts when the time-base is working, and do not attempt to change them when the H.T. is on.

For wave-form measurements the double time-base could be adapted by making one or two alterations (see the article in the October issue, p. 447), but it is more convenient to build a separate time-base altogether, and mount it alongside the other one as shown. The circuit of this time-base is different, as it employs a pen-

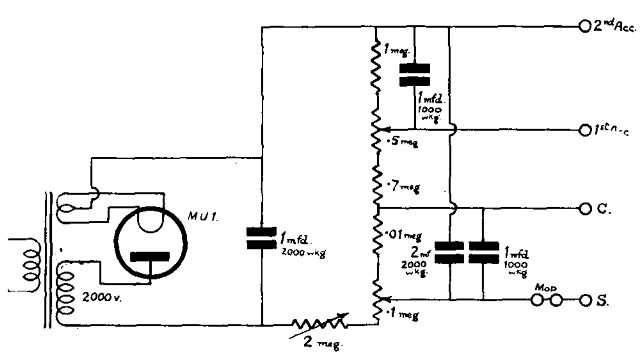
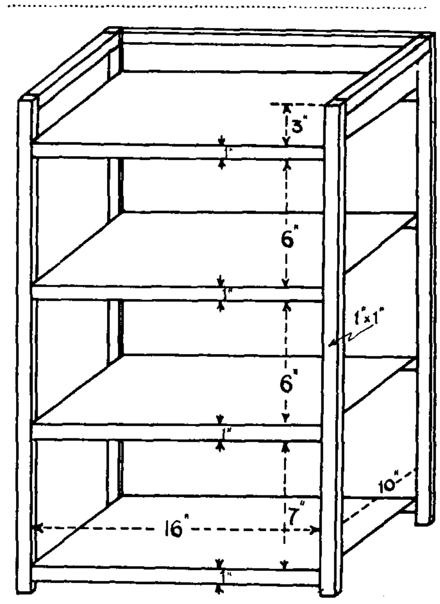


Fig. 3 (left.)—Exciter circuit for the high vacuum tube using the new Ediswan M.U.1. rectifier.

Fig. 6 (right). — Dimensions of the rack to hold the panels described in the article. The ebonite panels can be supported by thin fillets tacked on the inner rim of the cross battens.



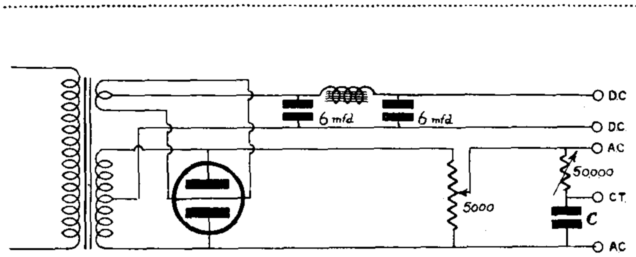


Fig. 4.—A useful testing circuit for giving D.C. and A.C. potentials for tube working. The centre tap gives a phase-splitting arrangement for circular traces.

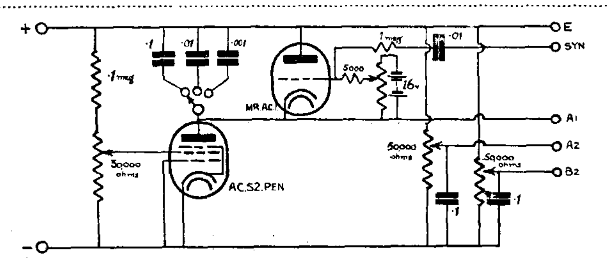


Fig. 5.—A single time-base for medium-voltage working using a pentode as a charging device. The terminals correspond to the markings on the panel in Fig. 1.

CATHODE-RAY EQUIPMENT

tode to act as a constant current charging device. The H.T. supply in this case is lower, and need not exceed 350 volts. This is obtained from a separate rectifier unit as it should be exceptionally well-smoothed. The range of condensers provided by the multi-contact switch is sufficient to give a range of sweep-frequency of 1-6,000 cycles, and the length of travel of the beam is controlled by the grid bias of the relay as usual. The switch in the centre of the panel disconnects the bias battery to save it when the time-base is not in use. The running down of the bias battery is generally shown by a shortening of the travel of the beam, and if the spot refuses to move at all an open-circuit in the grid of the relay, or zero bias should be suspected.

The lower panel on which the inter-connections between the various pieces of apparatus are made, is cut from a 16 in. by 7 in. ebonite panel.

The layout of the terminals is given in the sketch of Fig. 1, and these terminals are connected to the various connecting tags at the back of the baseboards. On the lower row is a set of four terminals to which the deflector plates of the tube are joined.

Each of these terminals is connected to one side of a single-pole switch, the other side of which is connected to a common earth wire running behind the panel. Thus, any deflector plate can be disconnected and automatically earthed by switching.

Earthing Arrangements

Each of the time-bases has its " earth " terminal brought out to the panel, and the centre earth terminal is for connection to the earthing in the laboratory, if necessary. The The second accelerator is also brought to the panel for earthing purposes, and care should be taken of this terminal when operating the gear, as it is live at 2,000 volts until earthed.

On the top half of the panel, each time-base has its deflector plate connections brought to terminals which are labelled with the plate to which they should be connected. "Input" and "output" terminals for the double television time-base are also provided, the "output" terminals being connected to the adjacent " Modulation " terminals when television is being received. *The " modulation " terminals should always be kept short-circuited otherwise, since the tube will be ruined if the negative bias is removed from the shield.*

Assembly of Units

When all the panels and components have been assembled, they may be fitted in the wooden rack, shown in the sketch of Fig. 6. At the top of the rack is a ledge for stowing small accessories and meters. The tube is connected to the apparatus by means of a 5-core flexible cable, long enough to allow of it being moved to a convenient position a yard or so away. For television work it is preferable to have it at least this distance since the screen appears unpleasantly coarse at short range, and adjustments are not given their true value. There is also the question of interference from the transformers in the rack. The connections to the deflector plates are made by means of a separate four-core cable, which should be shielded. The capacity of this cable will not introduce serious errors on audio-frequency working, but may have to be considered in radio-frequency. Behind the lower panel is plenty of room for the single time-base mains unit and the cell for operating the tube cathode. Do not forget that this is " live " and keep it clear of the rest of the connections and from all metal parts. The cases of transformers should be connected to the " earth " leads on the individual items.

The above description covers equipment for most of the simple uses to which the tube may be put, but no doubt other refinements will suggest themselves to the experimenter as experience is gained in handling the tube. Before any elaborate work is undertaken the tube should be run on a simple wave-form from the A.C. terminals so that the controls may be familiarised and found in the dark, if necessary. As certain jobs may require to be done in the dark, the position of high-tension terminals should be noted particularly !

FOCUSING THE CATHODE-RAY WITH ELECTRONIC LENSES

THE cathode-ray, consisting as it does of a jet of fast-moving electrons, tends to spread, due to the mutual repulsion between the negatively charged particles. In the older cathode-ray tubes which contained a small quantity of gas the beam could be brought to a focus by varying the emission of the cathode to suit a given gas pressure. In this manner the beam became surrounded by a cloud of secondary electrons, formed by collision with the residual gas molecules, and this negatively charged cloud served to repel straying electrons back to the beam.

If such a tube were completely evacuated the beam would not focus and formed a large spot on the fluorescent screen. In modern vacuum tubes a concentrating device or electronic lens is used to obtain a sharp focus—such lenses may be either magnetic or electrostatic.

The principle of these lenses makes use of the fact that electrons move at right angles to magnetic lines of force and along electrostatic lines of force. A simple magnetic lens consists of a coil of insulated wire wound round the neck of the C.R. tube. When a current flows through this coil the magnetic lines of force exert an inward pressure on the electrons focusing being carried out by varying the coil current.

The principle of the electrostatic lens will be clearly understood from the following. There are two accelerating electrodes and the potential difference of about 1,500 volts between them together with their construction causes a converging field to be formed. The beam is brought to a focus by adjusting the potential of the first anode.

These electronic lenses are exactly analogous to optical lenses and the same laws hold good for both types. The spot on the fluorescent screen is an image of the active surface of the cathode and the relative sizes of image and object will be dependent on the distances between cathode, lens and screen.

A Simple Radiation Meter

By Arthur Weston.

This is a simple piece of apparatus which can be made up quite easily. It will afford proof of whether or not an increase in feeder current means increased radiation.

VERY often I have been co-operating in tests to ascertain whether or not the field strength of a station has increased after alterations had been made to the equipment.

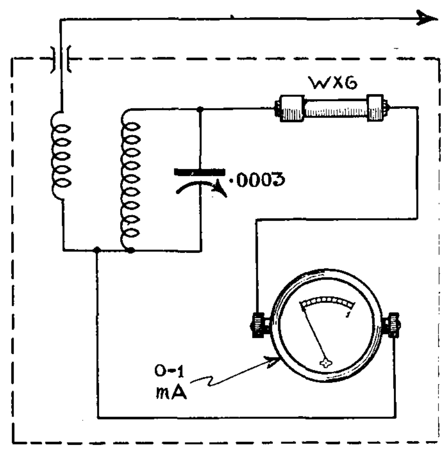
In some instances it has been mentioned that as the feeder current had perhaps risen from, say, .5A to 1A or so, there should be a decided increase in signal strength at the receiving end.

Only just recently, after the aerial current had been almost doubled on the 80-metre band the operator was surprised to hear that the signal strength was unaltered. There is a lot more in radiation than obtaining the maximum feeder current. A high current is essential, but only if everything else is in order.

One of the best methods of improving the actual aerial radiation from your station is to have some simple means of measuring the actual percentage increase or decrease in the radiation after you have made what you hope to be improvements.

A tuned coil with a small rectifier and either a galvo. or 0/1 milliampere meter are all the components required for this gadget.

The tuned coil can be wound on a small 1½-in. former and should have sufficient inductance to cover whatever band is required. For a rectifier you cannot do better than use the Westinghouse metal rectifier of the WX6 type



The unit consists of a tuned coil across a small reading meter, the a.c. input to the meter being rectified by a small Westector. This type of instrument is invaluable to the low-power transmitter.

to rectify the input to the D.C. milliampere meter.

On the end of the coil wind a small coupling coil of about six turns, joining one end to the earthy side of the tuning coil and the other side of the coupling coil to a small aerial having total length of about nine inches.

The whole unit should be boxed in a shrouded container having the aerial coming up through the lid, via a bushed hole. On the front of the container can be mounted the tuning condenser and dial, side by side with the meter.

Make a few experiments with the coupling coil so the tuning is fairly sharp, as a finer reading can then be obtained. With the help of another operator the feeder currents can be ignored and the transmitter tuned to give maximum radiation as measured on the meter.

Incidentally, the best position for the meter is on the ground beneath the aerial, or at a short distance from it if the tuning is too flat.

Of course, if the radiation is such that the reading goes off the meter scale then the unit must be positioned further away until you obtain a more or less centre reading on the meter.

An inexpensive meter that will do quite well can be obtained from Sifam. This meter is almost dead beat, but, at the same time, is sensitive to small, quick changes in input.

Constructing Your Own Fixed Condensers

SEVERAL times just recently I have been held up with my experiments through not having a small fixed condenser handy.

Sometimes it is not convenient to wait and so waste a whole week-end, in which case, try making your own condensers or repairing some of those which have broken down.

With large condensers of 1-mfd. or over it is fairly simple to take them to pieces and find the cause of the short-circuit. The larger 4-, 6- or 8-mfd. are even easier for they are usually made up in sections.

To repair such condensers all you have to do is this. Remove the top of the case and unsolder the connections from the terminals at the top. With moulded cases you will have to heat the wax so it can run out of the bottom. The best way to do this rather messy job is to place the whole condenser into a container of hot water and wait until the wax has all run out.

You will be able to remove the condenser from its case without any trouble, and then it is quite a simple matter to unwind the foil and paper in the section that shows a short-circuit.

When you find the point of breakdown, insert some extra dielectric in the damaged part and re-wind. When re-winding, make sure the material creases in the same spot as before, otherwise you will have to remove the crease with a hot iron. Re-wind very carefully and make sure the material is very tight.

With a large condenser of high voltage it is sometimes an advantage to scrap the entire faulty section and re-connect up the balance, so having a smaller capacity condenser on which you can rely. When the breakdown has been overcome the condenser can be put back into its case and fixed in position with more hot wax.

Constructing small fixed condensers is a very simple matter. The required dielectric can generally be obtained from an old broken-down condenser of a higher capacity. Care must be taken in ironing out the creases and wrinkles with a hot iron.

If you are not concerned about looks, the condenser can be mounted between two pieces of card and either bolted or eyeletted between them. Interleave mica and foil on the lines of the list given below and you will be able to make fixed condensers of the capacities stated.

Number of plates.	Size of plates in cm. 2x1.	3x1.	4x1.	4x2.
2	.0002	.0003	.0004	.0008
3	.0004	.0006	.0008	.0016
4	.0006	.0009	.0012	.0024
5	.0008	.0012	.0016	.0032
6	.001	.0015	.0018	.004
7	.0012	.0018	.0024	.0048
8	.0014	.0021	.0028	.0056
9	.0016	.0024	.0032	.0064
10	.0018	.0027	.0036	.0072
11	.002	.003	.004	.008
12	.0022	.0035	.0044	.0088

Mica Dielectric .002 in. thick.

RECENT TELEVISION DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS

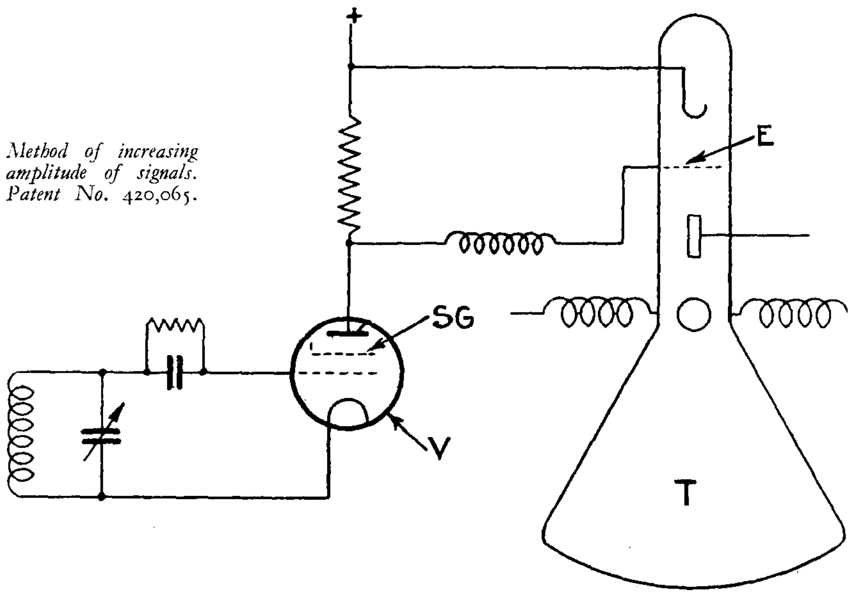
Specially Compiled for this Journal

Method of Increasing Amplitude of Signals :: Method of Matching Valve to Neon Lamp :: Scanning Sound Films :: Television Call Signs :: Focusing the Cathode-ray :: Preventing Distortion.

Cathode-ray Receivers

(Patent No. 420,065.)

The incoming signals are first passed through a grid-leak rectifier V before being applied to the intensity-control electrode E of the cathode-ray tube T. The valve V is of the screen-grid type with a comparatively-low biasing-voltage on the screen grid S.G. The arrangement offsets the normal tendency of the cathode-ray tube to "blurr" the light-and-shade values of the darker portions of the picture, and to accentuate the high-light portions. The action of the valve V tends to increase the amplitude of the "dark" signals and reduce the amplitude of the high-light signals, thus ensuring a more uniform reproduction of the original tone-values.—(*Electric and Musical Industries, Ltd., F. Blythen,* and *J. Hardwick.*)



Method of increasing amplitude of signals. Patent No. 420,065.

Television Receivers

(Patent No. 420,074.)

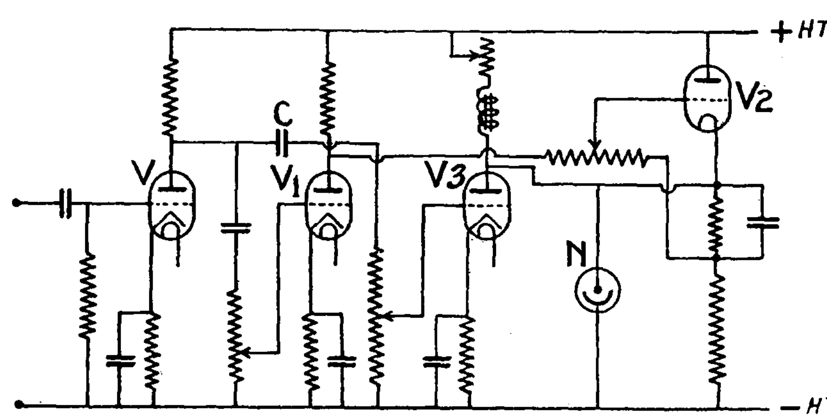
The impedance of the ordinary crater type of neon lamp is of the order of 200 ohms. In order to "match" this with the much higher impedance of the last valve-amplifier V3, the lamp N is arranged in parallel with that valve, and in series with an auxiliary valve V2. In addition the signal output from the first valve V is fed directly to the output valve V3 through a coupling condenser C, whilst the valve V2 is fed with the same signals in phase-opposition through an intermediary valve V1, which effects the necessary phase-reversal. The arrangement prevents the distortion which normally arises when the load impedances are not equally matched.—(*Marconi's Wireless Telegraph Co., Ltd., H. M. Dowsett* and *E. F. Goodenough.*)

Scanning Sound Films

(Patent No. 420,391.)

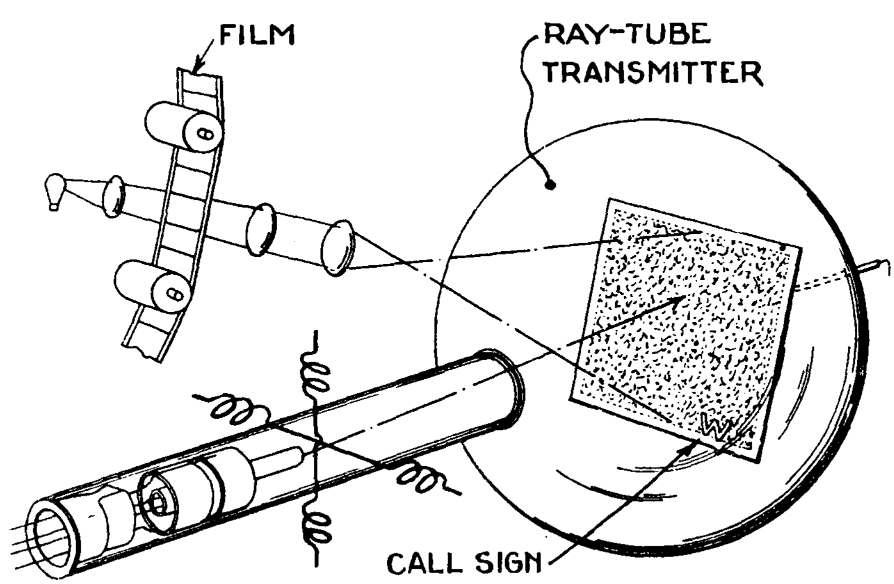
It is possible to scan a picture twice in succession, say, at a line frequency of 30, and to interleave the two lines at the receiving end, so as to produce substantially the effect of 60-line scanning. But there is a limit to the picture-repetition frequency in this case, since if it is made too high the "persistence" of the fluorescent screen tends to produce blurring. A particular problem arises when such a system of scanning is applied to a cinematographic "sound" film, where it is necessary, on the one hand, to move the film through the gate at the normal rate of 24 a second in order to preserve the natural tone frequencies of the speech, whilst, on the other hand, the picture repetition frequency should not exceed 16 per second if blurring due to the persistence of the first set of interleaved lines is to be avoided.

According to the invention, two successive picture frames are scanned simultaneously at the transmitter



Method of matching valve to neon lamp. Patent No. 420,074.

with a 24 frame frequency and a 38 line frequency for each picture. At the receiving end the lines are interleaved so that each picture is built up of two pairs of 38-lines, each repeated 12 times a second. This produces an effective 76-line scanning, though since each set of interleaved lines is repeated only 12 times a second, one set does not blurr with the other on the fluorescent screen. —(*Marconi's Wireless Telegraph Co., Ltd.*)



Arrangement for televising call-signs. Patent No. 420,479.

Television " Call-signs "

(Patent No. 420,479.)

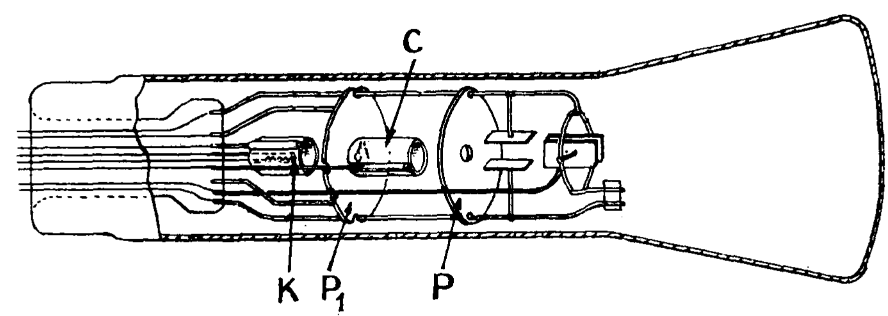
In order to identify a television programme it is possible to use a slide or plate containing the name of the station, and to transmit this before each item, so that each observer sees an image of the card. Or, of course, the name of the transmitting station can be announced by voice. But there is an advantage in providing a constant means of identification, and this is ensured, according to the invention, by inserting a small " letter " mask, such as W, in one corner of the sensitive screen on the cathode-ray transmitter. This prevents the cathode stream from scanning the masked part of the sensitised screen.

At the receiving end a corresponding bright image of the call-letter is constantly visible. The arrangement can also be used for superposing any other sign, such as a trade mark or other advertising device, on the received pictures.—(*Marconi's Wireless Telegraph Co., Ltd.*)

Focusing the Ray

(Patent No. 420,667.)

The tube is fitted with an " electron-optical " arrangement consisting of a cylinder C and two plates P, P1, for throwing a clear-cut image of the anode-aperture on to the screen. The plate P1 is positive with respect to the cathode K, the cylinder C is negative with respect to the plate P1, and the plate P carries a high positive potential of from 2,000 to 4,000 volts. The electrostatic lines of force from these electrodes are " curved " by mutual interaction, so that they act upon the electron stream as it passes through in much the same way as the curved surface of a lens refracts a ray of light. By suitable adjustment of the applied potentials the electron stream can therefore be concentrated and brought to a sharp focus on the fluorescent screen.—(*Radio Akt. D. S. Loewe.*)



A special cathode-ray tube construction. Patent No. 420,667.

Cathode-ray Tubes

(Patent No. 420,876.)

Relates to cathode-ray tubes of the type in which, for the better concentration of the stream, a low-voltage anode is followed by a second anode at a considerably higher voltage. In such tubes it is found that the presence of the internal wire-connection used to convey the voltage to the second anode exercises a disturbing influence on the path of the stream, and is therefore liable to produce distortion in the received picture.

This undesirable effect is prevented, according to the invention, by arranging the ordinary lead to the first anode so that it acts as a screen, inside the tube, to protect the electron stream from the effect of the high-voltage lead to the second anode.—(*Radio Akt. D. S. Loewe.*)

Summary of Other Television Patents

(Patent No. 419,623.)

Improved means for adjusting the mirror elements of a scanning drum. —(*Wilkins and Wright, Ltd.*, and *J. H. Hewitt.*)

(Patent No. 420,067.)

Method of concentrating the electron stream in a cathode-ray receiver for television.—(*E. Hudic.*)

(Patent No. 420,091.)

Synchronising the electron beam in a cathode-ray receiver by utilising the " tripping " action of a component of the picture signal.—(*G. B. Banks* and *Baird Television, Ltd.*)

(Patent No. 420,538.)

Improvements in the construction of cathode-ray tubes.—(*Radio Akt. D. S. Loewe* and *B. Wienecke.*)

(Patent No. 420,669.)

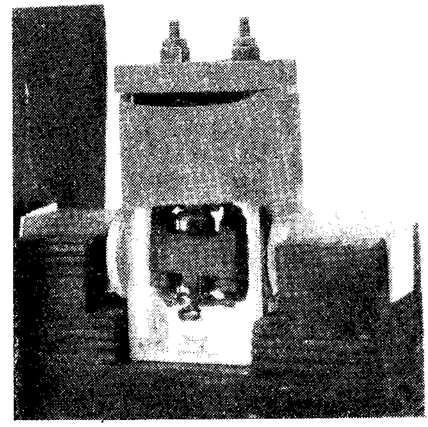
Indicating the direction of a beacon station by televising a picture showing its bearings relative to the receiver.—(*Marconi's Wireless Telegraph Co., Ltd., H. M. Dowsett* and *L. E. Q. Walker.*)

THE MIDGET MIRROR-DRUM RECEIVER

MAKING AN EFFICIENT KERR CELL

By R. L. Ashmore

Details of a very efficient miniature mirror-drum receiver were published in last month's issue. This article deals with the double-image prisms and particularly with the construction of the Kerr cell. This cell will be suitable for use with any scanner which requires a modulated light and it represents the latest practice.



A photograph of the Kerr cell described in this article. The container is a glass box and the construction is simple.

THE matters in the construction of the Midget Mirror-drum Receiver which remain to be described are the assembly of the double-image prisms and the construction of the Kerr cell. This latter, by the way, will be suitable for use with any scanner which requires a means of modulating a constant source of light.

The Double-Image Prisms

The small plano-convex achromatic lenses will have to be cemented with Canada balsam (in Xylene, used cold) to the polished face of the double-image prisms. When cementing, no account need be taken of the orientation of the prisms, but in use the second one must be rotated until the double images it produces merely increases the separation (at 45° to the horizontal) already produced by the first prism.

Most of the optical adjustments can be tested before the Kerr cell electrodes are introduced. The first requirement is that the light through the Kerr cell shall be parallel. This may be roughly tested by using only the first lens and prism and focusing the light on a distant wall, or more exactly, by looking down the beam with a telescope that has been focused on a star, etc., taking the precaution to use the light very dim, or smoked glass.

The Kerr cell box and other components may then be placed in position and the nitro-benzene poured in. It will be found very convenient to use a thin piece of mica against this Kerr cell box to simulate the effect of the Kerr cell. If its thickness is suitably chosen most of the light from the two-side images will be combined in one central image, which is then used for all adjustments.

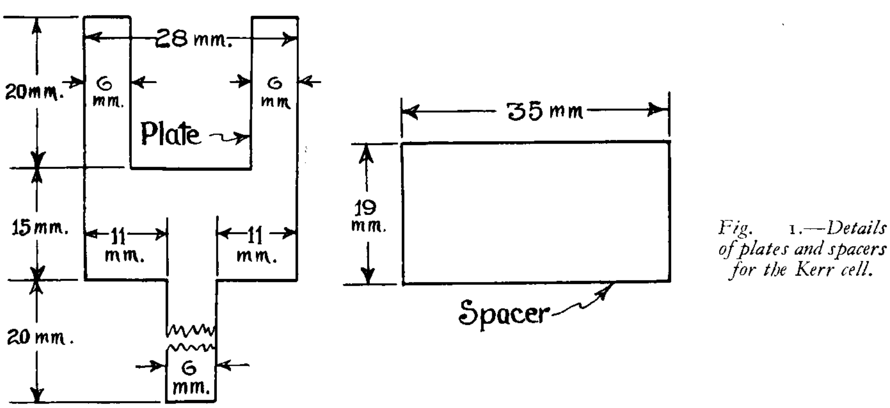


Fig. 1.—Details of plates and spacers for the Kerr cell.

Making the Kerr Cell

We now come to the construction of the Kerr cell. The writer has prepared and used several of this type and so can recommend a construction which does not involve any tools beyond what may be found in any workshop.

Eighteen plates are used of a thickness of .008 in. While it is not absolutely essential to use nickel for the plates, the consensus of opinion is in favour of that metal. A spacing of about .02 in. is used, which means that spacers of any convenient sheet metal of 26 s.w.g. are used. These spacers, of course, will be 17 in number. The plates and spacers are cut as shown in Fig. 1.

It should be noted that the sheet metal for the plates used is cut with the grain of the metal in the direction indicated by the double-headed arrow in order to ensure that the lugs are strong. The cutting may be done with ordinary shears or scissors and the cuts along the grain should be made first as this reduces the risk of severance of the longitudinal "fibres"

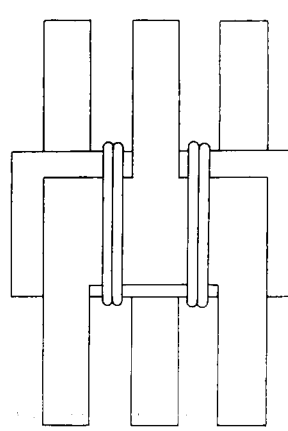


Fig. 2. Method of assembling the plates of the cell.

MAKING A LIGHT-MODULATING CELL

on making the cross cuts. The use of the shears will buckle the edge of the metal so that the plates must subsequently be flattened by hitting with

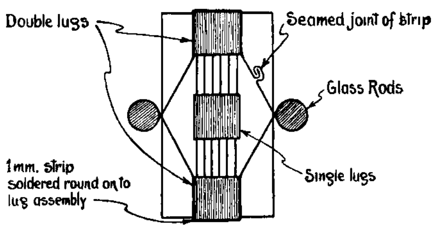


Fig. 3.—Diagram showing how the plates are secured to the U-shaped glass rods.

a fairly heavy hammer through a block of flat-faced steel on a flat-faced anvil or block.

The plates may then all be put together and filed between the lugs as it is difficult to cut that part of the edge exactly to the line with the shears.

After the removal of any burr or sharpness from the edges of the plates with a fine file, they must then be roughened, in the case of nickel by boiling for about half an hour in diluted sulphuric acid (about one part of strong crude acid is added to two parts of water, *not* vice versa). Of course, if another metal is used this treatment must be varied to suit, but in any case the smooth face of the rolled metal must be rendered matt in order to minimise regular reflection, which involves change in the character of the polarised light used.

The plates are assembled with the double lug end alternating with the single lug end, the spacers being, of course, inserted between each pair of plates. Holding the assembly in the hand, narrow elastic bands are put round, as indicated in Fig. 2, and the assembly nicely straightened up. It is then clamped in a vice with one of the three sets of lugs uppermost and with a pair of pliers these are bent so as to be pressed together symmetrically. They are then cut off with the tops level, leaving about 1 mm. of the upright portion. The assembly is then reversed in the vice and the other side treated similarly.

The assembly is held between the limbs of a glass U bent from a glass rod of about 6 mm. diameter, giving an overall width of between 26 and 27 mm., the bend being as sharp as is practicable. (The glass rod is preferably bent with a small blow pipe flame in the normal manner of table glass work, but if necessary an ordinary bunsen burner can be used.)

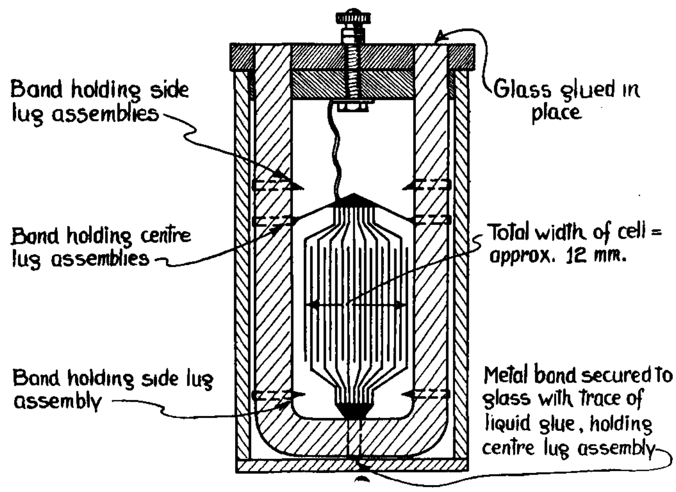


Fig. 4.—A section through the completed cell.

Having cut four 1 mm. wide strips of the same foil as the plates about 1 mm. wide, and say 15 cms. long, one of these is soldered to the central lug assembly and wound round the centre of the bottom of the glass U and, having been secured by the normal method of "seaming," a touch of solder is applied. In every case zinc chloride solution (killed spirit) should be used as soldering flux, rather than a paste, so that the surplus can be subsequently washed away.

With another strip of the foil the side lug assemblies are secured to the side of the glass U as low as possible in the manner indicated in Fig. 3. The centre lug assembly at the top is similarly fixed to the side glass rods and the side lug assemblies are fixed in the same manner as the bottom ones, the point at which they are tied

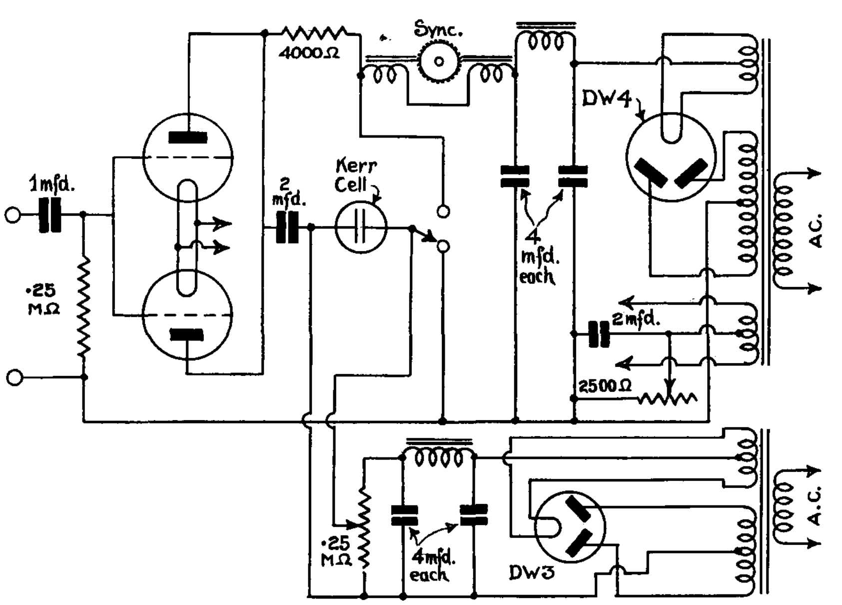


Fig. 5.—Circuit of amplifier suitable for use with the Midget Mirror-drum Receiver.

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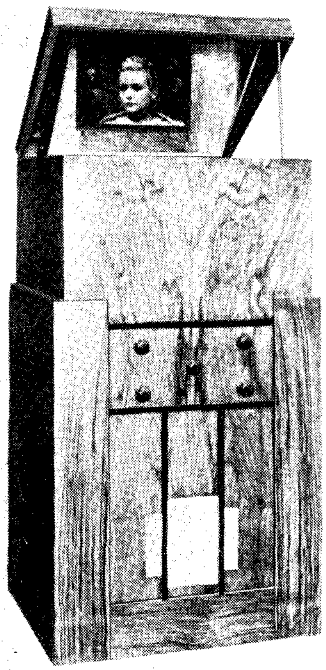
A DEMONSTRATION OF THE BAIRD 180-LINE RECEIVER



A Baird high-definition cathode-ray receiver.

RECENTLY the Baird Co. amply demonstrated:—

That the transmission by television of pictures of high-definition over a large area is now a practical possibility.

That this company with its studios and high-power ultra-short wave transmitters at the Crystal Palace can transmit outdoor and indoor scenes of all types, and also talking films.

That the reception of the programmes in any house in any part of the Greater London area is possible.

There is thus an immediate possibility of giving to a population of over 10,000,000 people entertainment programmes of high-definition pictures with the accompanying sound.

The demonstration was given in the company's offices in Victoria Street, South-west London, and the transmission, which was entirely by radio, was made at the Crystal Palace. Throughout the whole of the demonstration, which lasted approximately an hour, two particular features were very noticeable, viz.: once the receiver had been switched on it could be left entirely alone and the picture remained dead steady and also that the picture was sufficiently bright to be observed quite well in ordinary room lighting. This disposes at once of two impressions that have been fairly prevalent, that a television receiver requires constant attention, and that it can only be used in a darkened room.

Two types of receiver were shown in operation, one which gave a picture 8 ins. by 6 ins., and the other 12 ins. by 9 ins. The actual demonstration was with 180-line scanning, though in both cases the frequency can be increased without alteration to the receiver. Both are extremely simple to operate and have two connections only, one to the electric light mains (A.C. or D.C.) and the other to a special form of aerial.

The aerial consisted of a stiff wire about 10 ft. long, with a connecting cable. This was mounted vertically on the roof of the building, but it was shown that quite satisfactory reception of pictures could be obtained with the aerial inside the room.

The larger of the two sets is enclosed in a cabinet 4 ft. high, 2 ft. 3 ins. wide, and 2 ft. deep, and is shown by the photograph. The colour of the picture is black and white with a complete absence of flicker.

"Making a Kerr Cell"

(Continued from preceding page.)

to the glass rods being a little higher up to avoid "shorting."

A lid for the cell is made by cutting two pieces of ¼-in. vulcanised fibre, one to go inside the glass box and the other to rest on the top. The whole is inserted in a glass box 30 mm. square and 60 mm. high, or its equivalent. The glass rods are passed through holes in this two-part lid and the terminals serve to hold the pieces of fibre together.

After well washing the cell, the electrodes are, if need be, adjusted with small pliers, and the strips of foil are twisted so as to be edgewise. The separators are then removed and a final rinse is given and the cell is dried. Then the attachment of the central lug assembly at the bottom of the cell is secured to the glass laterally with a trace of fish glue. (The new organic cements are not suitable, as is usual because they are affected by the nitro-benzene.) With the same cement the glass U is secured where it passes through the lid.

Connections are taken, one from the central assembly and lugs at the top of the electrodes to one terminal and the other from one outside assembly of lugs at the top of the electrodes to the other terminal. Thin wires soldered in place are preferable.

Fig. 4 shows a section through the completed cell.

When assembled the electrodes are subjected to a low-voltage test and lined up carefully to obstruct the minimum amount of the parallel light.

The output from an amplifier is then fed to a power output stage, which consists of two 5-watt triode valves connected in parallel. The particular valves used are the Mullard DO26. This gives a very large output swing for a comparatively small grid input.

It will be noted from the circuit in Fig. 5 that in the output of this stage a switch is provided for reversing the picture to either positive or negative at will. The anode resistance must be able to carry the very high current flowing, and a 40-watt rating is considered a minimum. A separate control is provided for varying the bias according to varying operating conditions. This also must be capable of carrying the current of the two valves.

The Kerr cell is isolated from the amplifier by means of a large condenser, and the cell bias is obtained from a separate eliminator capable of delivering about 700 volts. This is found necessary for the full retardation of the cell described earlier.

The complete outfit is guaranteed to give very satisfactory images and the pictures will be very bright.

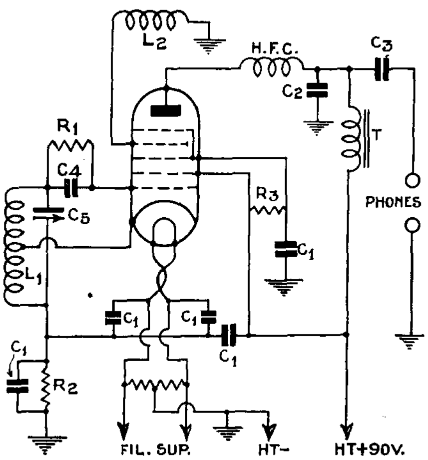
Our Policy
"The Development of Television."

The Short-wave Radio World

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

Electron-coupled Frequency Monitor

Now that electron coupling is the order of the day, here are some details of an electron-coupled frequency monitor using a pentagrid valve, type 2A7. The current issue of *Q.S.T.* gives details of a unit of this kind designed by W8KDM.



This unit provides a reliable means of frequency checking. A heptode valve of the standard B.V.A. type will be satisfactory.

First of all, the tuned coil. This consists of 90 turns tapped 30 turns from the earthy end. Use a 1-in. diameter former and wind with 28 D.C.C. wire.

The coil in the anode circuit is purely for pick-up and consists of about 65 turns on a 1-in. former. That is for the 80-metre band. For a grid condenser, a .00025 mfd. was used in conjunction with a resistance of 10,000 ohms.

With a 90-volt supply the resistance needed to drop the voltage on to the screen of the detector section of the 2A7 was 50,000 ohms. Finally, the cathode bias resistance. This should be 250 ohms for the 2A7 valve, but will have to be adjusted for English valves such as the Cossor 41MPG.

The pick-up coil should be left outside the metal box housing the monitor, while headphones are left permanently in circuit without any ill effects being noticed.

A Novel Frequency Meter

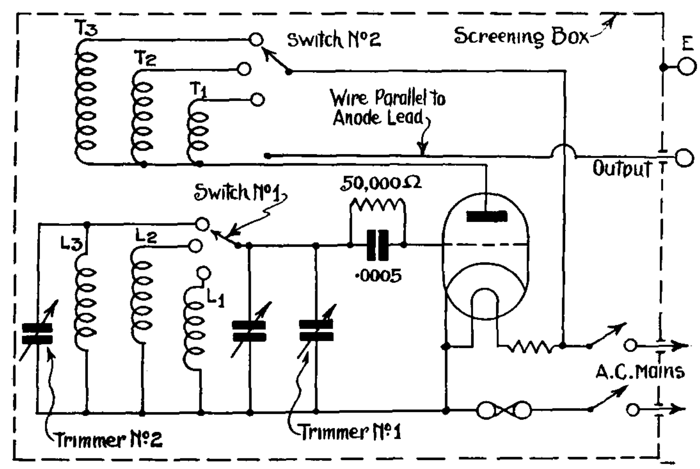
We are hearing a lot about frequency meters at the moment. Some work and some do not. Some of them tune to the required wave-band, while others rely on harmonics.

In the current issue of Radio-Craft there is an unusual circuit which should interest all with any ideas about careful frequency measurement.

The unit consists of a type 37 triode valve—having characteristics similar to the AC/HL type of valve—and three tuned circuits and complete switching.

It has been constructed to cover the 3,800-1,320 kc. band, in addition 1,500-540 and 380-132 kc. bands. Of course it can be modified to cover any waveband required.

A triode valve is usually very stable. This circuit is no exception to rule, so try out this oscillator - cum - wavemeter.



A trailing lead between the oscillator and the receiver under test, is sufficient to give ample coupling and overcomes the need of having to make a direct connection between the two units. We do not need to give any more details as the unit can be made up from the theoretical circuit.

A 5-metre Portable Transmitter

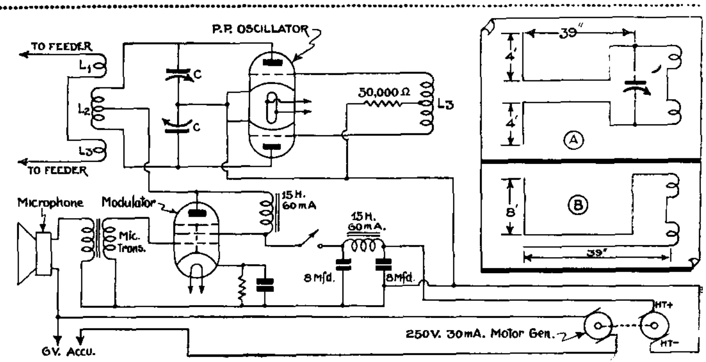
An interesting 5-metre portable transmitter is described in the February number of *Short-Wave Craft*. We are describing it here for it will interest the English amateur as the components and valves are easily obtainable.

Two valves are used and these are of the pentode and class-B types. A microphone is fed into the grid of the low-frequency pentode through a transformer of high ratio. As the low-frequency gain is on the low side, the bias applied to the pentode is increased to a high value.

Actually the pentode valve requires a cathode bias resistance of 500 ohms, but this has been increased to 3,500 ohms. Quality suffers a little, but reports show that it is not bad enough to cause distortion.

The pentode valve modulates a type 6A6 class-B valve. English equivalents are available, but with low-voltage heaters. This class-B valve is used as a push-pull oscillator in the usual way. A twin-gang condenser is used and we suggest for English readers the use of two Eddystone type 900 condensers ganged together.

Class B valves are very useful for transmission. All of the components used in this circuit have British equivalents, so the construction will not present any difficulties.



The plate coil consists of 6 turns on a $\frac{5}{8}$-in. former with spacing between turns equal to the diameter of the wire. On the grid coil wind 8 turns in the same way as with the plate coil.

Anode supply is obtained from a

(*Continued at foot of page 152.*)

Impedance Matching

The importance of Impedance Matching of circuit to line has not been fully realised by the amateur. This article deals fully with the principles of the problem.

ONE of the first and best learned lessons in communication-system design is that, to obtain the greatest possible transfer of energy from one circuit to another, the impedances of the two circuits must be matched. So straightforward is the concept that the lesson may have been overlearned. In very many cases the reason for the use of transformers as impedance-matching devices is not so much to gain in power transfer as to reduce distortion, frequency discrimination, and other common defects in voice-transmission circuits.

Mis-Matching

It is very easy to fall into the error of exaggerating the amount of reflection loss that occurs due to mismatched circuits. From the single consideration of power loss a surprising amount of mismatch can be tolerated. To arrive at a figure for reflection loss, the simplest example is the case of a resistive power source connected to a resistive load. In actual practice it is not often that pure resistances will be found in radio- or audio-frequency circuit, but in most cases the phase angle is so slight that for purposes of practical demonstration it may be considered to be zero.

In Fig. 1 a generator producing a voltage E_G and with an internal resistance R_G, is shown connected to a load R_G. The current that will flow in the circuit is $I = \frac{E_G}{R_{GL} + R}$; where $R_L = R_G$, that is in the case where the generator and load-impedances are matched, the current, $I = \frac{E_G}{2R_G}$, and the power in the load is

$$I^2R_L = I^2 R_G = \left(\frac{E_G}{2R_G}\right)^2 R_G = \frac{E_G^2}{4R_G}$$

When the impedances are not matched the current in the load $I'^2 R \frac{E_G}{R_G + R_L}$ and the power is

$$I'^2 R_L = \left(\frac{E_G}{R_G + R_L}\right)^2 R_L$$

The ratio of the power in the load for the matched condition to the power for the mismatched condition expressed in decibels is the mismatch, or the reflection loss. That is

$$N_{db} = \frac{I^2R_L}{I'^2R_L} = 10 \text{ Log.}_{10} \frac{(R_G+R_L)^2}{4R_G\ R_L} \text{ or}$$

$$N_{db} = 20\text{log.}_{10} \frac{R_G + R_L}{\sqrt{4R_G\ R_L}}$$

From this formula can be calculated the reflection loss that occurs due to connecting together any two impedances having small phase angles. For instance, if a 5,000-ohm vacuum tube were connected directly to a 500-ohm line, the impedance mismatch of 10 to 1 would cause a loss of 4.8 decibels.

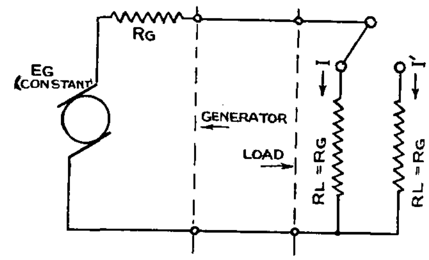


Fig. 1.—Showing a generator producing a voltage E_G connected to a lead R_L.

The losses calculated for a number of different impedance mismatches are shown in the graph, Fig. 2. For phase angles of less than 45 degrees the loss curve is practically the same, but the mismatch loss is always less when either circuit has a reactive component.

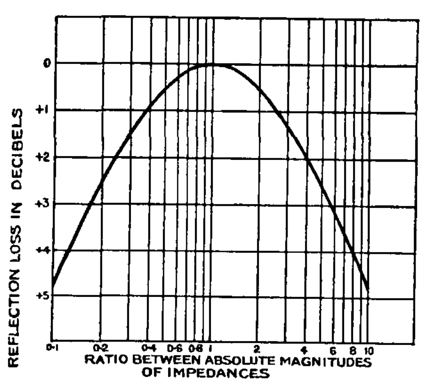


Fig. 2.—Reflection loss at a single junction in decibels as a function of the ratio between the absolute magnitudes of the two impedances. This curve is for a phase difference of 0°.

It is obvious, therefore, that in many cases the actual power loss due to operating between mismatched impedances is not serious. If "ideal" or no-loss transformers could be realised, it would certainly be worth while to use them where every milliwatt of the available power must be utilised. However, well-designed and carefully-made audio-frequency transformers of the usual type may have an inherent copper and iron loss of about 20 per cent. or 2 decibels. When it is considered that small power transformers have efficiencies in the neighbourhood of 85 per cent., an efficiency of 80 per cent. for audio-frequency transformers is quite good in view of the many other problems involved in their design, such as frequency characteristic, freedom from distortion, etc.

Correct Operating Values

The real value, however, of audio-frequency transformers and the reason why their use is so essential is to keep the circuit impedances at the correct operating values. For example, the design of a transformer to operate from a low-impedance line to the grid of an amplifier is not a simple job, and the successful operation of this sort of transformer depends upon its operation from the impedance for which it is designed. A line-to-grid transformer designed to operate from 500 ohms is apt to show frequency discrimination if operated from a line of 200-ohms impedance.

A designer of a voice-input circuit finding that the output impedance of his mixer panel is 200 ohms, which has probably been determined by the microphone impedances, would certainly insert a 200-500-ohm transformer between the mixer and the input of his amplifier, if its input transformer were designed to operate from 500 ohms. The use of the transformer is dictated not by the consideration of the reflection loss between the 200- and the 500-ohm circuit, which is less than one decibel, but by the fact that the impedances must be kept to their correct value to maintain proper frequency characteristics.

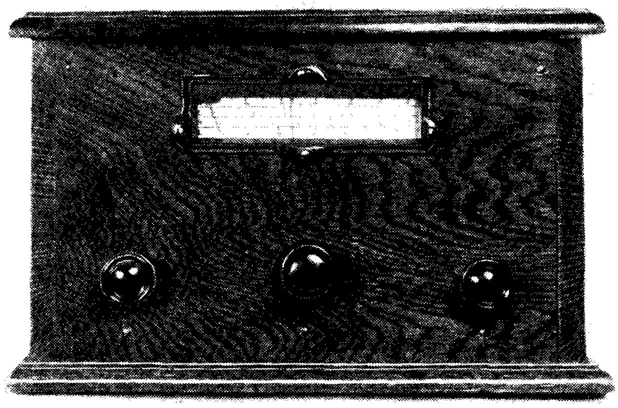
Another example of the necessity for correct impedance matching is in the familiar case of output transformers from vacuum tubes. The distortion introduced by a three-element tube is a function, among other things, of the impedance into which it works. Ordinarily, the distortion is a minimum when the tube is worked into an impedance equal to approximately twice the plate resistance of the tube. In the case of the PX4 tube the plate resistance is about 800 ohms, and for two tubes in push-pull is 1,600 ohms.

Push-Pull

When operating at a fixed bias potential, it is recommended that these tubes in push-pull work into 3,000 ohms,

(Continued at foot of next page.)

Commercial Receivers for the Short-waves: No. 2.



Eelex M2 Short-Wave Convertor

IF you have a receiver of the mains-operated type, the usual short-wave convertor will be of little use unless you are prepared to have a separate power supply.

This arrangement is not a convenient one—for the average listener who has to make one receiver do for local reception and general family use. A lot of spare wires would never do.

We have always advocated the use of an all-mains convertor so that every listener could listen to the short-wave stations without having to buy a separate short-wave receiver.

J. J. Eastick and Sons have just introduced a unit that we know will have a very wide appeal, for it is self-powered, will tune between 15 and 115 metres, has a tuning dial calibrated so that you know just where to look for the different wavebands and can be connected to any receiver by means of a special plug or two links.

It consists of a screen-grid oscillator coupled to a high-frequency pentode first-detector. This is one of the most efficient circuits for short-wave reception and shows that the unit was designed by short-wave experts.

One of the special features of this arrangement is that the oscillator setting keeps almost constant, making the receiver virtually a one-knob affair. As most listeners are unfamiliar with the tuning of a short-wave set this will be a salient point.

We tried the M2 convertor in front of our Universal 2 H.F. receiver (Nov., 1935), so turning it into a powerful 6-valve short-wave super-het.

Every afternoon we were able to hear W3XAL, on its 16-metre channel, on the loudspeaker. The transmissions from W2XAD and W8XK on the 19-metre band were also very reliable.

After making several reception tests we came to the conclusion that any listener with a little patience would be able to log several American stations every day under very ordinary conditions.

At £8 15s. this unit represents very good value for money in view of the number of stations that can be heard. The fact that it is easy to handle will undoubtedly appeal to many, while reliability is only one of the many desirable features.

"Impedance Matching"

(*Continued from preceding page.*)

which is approximately twice the plate resistance. From a consideration of the power loss due to mismatch the tubes could be worked into impedances varying widely from 3,000 ohms, but the distortion would become a serious factor. This is one of the reasons why the selection of the correct output transformer is so important.

The impedance of ribbon and velocity microphones averages between 25 and 40 ohms. The customary volume control used with these microphones has an impedance of 50 ohms. An inspection of the chart in Fig. 2 will show that the reflection loss due to coupling a 25- to 40-ohm generator and a 50-ohm load is negligible. The frequency characteristics of these microphones is not affected by such a small impedance mismatch. Therefore, it is sound practice to operate them into the regular 50-ohm mixer. If a transformer were used to couple these two circuits together, it would introduce a loss approximating 2 decibels, which would be entirely unnecessary. Similarly, 500-ohm and 600-ohm lines can be connected together without trouble, unless special balancing or isolating problems are present.

Impedance-matching transformers play a very important part in the circuits where these questions are serious. Generally, telephone lines are well-balanced, particularly high-quality lines of the sort used to connect remote pick-up points with the broadcasting studio. If these lines are connected directly to an unbalanced amplifier, which is one without a balanced and shielded input transformer, the resulting unbalance would affect the line and might introduce cross talk.

The customary care for such a condition is to insert a 1-to-1 transformer between the line and the amplifier input transformer. It has balanced windings and an electrostatic shield between the primary and secondary circuits so that a balanced line connected to its primary will remain balanced even though the secondary be connected to an unbalanced circuit. On short lines running around a studio or a laboratory, the question of unbalance is not usually so serious, but it is surprising the amount of pick-up difficulties that have been encountered due to the fact that some part of a short link between a mixer panel and a speech amplifier or some other short local circuit is unbalanced.

In the case of larger studios where several voice channels are running parallel through patch boards, relays, or other switching mechanisms, it is always considered good practice to run the wires in the form of a twisted pair, shielded by flexible copper braid. This type of connector maintains a capacity balance to ground, and if well-balanced transformers are used most of the cross-talk difficulties are eliminated.

"The Short-wave Radio World"

(*Continued from page 150.*)

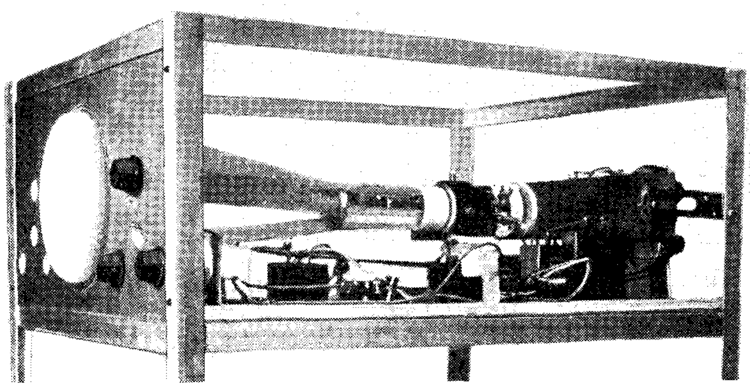
small generator running from a 6-volt accumulator. A generator of this kind is available from the Rothermel Corp. and is called the Gen-E.Motor. It will give over 200 volts at 50 milli-amperes from a 6- or 12-volt cell and only takes 1.8 amperes or .9 amperes according to the cell used.

With this simple rig, QSO8's have been had with stations up to 20 miles who reported R7. The whole outfit is very compact and can be made up in two units, the modulator and oscillator in one and the accumulator and generator in the other. Both units must be screened.

The new Mullard Pen-4VB with its slope of 10 milli-amperes per volt would be a very suitable valve for use as a modulator.

COMPLETING AND OPERATING THE SIMPLEST CATHODE-RAY RECEIVER

Here are final details and operating notes of a simple type of cathode-ray receiver. Full constructional articles have appeared in the four preceding issues. This receiver has been designed for the amateur who wishes to build his own set



and it represents the simplest type of this class, well within the ability of any amateur to construct. It has been so designed that with a trifling modification it will be suitable for the reception of high-definition pictures.

THE flex leads to the tube cathode have already been made, and the remaining leads are those to the shield, first accelerator, and second accelerator. The shield is connected to the centre tap on the " modulation " potentiometer (shown by wire No. 18 in the diagram). The first accelerator goes to the tap on the ½-megohm potentiometer which is used for focusing (wire No. 19), and the second accelerator goes direct to the H.T.+ terminal, thus receiving the full 2,000 volts H.T. Take this lead as directly as possible and do not allow any loose bits to trail over the chassis; on the other hand it must be long enough to allow the tube to be turned in its holder when necessary.

There now remains the interconnection of the time-base and the deflector plates of the tube, and this should be done with both baseboards in position. Go back to the time-base board and solder a length of flex to the anode terminal of each valveholder. The one connected to the slow-running time-base (with the .25 mfd. condenser) is connected to A_1 plate on the tube. The lead from the vertical time-base (.01 mfd. condenser) goes to B_1 on the tube. The remaining plates A_2 and B_2 are returned to the centre tappings on the shift potentiometers at the back end of the baseboard. Both these potentiometers are 2 megohm so be careful not to mix them! The A_2 plate is joined to the one which has a fixed resistance of 2 megohms in series with it. Refer to the diagram on p. 525 of the December issue to verify this connection.

Now turn to the synchronising potentiometer on the time-base front and check that the end of the resistance is connected to the negative wire. Solder a length of flex to the same tag and take it to the −ve output terminal of the set. The other end of the resistance goes to the +ve output terminal of the set and also to the .01 condenser, which isolates the modulating potentiometer on the other baseboard. The −ve output of the set is, of course, that end of the receiver output which is connected to earth. The earth terminal on the control baseboard is connected to the chassis or earth of the receiver. The terminals will be seen in the diagram of the set on p. 477 in the November issue, and are marked "C" and "A."

Connecting Up the Tube

With the completion of the wiring check up the circuit against the full theoretical diagram given in Fig. O, taking particular care to see that the deflector plates are connected to the correct points on the time-base, and that the shield circuit of the tube is complete through the modulation potentiometer and bias potentiometer.

The preliminary work of setting up the time-base can now be started. To see that this is working correctly, try it by itself and disconnect the tube supply from the H.T. by temporarily taking off the primary connection on the 2,000-volt transformer. Now switch on the time-base. The bias plugs in the battery should be set at 7½-9 on the horizontal sweep and 15-16 on the vertical sweep.

If all the wiring is correctly carried out the relays should glow as soon as the cathodes have attained their full temperature. The flickering of the 12½ times relay is, of course, perceptible to the eye, but the speed of the other one is too fast to appear as a flicker and it will seem to glow continuously. The speed controls will make a slight difference to the rate of flicker, but as these are in the nature of fine adjustments the change may not be noticed. If the relays do not discharge at all there may be an open-circuited resistance in the charging connection to the condensers, or the H.T. volts may be disconnected. Be careful when checking the latter, as the condenser is charged to the full 1,000 volts if the relay does not strike. If the slow-speed relay glows continuously instead of flickering, try the grid bias connections.

Assuming the time-base appears to be operating correctly, switch off and reconnect the H.T. supply for the tube, and connect up the cathode to the 2-volt cell. Before switching on the H.T. again, run the cathode cautiously up to red heat, observing its temperature through the tiny hole in the shield for the purpose.

A dull cherry red is the correct temperature, though final adjustments are best made when the tube is running properly. Now switch on the H.T. and the time-base should start away again and the lines should appear on the screen of the tube. If no lines appear, the focusing should be tried—possibly the negative bias on the tube is too high, or the accelerator connection has not been made.

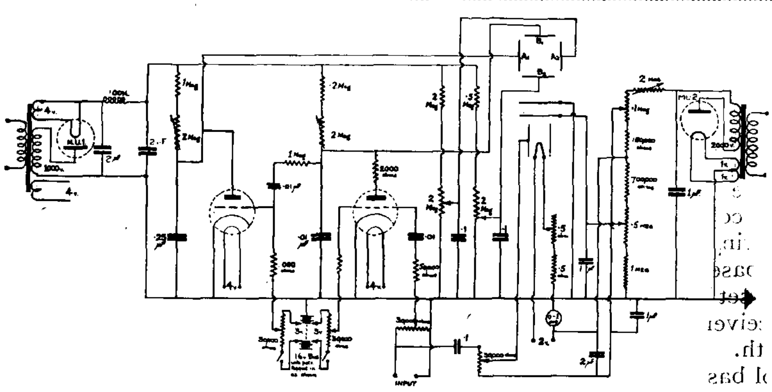
HOW TO OPERATE A CATHODE-RAY RECEIVER

An electrostatic voltmeter is of use in checking up H.T. voltages, but if this is not available a milliammeter of 0-1 mA may be used in series with 1-2 megohms. This takes an appreciable current, however, and allowance should be made for this when measuring actual voltage values.

Tube Bias

In the original high-vacuum tubes produced by the Ediswan Co., which were used in this circuit, the shield bias was of the order of 100 volts, and the resistances were designed accordingly in the exciter potentiometer. Later patterns, however, require a lower bias and it may, therefore, be necessary to reduce the total resistance in the bias potentiometer. This may be done by taking out the resistance of 100,000 ohms in series with the bias potentiometer (see February issue, p. 99) and replacing it with one of 10,000 ohms. *But don't attempt any alterations with the H.T. on.* If the lines appear but are too dim, the series resistance in the main H.T. lead can be cut out altogether and short-circuited with a piece of wire. This gives a full 2,000 volts to the tube and should produce a very bright image on the screen. The sensitivity of the tube is reduced at this high voltage, so a compromise may have to be made between the deflection and the intensity of the image. One or two values of resistance may be tried in the clips until a satisfactory condition is attained.

It is probable that the lines will not be central on the screen. The shift potentiometers are arranged to compensate for this to some extent, but if the lines are still off centre, it is possible that there is a strong magnetic field in the neighbourhood. Try moving the whole framework about, or try turning the tube completely through 180°. There is generally an optimum position for the tube and this should be found by experiment. If the time-base is not working, the spot will appear stationary on the screen, and in this case the tube should immediately be switched off while the trouble is investigated. If the spot is allowed to remain sharply focused on the screen for a long period there is a risk of spoiling the screen by burning, if indeed the glass is not actually punctured. Whenever the tube is running the beam should be deflected across the screen to prevent damage due to this cause.



The complete theoretical circuit of the Simplest Cathode-ray Receiver.

If the lines are drawn on the screen and the tube is focusing nicely, try the effect of the shield potentiometer—it will cut off the beam completely if it is rotated far enough. The best operating point for television signals is obtained by adjusting this potentiometer, and the lines should be slightly blurred rather than accurately focused, as this tends to reduce the contrast between the lines and the spaces.

Time-base Speed

If all the values of the components are correct and the voltage is of the right value, the speed of the time-base will be approximately correct for 30-line television. It will need more careful setting, however, to receive a picture, for this reason:

As distinct from the mechanical systems the scanning of the cathode-ray tube is by two independent circuits. This means that the speed of the vertical and horizontal movements can be adjusted independently. It is thus possible to get 30 lines drawn on the screen by a variety of combinations of speed within the limits of the resistance settings. For example, the horizontal speed may be 12 per sec. and the vertical speed 360. This will give 30 lines, but they will be the wrong 30! The first step is therefore to get the 12½ cycle sweep running correctly, and for this purpose a mains transformer can be used if the supply is 50 cycles. If the primary of a mains transformer is brought near the tube, on switching it on the field from the core will produce interference in the beam and four dark lines will appear on the screen, corresponding to 50:12½.

The speed of the horizontal time-base can then be altered until these dark lines are perfectly stationary on the screen. The speed will then be exactly 12½ cycles. The vertical time-base can then be adjusted until 30 lines are counted by the eye, and the screen is ready for reception. The final adjustments of speed can always be undertaken when the signal is being received, care being taken not to make any radical alteration so that the ratio is lost altogether.

The screen can be tried on radio signals without waiting for actual television. In this case a more or less symmetrical pattern will chase itself across the screen as the audio-frequency alters. This enables the modulation adjustments to be tried in conjunction with the focus, and the correct depth of modulation to be estimated. The heavy passages should produce well-defined black areas on the screen, the scanning lines remaining perfectly true. Over-modulation may result in the curling of the lines. The synchronising knob will have no effect until actual television is being received, then the increase in synchronising impulse will distort the lines at the top or bottom of the screen, and the control should be kept just below this point.

Caution

If the circuit is assembled according to the diagram and the values of the resistances are correct the re-

(*Continued on page 170*)

Trade Notes of the Month

Reports on Apparatus Tested

A new 10-metre Oscillator Valve.

IT seems as if the Mazda ES30 triode valve has been overlooked by the amateur in the past. We have been testing this valve to see how it stands up to rough usage and find that it is one of the easiest of its kind to operate.

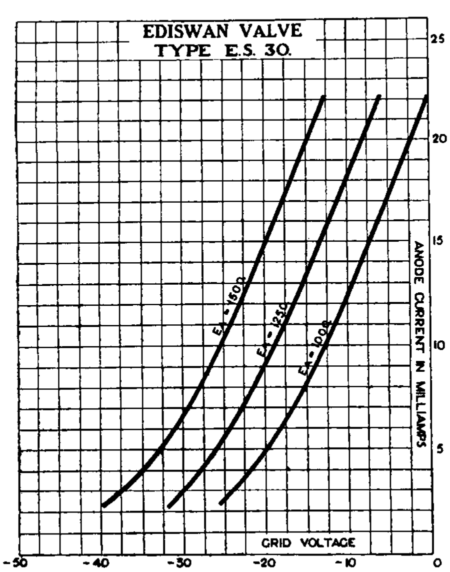
We were surprised to obtain well over 20 watts at 28 mc. with 500 volts on the anode. As an oscillator on the 20-, 40- or 80-metre bands it is ideal. The base is of the low capacity kind, such as used on the DO60 type of valve.

Its characteristics will give some idea as to its capabilities and value to the amateur. It is a valve that will stand bad overloading, oscillates very freely and has a multiplicity of uses.

The characteristics are as follows:—

Filament voltage	6V.
Filament amps	1.5
Filament emmision	80 mA.
A.C. resistance	35,000 ohms.
Magnification factor	35.
Slope	1. mA per Volt.
Price £2.	

This valve has been adopted by the services after extensive tests and we feel sure it will prove very popular.

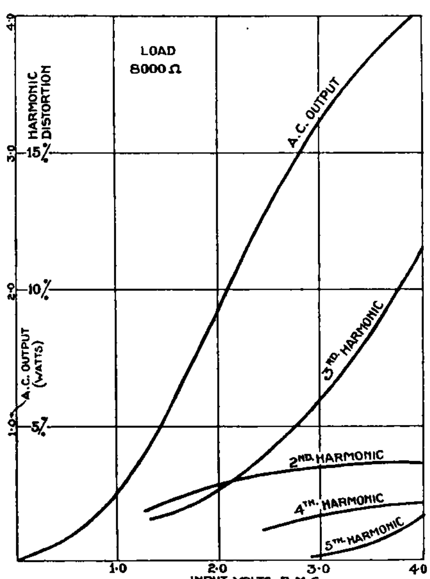


This ES30 will dissipate 30 watts at up to 1,500 volts. At 10 metres the anode dissipation can be to 20 watts.

A New Steep-slope Pentode for the Short-Wave Receiver.

A NEW low-frequency pentode having a very steep slope has just been introduced by the Mullard Radio Service Co. It has been designated the PEN.-4UB and is intended for use in the output stage of A.C. mains operated receivers.

At first glance you may not see just why this valve is going to be so important to the short-wave set builder. Here



The PEN.4VB with an input 3.6 volts R.M.S. will give an output of 3,800 milliwatts for 10 per cent. total harmonic distortion.

are a few details that will give some idea of what this wonderful new valve will do.

Operating Details.

Heater voltage, 4 V.
Heater current, 1.95 A.
Max. anode voltage, 250 V.
Max. aux. grid voltage, 250.
Optimum load, 8,000 ohms.

When operated under these conditions with an approximate anode current of 32 milliamperes, the mutual conductance is 10 milliamperes per volt.

With the small input of 3.6 volts r.m.s. the undistorted output is 3,800 milliwatts, the content of total harmonic distortion being 10 per cent.

For 5 per cent. total harmonic distortion a grid input of only 2.5 volts r.m.s. is required to give 2,600 milliwatts output. This is equal to a sensitivity of 416 mW/V_2.

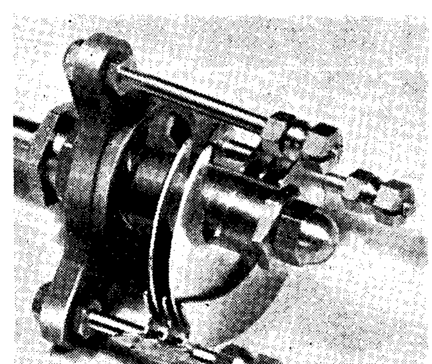
With the suggested anode and grid voltages the negative bias is obtained by means of a series cathode resistance suitably de-coupled. This resistance should have a value of 145 ohms. The actual bias voltage required is 5.8 volts.

New Eddystone Lines for The Home Constructor.

EDDYSTONE are always quick to see what new lines the home constructor will require. Having five active amateur transmitting station operators on their staff the components are always just what are wanted.

One of the most interesting components at the moment is the 15 mmfd. band-spread condenser with DL9 insulation priced at 3s. 9d. It consists of two moving and three fixed plates with the absolute minimum loss. A condenser of this kind will enable the short-wave listener to spread the 20-metre band over 70 or 80 degrees of the tuning scale.

In addition to this component are a screened all-wave choke type 982, price



DL9 insulation is used in the mounting of this band-spread condenser. The total capacity is only 15 micro-micro-farads.

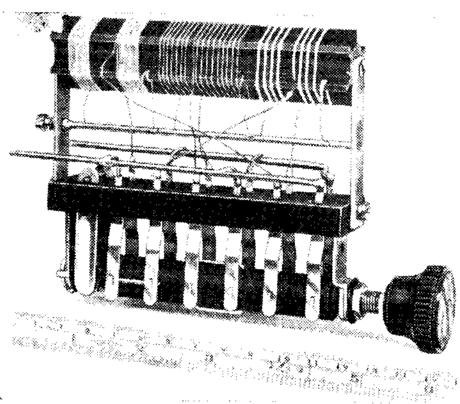
5s., a short-wave choke wound on steatite former type 948, steatite valve holders suitable for television or short-wave work and a special air dielectric trimmer with a capacity of .000065 mmfd. The price of this component is 3s. 6d.

Gas-filled Relays.

The Edison Swan Company inform us that they have developed two new relays with rare gas filling instead of the more usual mercury vapour. These valves will have a particular application to high-speed time-bases for cathode-ray tube circuits, and are now available with neon or helium fillings. The characteristics are similar to those of the MR/AC.1. mercury vapour relay, and the types are distinguished by the letters NE/AC.1 and HE/AC.1 respectively. The price is the same as before, namely, 35s. and customers should specify the gas required when ordering.

The Mervyn 3-range Short-wave Coil.

Litz-wound short-wave coils are certainly a new departure and a distinct step in the right direction. A new Mervyn short-wave coil has been constructed to cover wavelengths between 6 and 59 metres, with two wavebands covered by a Litz-wound coil.



The Mervyn 3-range short-wave coil.

Using a high grade low-loss tuning condenser the coil has the following waveband coverages. Coil 1, 6-18.5 metres with an inductance of 1.05 mh. Coil 2, 14.5-32 metres with an inductance of 2.8 mh. Coil 3, 26-59 metres with an inductance of 9.6 mh. These measurements were obtained with a condenser in parallel, having a maximum capacity of 100 u.u.f. and a minimum capacity of 20 u.u.f.

With a standard condenser of average quality and an average minimum capacity of 33 u.u.f. the minimum wave ranges rise to 9.5 metres on coil 1, 18.5 metres on coil 2 and 34 metres on the third coil.

The coil is supplied completely wired and in such a manner that only three external wires are required. These are to grid, earth and reaction. The reaction winding has to be coupled by means of a .0005 microfarad fixed condenser.

An autodyne detector circuit will suit this coil in every way so that readers will be able to construct an efficient short-wave super-het.

A feature that will merit particular interest is the switching arrangement. Although this switch is of the multi-contact type losses have been kept to a minimum.

All coils are tested and adjusted to the above standards before dispatch so that readers will be able to rely on the wave ranges.

The price has been set at 15s. 6d., this price including the circuit diagram of an autodyne detector circuit.

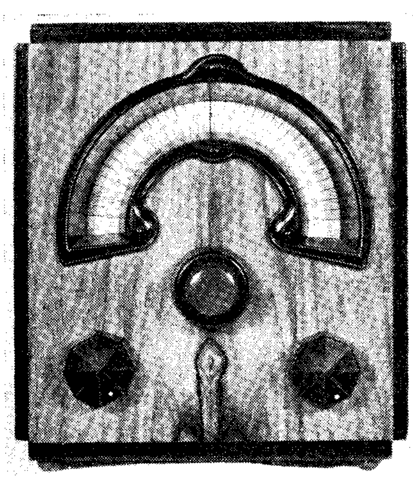
Short Waves with any type of Receiver.

We have been testing a short-wave super-heterodyne convertor-cum-plug-in adaptor, which we have been able to use in conjunction with ordinary receivers having one or more high-frequency stages; with super-hets., so giving triple detection; and with the usual type of detector-low-frequency receivers.

This flexible adaptor has been produced by Unit Radio, who are well known as short-wave specialists. The de luxe model is supplied with a 100-1 micrometer dial and two coils tuning between 13 and 60 metres. There is a standard model with a simpler dial which is a little cheaper. The de luxe model is 47s. 6d., while the cheaper model is 39s. 6d.

With this unit we were able to receive quite a large number of 20-metre amateur phone stations during an afternoon's test. An experimental programme from VK2ME Sydney was held for over two hours. When used as a super-het. convertor it was sufficiently selective to separate most of the amateurs on the 40-metre band.

With this unit it is possible to receive short-wave stations with the minimum of expense, graduating later to a specially designed short-wave receiver. The makers of this excellent unit are Unit Radio, 12 Pultney Street, London, N.1.



This is the de luxe version of the unit adaptor. It will tune between 13 and 60 metres and is supplied with a 100-1 micrometer tuning dial.

British Television Supplies, Ltd., state that they are at present working on a television receiver which, it is hoped, will be marketed at a figure around £25. It will be capable of receiving high-definition television by either the Baird or the Marconi-E.M.I. process on ultra-short wavelengths.

The entire share holding of this concern has recently changed hands, and a new board of directors has been elected.

Death of Baird Research Engineer.

It is with deep regret that we announce the death of Donald Price, the well-known amateur transmitter and television research worker. During the course of his work at the Baird laboratories at the Crystal Palace he received an accidental shock from a low-tension charger. The fact that he only came into contact with a comparatively low-potential makes the cause of his death even more inexplicable.

Mr. Price has been engaged in television research for a number of years while, with his short-wave transmitter he has been able to make contact with amateur stations in every part of the world.

It should be understood that his death was not caused by contact or work in conjunction with the television transmissions from the Crystal Palace.

Leytonstone Television Society.

Leytonstone now possesses a really enthusiastic television society formed by the activities of Mr. A. W. Read, 71 Montague Road, Leytonstone, and readers are invited to write to him for full particulars.

Meetings are held on Mondays and are entirely devoted to Theory of Television and Short-wave Work, whilst on Wednesdays practical demonstrations are given in television.

Apart from its normal lectures and practical demonstrations this Society is making arrangements to obtain the facilities for allowing experimenters to conduct their experiments under ideal conditions, by fitting up a laboratory; this will provide a large number of experimenters with the means which would otherwise be unobtainable. Enthusiasm is the only qualification for membership of this unique society.

A Multi-purpose 10-watt Amateur Transmitter

By G6FO.

Designed for the reader requiring a flexible arrangement, this transmitter has several useful and interesting applications. While it is suggested that its main use should be for 160-metre CW working, it also has possibilities in other directions, some of which are outlined below.

THIS transmitter is built round the familiar self-excited push-pull tuned-plate-tuned-grid oscillator, the basic circuit of which is given in Fig. 1. Push-pull has been chosen because of the greater power output and, more particularly, the stability which it gives. Oscillation is obtained by resonating the tank circuit C-L with the grid circuit C1-L1.

In Fig. 2 is shown the arrangement adopted for triode valves and an A.C. supply. This is the circuit with which it is proposed to deal with fully in this article. For working on either 160 metres or 80 metres crystal control can be applied in the manner indicated, but

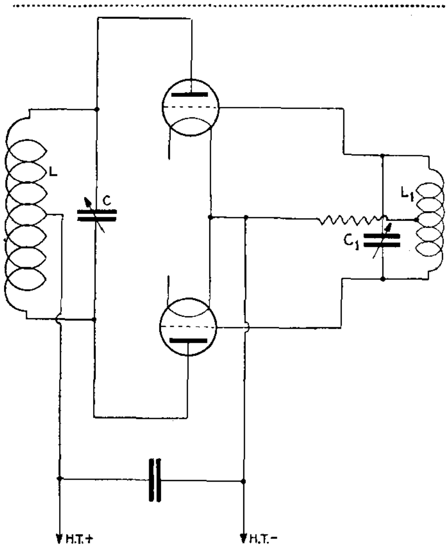


Fig. 1.—Both ends of the tuning condenser C are at high potential. C1 is of the ordinary broadcast receiver pattern.

direct control in this way is not advised below 80 metres owing to the probability of the crystal being fractured. Forty metre crystals are comparatively fragile and should not, in general, be used in an oscillator keyed direct. By using the appropriate coils at L1 and L2, the set can be operated self-excited on any of the amateur frequency-bands but, here again, such an arrangement should not be used below 40 metres, as on 20 metres the stability is not of a very high order and the electrical efficiency is low; in certain circumstances, however, an expert operator can produce stable, good-quality signals on 20 metres using self-excited circuits. When crystal-controlled on either of the two low-frequency bands, the set can be modulated effectively by the usual methods.

Another possible application of this set would be as the neutralised power-amplifier of a CO-BA-PA transmitter, either directly driven from the buffer stage or link-coupled; again, it could be used as a locked amplifier by the Goyder-lock method. As a neutralised amplifier, the neutralising condensers are connected as shown in Fig. 3, while Fig. 4 is a circuit arrangement for pentode valves.

As some slight modifications and differences in the method of adjustment are involved in the case of each of these various uses to which the set can be put, it is proposed for the moment to regard it primarily as a 160-metre C.W. transmitter.

It may be said that the amateur who decides to build this transmitter now will be providing himself, as has been shown, with a useful unit of considerable value in the future development of his station.

Assembly and Construction

Turning now to Fig. 2, the first thing to notice is the split-stator (series-gap) grounded-rotor tank tuning condenser C1. Though a single condenser such as C in Fig. 1 can be used here, the split-stator type is advised, and each section should be of .0005 mfd. for 160-metre working. The Cyldon is recommended, since in their standard receiving condenser the plates are spaced sufficiently to prevent flash-over in low-power working (with up to 400 volts on the plates of the valves) while connections can be taken off at convenient points.

L1-C1 is the tank circuit, and it should be solidly built and well insulated. For 160 metres, about 35 turns will be required for L1. This can be made up of either 7/22's aerial wire or No. 8 soft-drawn copper wire wound on a 3 in. diameter former, the turns being spaced an ⅛ in. As most constructors will have their own ideas about the making of such coils, precise details will not be given, but the former could be a 3 in. outside diameter ribbed ebonite tube, or better, a low-loss former could be built up with wooden end-pieces and notched ebonite strips.

The coil can be mounted in several ways. Perhaps the best is to rest it longitudinally on the baseboard and take its ends to stand-off insulators. This facilitates coil changing and provides for the future use of the set as a unit in a two- or three-stage transmitter. The condenser C1, which can be mounted on an ebonite strip secured to

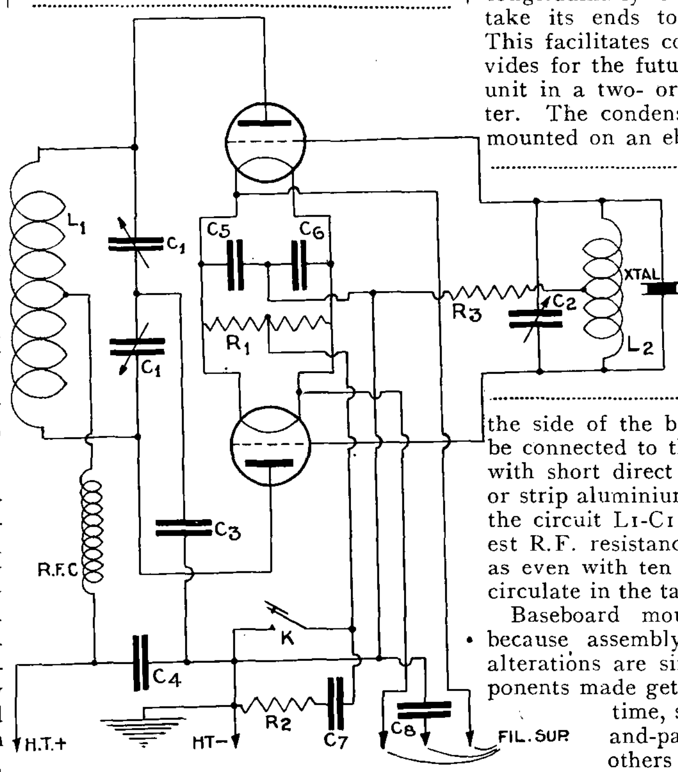


Fig. 2.—All the values for the complete transmitter are given in the text. Tuning condenser must be suitable for the high-tension you are to use.

the side of the baseboard, should then be connected to the stand-off insulators with short direct leads of copper strip or strip aluminium. It is essential that the circuit L1-C1 should have the lowest R.F. resistance and losses possible, as even with ten watts, heavy currents circulate in the tank circuit.

Baseboard mounting is suggested, because assembly and any necessary alterations are simplified and all components made get-at-able. At the same time, some may prefer rack-and-panel mounting and others some form of unit construction. These things are largely a matter of taste and are of little importance as long as the electrical requirements are not sacrificed to appearance. If the constructor is an "A.A" man or a beginner, he is advised to adopt baseboard mounting for the reasons given above. A piece of five-ply wood about 12 ins. by 15 ins. should be used, raised by strips 2 ins. deep fixed along the narrow sides. The coil L1 will probably have to be separately supported, as it will of necessity be rather large. Components such as C3, C4, C5, C6 and R1 can be mounted underneath.

The valve-holders should be placed symmetrically in relation to C1 and L1, so that the plate leads can be kept short. In fact, the symmetry of the circuit, as indicated in the various diagrams, should be carefully maintained in the lay-out, and the two tank condenser leads, the two plate leads and the two grid leads should as nearly as possible be of equal lengths. The R.F. wiring can be carried out in No. 16 tinned copper wire, kept clear of the baseboard, and the rest of the connections made with good quality rubber-covered wire such as lighting flex, *not* the red-and-black variety.

The R.F. choke R.F.C. can be either an Eddystone S/W choke or else a 1 in. diameter paxolin former 3 ins. long wound full of No. 32 enamelled wire. It should be mounted out of the field of the tank circuit. An R.F. choke is not entirely necessary at this position in this circuit, but it serves to keep radio-frequency currents out of the power supply. It will be seen that the H.T. is taken to the electrical centre of L1. This should be accurately located and the connection can be made by means of a flexible lead and clip. C4 is a by-pass condenser of .002 mfd. capacity, and C3 should be of the same value. The function of the latter is not by-passing but blocking, in case the series-gap condenser C1 should flash over, in which case the H.T. would be shorted to earth. Note that C3 and C4 must be rated at twice the voltage to be used on the transmitter.

C5 and C6 are filament by-pass condensers and can be of the ordinary receiving type, while all these fixed condensers must be non-inductive. R1 is a 30-ohm potentiometer-type resistance, with an adjustable slider to which the key connection is taken. R3 is the grid-leak, 2-watt compression-type, and those of Graham-Farish manufacture are very suitable for all low-power transmitting purposes. Its value depends on the valves used, and will be discussed later.

C2-L2 is the grid tuning circuit, and here a departure from the usual practice is recommended. L2 is of high resistance, giving a flat resonance curve, as in the well-known tuned-plate-resonant-grid circuit, sometimes known as the "TNT" oscillator. This arrangement improves stability when the set is used self-excited. To make the transmitter more flexible and also to tune the grid circuit accurately to the crystal frequency, should one be used, a .0003-mfd. variable receiving condenser is connected at C2. For 160 metres, L2 can be 42 turns of No. 32 enamelled wire on a 1-in. diameter ribbed ebonite former (ribbed rod) with a tapping taken out at the 21st turn. The winding will occupy just over half-an-inch. The former can be mounted on three valve pins to which the connections are taken and then plugged into a valve-holder. The two grid leads and the grid-leak are connected to the latter.

Alternatively, the coil may be wound on a 1-in. diameter tube and some other form of mounting adopted. As before, these finer points can only be left to the choice and discretion of the constructor, who will in any case have his own ideas about them. If a crystal is to be used, the holder is connected across the grids, as shown.

Tuning and Operation

Suitable valves to use with this transmitter are a pair of LS5's, the old stand-by, Osram PX4's, or Mullard

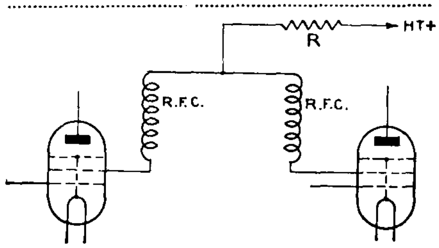


Fig. 4.—Both valves obtain the screen-current from a common tapping. The H.F. chokes are important.

T25D's, or Mazda P650's. These last are recommended and are still available in limited quantities direct from Ediswan's, though they have actually been withdrawn from the lists. The question of valves depends upon what is on hand and whether the constructor is prepared to go to the expense of making extra purchases. Other considerations are the question of the power supply to be used with the set and also the L.T. available.

Assuming it is A.C. and that there is some choice in the matter of valves, P650's should be used. They are extremely useful for all sorts of purposes in the amateur "shack," are very robust and have excellent characteristics; though it is far exceeding the maker's rating, P650's can be operated with up to 400 volts on the plate, and, in a well-designed and properly tuned circuit, can safely be made to handle 10 to 15 watts.

For the preliminary tuning, the crystal holder should be entirely disconnected, and a low value of H.T. used. With an 0-100 mA milliammeter in series with the H.T. positive lead and the key closed, the condensers C1 and C2 should be adjusted till resonance is obtained, indicated by a minimum reading on the milliammeter. The best way of doing this is to set C1 to about two-thirds mesh and swing C2 till the meter kicks back. With P650's, the grid-leak value will need to be about 50,000 ohms, with PX4's the same, with T25D's about 25,000 ohms, and with LS5's 10,000 to 15,000 ohms. These values depend on the H.T. used and are not arbitrary, while grid-leak values are always a matter for experiment.

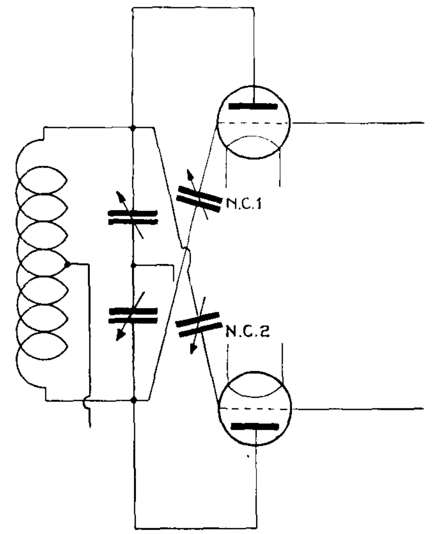


Fig. 3.—These "neut" condensers N.C.1 and N.C.2 can be obtained from Bulgin. They should have long extension handles.

When the set is oscillating, it should be tuned into the 160-metre band with the aid of the receiver and/or frequency-meter-monitor, this last being an indispensable piece of apparatus in any amateur station, and the frequency set to the desired value. An indication of R.F. output can be obtained by holding a tuning-lamp—which, for the uninitiated, consists simply of a loop of wire of the same diameter as the tank coil with a 3½-volt flash-lamp bulb in series—near one end of L1, when a glow should be visible. The H.T. should now be raised to the full voltage to be used, say, 250-300 volts, and the grid-leak value adjusted till the plate current is about 15 mA at resonance.

It will be found that the grid circuit tuning is fairly flat, and the best setting is such that the R.F. output as indicated by the tuning-lamp is a maximum and the quality of the note, as picked up on the monitor, as clean as possible. Slight variations of C2 will make a considerable difference in connection with these effects, while for maximum R.F. and the best quality note, it will be found that the plate current reading is sensibly a minimum, unless the R.F. choke R.F.C. is resonating. The result of short-circuiting this should be noted.

All the adjustments detailed above should, of course, be carried out with the set unloaded; that is, no aerial or "artificial aerial" load should be applied till the transmitter is correctly tuned.

On keying the set, the note should be clean, sharp and steady, with no tendency to chirpiness. And here a few remarks in connection with the keying circuit are necessary. The key is in the centre-tap position, and the resistor R2 and condenser C7 comprise the key filter circuit, the object of which is to eliminate sparking at make-and-break. A little consideration will show that there is a time-factor involved, since the condenser C7 has to discharge through R2 while the key is up. To absorb thumping and produce clickless and sparkless keying, R2 and C7 must be adjusted to suit the particular conditions under which the key is operated. In other words, their value depends to a certain extent on the size of the gap and the keying speed. A safe value with which to start is .25 mfd. for C7 and for R2, a 2,000-ohm wire-wound resistor. These values can be experimented with till the desired effect is obtained.

There are, however, other factors which combine to affect the quality of the note. These are the regulation of the power supply, the loading of the transmitter, and, when the set is used self-excited, mechanical vibration. This latter can be largely eliminated by mounting the set on rubber pads on a firm table or shelf away from the operating position, keying and power supply leads being run loosely for the last eighteen inches or two feet of their lengths before connecting to the transmitter.

Power supply regulation and the problems connected with a properly designed power-pack for a C.W. transmitter do not come within the scope o this article, but the point is that the voltage variation of the H.T. due to keying should be minimised as much as possible, or the note is bound to be chirpy. If there is much A.C. in the signal, it will show that the power pack is being over-loaded or that R.F. leakages are taking place. The filament circuit should be made symmetrical by adjusting the slider of R1 till the cleanest note is obtained.

The constructor is advised to read carefully the advice and directions which are given regarding the tuning of the radiating system, which is a very important point in the proper adjustment and working of the set. Suffice it to say that in a self-excited oscillator, or, for that matter, a crystal-controlled or driven transmitter of any sort, the load should not be such that the output circuit is so heavily damped that the R.F. falls off, even if high aerial readings are obtained.

The degree of coupling between the tank circuit and load should be such that a good transference of energy is obtained consistent with a clean and steady note and no falling off in R.F. output. To take a case, suppose that with 300 volts on the plates of the valves, the plate current reading with the set unloaded is 15 mA. When the load is applied (the aerial brought into tune), the meter reading should not be allowed to exceed 30 to 33 mA. This will give 9.0 to 9.9 watts input in any case, but the point is that plate current should not be pulled up as far as it will go.

Dealing with the other condition in which the transmitter can be used, crystal-controlled, the application is quite simple. As before, the H.T. should be reduced to avoid damaging the valves during the tuning operations, and the crystal connected across the grid coil. If a calibrated monitor or frequency meter is available, as it should be, the process is greatly simplified. The transmitter is tuned to the crystal frequency and C2 is carefully adjusted about this frequency till the crystal takes control. If the "rock" is a good one, it will hold the oscillator through wide tuning ranges, and the point will be easily found. There will be a drop in the plate current reading for resonance with the crystal working, and the quality of the note will also change. It should be cleaner and smoother than when the set is self-excited.

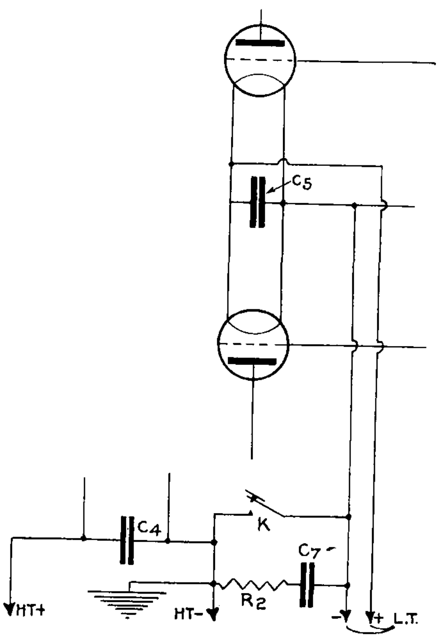


Fig. 5.—Unless you want to interfere with the local listeners, make sure to use key click eliminator across the key.

Condensers C1 and C2 should be carefully adjusted for maximum R.F. output, and it will be found that whereas the tuning on C1 was previously rather sharp, it will now be flatter. When the load is applied, both the transmitter tuning condensers and the aerial condenser(s) will require careful setting for the best R.F. output and the cleanest note. If there is any tendency to chirpiness or "dragging" with the crystal in circuit, due to the latter not picking up well on keying, a high resistance of about 100,000 ohms can be connected across the key contacts. This will ensure that the H.T. is not completely broken and will keep the set oscillating feebly when the key is up. A weak spacing wave will be radiated if this is done and, while it is not in itself very desirable, this will give the transmission the authentic T9 effect.

One further point to notice in Fig. 2 is the disposal of the filament supply winding centre-tap. This is earthed through the 2 mfd. condenser C8; it may be found unnecessary, though it will probably help to reduce the percentage of A.C. ripple on the signal. The centre-tap cannot be directly earthed, as by doing so the key would be short-circuited, hence the condenser.

A good earth should be used, with a well-insulated direct lead, as in A.C. operation the efficiency of the earth is most important.

General

It should be noted that when using P650's, a 6-volt filament supply is required, since these valves are rated at 6 volts, the filament current being 0.5 amp. As 6-volt windings are non-standard on the ordinary transformers, two 4-volt windings of sufficient capacity may be joined in series, with a suitable control rheostat; indeed, this arrangement is desirable, as it takes care of the voltage drop in long filament leads.

With more than about 300 volts on the plates, it may be found difficult to limit the input to a reasonable figure, even by increasing the grid-leak value, an adjustment that can be taken too far. Experiments should therefore be carried out to determine a convenient H.T. supply voltage and grid-leak resistor to give good R.F. output within the required power input. In general, where 10-watt working is involved, 300 volts H.T. is ample. More than this makes the set unmanageable as regards limiting the input.

A transmitter of this type is quite suitable for operation with battery-type valves when ultra-Q.R.P. is used and no mains are available. In Fig. 5 is shown the circuit arrangement for battery-fed filaments, C5 being the filament by-pass condenser. If possible, ¼-amp. valves should be used, as some of those having patent dull-emitter filaments deteriorate rapidly

(*Continued on page* 170.)

Correspondence

Correspondence is invited. The Editor does not necessarily agree with views expressed by readers which are published on this page.

Mr. Parsons's Aerial Image :: Cathode-ray Tubes
Congratulations :: Cathode-ray Sweep Circuit

Re Mr. Parsons's Aerial Image

SIR,

I apologise for this intrusion into the argument, but there is perhaps one point which seems to be overlooked, a physiological (plus psychological), and I trust the query will not be considered too personal. But, what happens to his eyes when he gets tired? (Together with, how long had he been staring at the discs? I know from experience how tiring this can be.) Do his eyes tend to alter focus markedly when tired, i.e., focus say to 10 ins. away, and, most important, do they tend to converge to any point? This might account for much and is on a par with the shock I got when, thinking I was out of the scanning beam of the transmitter, I looked at the receiver screen and saw a face! I must have got sadly lagging optical nerves!

To another subject! Certain "dailies" are having competitions for a suitable name for "one who looks-in." From the Report the obvious seems to be "Millionaire" or "Londoner."

R. H. PARKINSON (Chaddesden).

* * *

Cathode-ray Tubes

SIR,

Congratulation! The first number of TELEVISION AND SHORT-WAVE WORLD certainly fills a much-felt want. I feel convinced that it will receive the support that it deserves.

The much-awaited P.M.G.'s report held quite a surprise. Few, I think, expected the report to recommend a 240-line screen; we could certainly not have wished for a better start.

There is one point, however, that is rather disconcerting, the report speaks of a picture size of 6 ins. by 8 ins., and even bigger, i.e., 9 ins. by 12 ins.; this no doubt refers to the size of the picture obtained on the fluorescent screen of a special Baird-type cathode-ray tube. I am afraid this is out of the reach of the amateur and experimenter as it does not appear on sale so far as a separate unit.

It would seem, therefore, that, short of some means of magnification of the image, the obvious thing is for the valve makers to concentrate on the production of tubes with a screen at least one foot diameter. I personally cannot see why this could not be done, and quickly, to enable the experimenter to have apparatus ready for the forthcoming transmissions. The Baird laboratories have done it, therefore the valve people can.

I am, of course, aware that there are other means apart from cathode-ray tubes (mechanical) of producing a large image, but these are not so easily adaptable to an alteration in the number of scanning lines as a cathode-ray arrangement.

In closing, I was rather surprised to read that for the next two years television was to be put to the acid test of public opinion, I take it that this means the opinion of the people inside the service area of the first transmitter installed. There are going to be a lot of grumbles outside of this area, and I can forsee a false impression being gained by the Advisory Committee.

C. E. MILES (Streatham, S.W.).

* * *

Congratulations

SIR,

We would like to add our congratulations to the hundreds that are, without doubt, pouring in on your new TELEVISION AND SHORT-WAVE WORLD.

America has hitherto led the field in catering for the short-wave experimenters. Most of the American journals are sent us, but there is no doubt whatever that your new journal is definitely better in all respects.

We would like to suggest an improvement, but we cannot imagine one. It will be very difficult to improve it, although from your past record, we know it is your "speciality," improving *good* books.

H. MONTAGUE SMITH, Hon. Sec.,
WESTERN ENGLAND TELEVISION AND SCIENEFIC SOCIETY (Bristol).

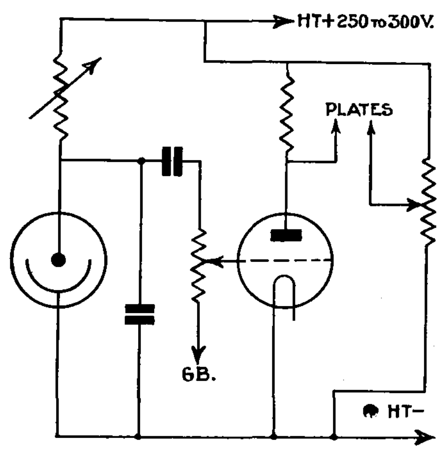
* * *

Cathode-ray Sweep Circuit

SIR,

Now that the cathode-ray oscillograph seems to be asserting its superiority over other systems of reception, some of your readers may be interested in the following suggestion, which I have not so far seen described in the technical Press. As I have not yet had any opportunity of putting the scheme into practice myself, I should be interested to hear of the experiences of anyone who cares to try it.

The chief disadvantages of the Thyratron time-base circuit seem to be the cost of the discharge-tube itself, and the necessity for either a high-voltage supply or a constant-current device to ensure a uniform charging rate; these might be avoided by using a valve to amplify the pulses generated by a neon discharge circuit, as in the diagram.



The small voltage sweep of the neon (about 20 volts) permits the use of a comparatively low H.T. supply without sacrificing uniformity of charge, and, provided the time-constant of R.C. be chosen so as to pass the basic frequency of the voltage swing without serious attenuation, satisfactory waveform should be obtained. (This consideration should also govern the choice of decoupling components in a free grid-bias system if such be used.) An actual anode voltage of 150-200 should suffice for a 200-volt peak-to-peak swing, and with the large input

More about the No-screen Image :: The Amateur Experimenter :: Television in the Provinces

available the choice of valve would not be critical. Almost any spare general-purpose type should do.

F. H. Woodbridge (Cambridge).

* * *

The No-screen Image

Sir,

I am sure you will not wish to use your valuable space for comment upon all of the detailed nonsense Mr. Parsons has written in explanation of his phenomenon.

I would like to say, however, that with the aid of a two-foot rule I have plotted Mr. Parsons *two* visors, and conclude that the dancer he saw was "doing her high kicks," on the tip of that gentleman's nose, observing that he had both left and right hands on the controls of the *two* visors.

Is it too much to hope, Mr. Editor, that you will allow Mr. Parsons to have one more letter on the subject? I thank you for your past indulgence.

B. Luff (Watford).

Sir,

Now that Mr. Parsons has honoured us with a detailed description of his apparatus I trust you will permit me to keep my promise to him to give him some constructive help.

In order to get a no-screen image of high optical quality, in contrast to his present crude image, let him forsake television and concentrate his attention on the homely magic lantern. If he will take a magic lantern into an old shed which has a perfectly black surface all over it, and will take reasonable precautions to see that light only comes out of the lantern by way of the front lens, he will be able, by simply focusing the lens on the desired point, to form an image of the slide at any point in mid-air he wants, and provided the black wall he shines the light on is strongly absorbent the effect will not seriously interfere with the image. The shed should be as free from dust as possible.

Mr. Parsons need not be upset by the simple fact that, as there is no screen to reflect the light, the image will normally be invisible, for this is the fundamental and essential feature of all no-screen images, except when it is possible to place the eye in the direct line of the lens and image, in such a way that the lens or mirror forming it subtends at the eye a solid angle equal to and greater than that subtended by the image, and of such a shape as to allow the image to appear framed in the lens. This is also the case with the virtual images formed by the magnifiers of the ordinary Baird disc machines. The necessity of getting the eye in line with the lens and image limits the number of people who can observe the image in comfort, as he will know if he has ever been one of a crowd jostling for a place in front of an old disc machine.

My second piece of constructive criticism is that the next time he tries to throw the image from one visor on to the spokes of the disc of another he point the first visor so that its axis is pointing towards the disc of the second machine, and use a lens to focus the spot on the spokes of the disc. He will find this much more satisfactory than having them with their axes at an angle of 60°. Incidentally it is pretty obvious that what would happen if he succeeded in throwing the image on the spokes of the other disc would be that he would get an image traversed by vertical dark lines representing the occasions when the spot goes through the space in between the spokes of the disc.

And thirdly, I cannot too strongly advise Mr. Parsons to purchase a good miniature camera, and keep it by him on his workshop bench loaded with a fast film, with which he will find it quite easy to photograph the most shadowy image with quite a short exposure. Furthermore, and this is most important, when he next observes an interesting phenomenon he can take two or three photographs, from different known viewpoints, of his apparatus, so that he may place it in exactly the same position at any later date should he desire to repeat the phenomenon.

Finally, while burglar stranglers and light-beam wireless may be all right for the local press, I am afraid he has seriously underrated the intelligence of your readers if he expects anything so vague and unscientifically described to be regarded as a contribution to science.

G. L. Rogers (Cambridge).

OPINIONS ON THE TELEVISION COMMITTEE'S REPORT

The Amateur Experimenter

Sir,

I am very pleased to note the findings of the Postmaster-General's Committee, particularly with regard to the adoption of 240-line pictures. The detail obtainable should definitely place television in the realm of entertainment.

At the same time, there is a great deal of experimenting to be done, since the technique of short waves is understood by comparatively few listeners, and in this connection I foresee the revival of enthusiasm of many amateur constructors.

In the early days of wireless the amateur constructor flourished mainly because of the high prices ruling at that time, and it would seem that the same state of affairs will prevail in the television world.

Everybody realises the immense help which the amateur experimenter has given to the industry, and your paper is doing valuable work in stimulating their interest in television.

It is only by reading all the available literature on the subject and by continuous experimenting that we can hope to gain a sound knowledge of the new science which is being inaugurated.

W. W. Burnham, Manager.
The Edison Swan Electric Co., Ltd. (Radio Division).

Television for the Provinces

Sir,

I think the Television Committee are to be congratulated on their suggestions for the future development of television. No doubt many lookers who live outside the London area will be disappointed that for at least some time to come, only those living in London will have a television service. I feel there is little doubt that it will be a long time before the rural areas, to which it would be the greatest boon, will have a service. Still, ultra-short waves may have a longer range than is generally supposed—let us hope so for the country cousin's sake.

The cost of a cathode-ray tube, if the present high price be maintained, will probably hamper the popularisation of television. It is to be hoped that firms sponsoring mechanical scanners will be able to offer some healthy competition.

ROBERT DESMOND (London, N.W.).

(Mr. Robert Desmond is a well-known contributor to this journal and is engaged professionally in television development.)

* * *

240 Lines and Mechanical Systems

SIR,

Now that the eagerly awaited report of the Television Committee has been published, I feel sure that the commercial development of television which has for so long lagged far behind its technical progress, will at last make rapid headway.

Perhaps the factor which might be regarded as most controversial in the report, is the selection of the high figure of 240 scanning lines as the standard of definition for immediate adoption. This selection has caused considerable dismay for the moment amongst the supporters of those systems which can only handle such a high definition with great difficulty at their present stage of development. There can be little doubt that the time taken before a wide service can be put into operation would have been shorter had a lower number of scanning lines, say, between 100 and 200, been chosen, as this would have rendered available at once equipment of a wide variety.

The high figure of 240 lines has undoubtedly been made possible through the great advance in transmitting technique brought about by the systems of "electron scanning" evolved in a practicable form only during the last year. Up till then, the technique of receiver design seemed well ahead of that of transmission; this had been the case since the earliest days of television, and it did not seem possible to transmit anything other than films at definitions higher than about 120 lines.

This state of affairs has been suddenly and strikingly reversed. In my opinion it is still a matter of doubt whether any system of television is yet so far perfected that a 240-line transmission of perfect quality can be sent out and received by radio, and reproduced on the viewing screen, without experiencing some loss of quality. It has been suggested that the best images at present possible in the home are about of the order of definition of a *perfect* 120-line image. This is a very good and useful definition, in comparison with that which has been available up to the present.

It is on the radio side, however, that we shall experience the greatest difficulty at first in handling 240-line television. Satisfactory receivers have yet to be designed, as few, if any, are yet available. When this problem has been solved, as it may well be in quite a short time, there still remains that of transmission. On the question of the practicability of designing a substantially perfect radio transmitter for a modulation range up to nearly a thousand kilocycles, very little published information is available. Whilst there can be little doubt that such a design is possible, its evolution may perhaps take time. It is interesting to note from reports on recent work of the Radio Corporation of America, published in the proceedings of the I.R.E., that their most recent equipment was admittedly unable to do full justice to television signals of more than about 120 lines; higher definition signals suffered appreciably in the radio circuits.

I do not wish it to be thought, however, that I am antagonistic to the selection of 240-line definition. In spite of the foregoing remarks, this high standard cannot fail to raise the eventual standard of the television service, and it has the inestimable advantage that the standard should not require revision for a fair number of years. In my opinion this fact alone quite justifies the choice which has been made.

In other respects the Report seems eminently fair and reasonable. I notice with particular approbation the emphasis laid on the provision of ample facilities for experimental research, and hope that this will lead to a reasonable degree of freedom for the amateur experimenter, working on the radio aspect of television.

It is of interest to note that the possible use of modified scanning systems to reduce flicker is referred to in the Report, and their effectiveness admitted, whereas no such system is recommended for adoption. I cannot but deplore the suggestion, however tentative, that the images per second might be increased to 50 at some later period, to eliminate flicker.

More economical means of doing this are theoretically possible, and must be sought for. Surely the present enormous frequency band is wasteful enough?

I am also a little disappointed that the additional use of a medium-definition service, of round about 60 lines, has not been decided upon. Such a service, capable of reception in all parts of the country on a wavelength near 200 metres, seems to me to be essential for the full exploitation of television as it is to-day, and for several years to come.

E. L. GARDINER (London, W.).

* * *

Ghost Images

SIR,

I wonder how many "lookers" were able to receive television (those outside the service area of London National) on Wednesday night, February 13, free from its very strange behaviour of a peculiar motor-boating signal, which appeared on the screen alternately as the image, then the form of a ghost image, constantly, at the rate of about 80 times to the minute throughout the whole transmission.

This was free from fading and remained synchronised.

I have been looking-in since 1930, but never received such a strange phenomenon.

N. M. BUTLER (Breaston, nr. Derby).

* * *

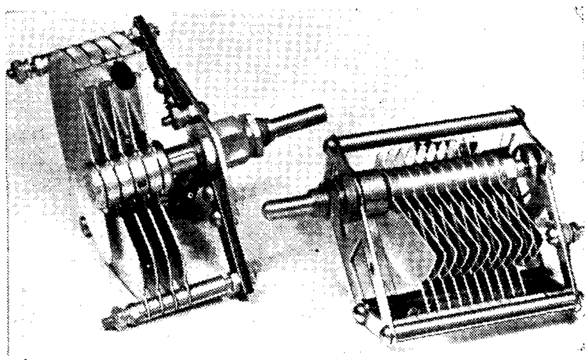
"The Off-the-Screen Image"

SIR,

I have received letters in connection with the above subject and have secured the type of information I sought at the outset. One letter, from a very authoritative source, throws some considerable light upon the subject. It is gratifying to know that one is not alone in this type of experience and I am very grateful to you, sir, for having made it possible for me to compare notes with the source I refer to.

Thanks, too, to your many correspondents for their interest taken. When I have gathered together certain other information I shall, if occasion warrants, write an account of my investigation.

ALBERT PARSONS, F.R.A., F.T.S.



These two condensers are ideal for transmitting work. On the left is the new Stratton .0001-mfd. condenser having very low-loss insulation, while on the right is a special Jackson condenser having a maximum capacity of .00015 mfd.

Heard on the Short Waves

By

Kenneth Jowers

THIS has been quite an eventful month. I have been able to arrange to have reception reports from nearly every part of the country while, during some spare week-ends that I had, I have been able to call on many old friends, partially for business and partially for pleasure.

The most interesting time I had was when I made a tour of Essex and saw some of the transmitters which you probably all know so well.

The only unfortunate feature about it was that I picked a rather bad week-end to make this trip, when the roads were completely ice-bound, which made travelling rather dangerous.

My first call was on G5UK, who was able to show me some of his experimental gear, including his top band transmitter, which uses a pentode CO and Det.5PA, his tri-tet forty-metre transmitter and his push-pull five-metre oscillator.

I was glad to see he was interested in television, which is really very closely related to short-wave radio and is using a disc receiver, in which G2OV was very interested. While I was there he had several QSO's on the forty-metre band and he was able to demonstrate his two receivers to me.

Actually, as his aerial system is not particularly well situated, his results are particularly noteworthy, for he is able to contact with New Zealand, Australia, India, etc., quite reliably.

After that I dropped in on G2KT about 5 o'clock, and had plenty of time to inspect his transmitters.

Even though his feeders sagged a little and were touching the roof, radiation was still good, and he was able to make some very good contacts on the 20- and 40-metre bands. The high spot of the evening, however, came later, when on the top band I was able to have QSO's with several other friends, including G2LZ, G6KV, G2OV and G5UK, whom I had previously seen.

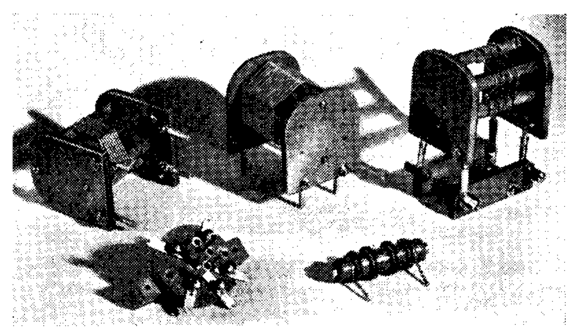
I did not arrive at G6KV's place at Laindon until well after 9 o'clock, intending to stop only a few minutes, but one thing led to another, and I was still there at 10.30 when he came on the air.

The gear there is very straightforward, which probably accounts for the exceptional efficiency of this station. Readers will have probably noticed that in the reports received from various parts of the country, the call G6KV is always very prominent. The transmitter consists of a crystal oscillator stage, a buffer and PA, the actual power being a little under 10 watts. It was just before midnight before G6KV finally closed down, leaving me with at least sixty miles to go. Fortunately G6KV has his own special methods of keeping out the cold. So the long journey did not worry me very much, and I was home in under two hours. It is very interesting being able to compare these transmitters, and I hope shortly to be able to tell you something about the amateur stations in the Birmingham area.

One of our new readers, N. Brandon, of Barnet, has been doing particularly well on a detector-low-frequency receiver. Although stations logged are mainly commercial broadcasters, the logs are a lot more original than most. For instance, stations such as VUB Bombay, ZJT Jo'burg, W1XAZ, Boston, OER2 Vienna, VQ7LO Nairobi, YB3RC Caracas, HJ1ABB Barranquilla, YV5RMO Maracaibo, and COC Havana all figure very prominently in his report. Remember that he only uses a two-valve receiver, on the 19-, 25-, 31- and 49-metre bands.

In Glasgow, B. McDougall is still reporting on amateur-band reception. His logs average 20-25 stations and include G2OC at R4, 6YU at R7, 5JW at R5, 2MV at R6, 2XO at R7, 2AO at R6, 6KV at R5, etc.

Writing from Bangor, Ulster, W. Sullivan, 2BJH, mentions that the American twenty-metre phone stations are falling off in strength whereas Aus-



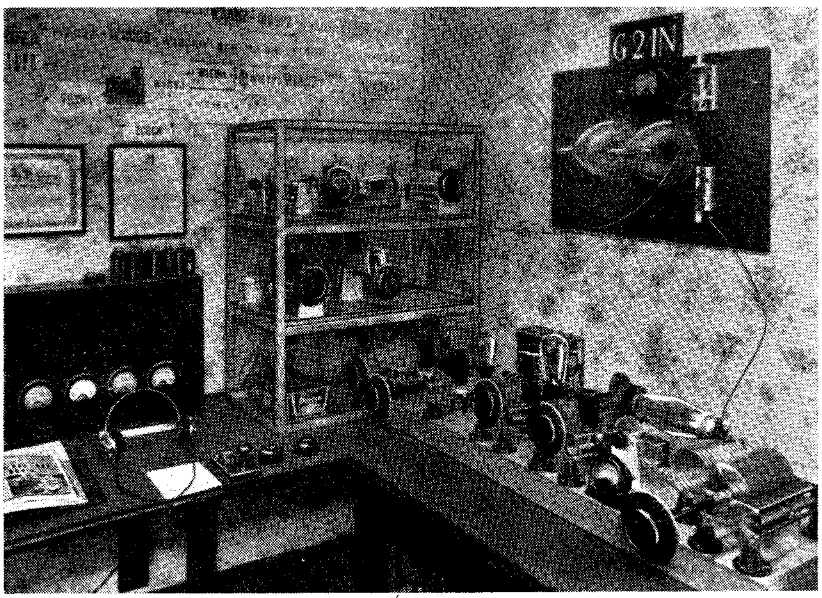
Wright and Weaire are making a very extensive range of short-wave components on Mycalex former. Typical examples are these short-wave coils, high voltage test valve-holder and a non-resonant short-wave choke.

The Epoch Condenser Microphone.

tralians and New Zealanders are averaging R8, usually between 8 and 11 a.m. This report rather contradicts some of the views of English listeners who find 20-metre phone stations particularly interesting.

2BVV says that at Reigate 20-metre phone stations are coming in very well from 10 a.m., fading out at 14.00, while the 7-megacycle band is utterly useless for DX reception.

One of the most successful receiving stations is owned by John Preston, of Muirkirk, Ayrshire, who, owing to an exceptionally fine receiver, locality and general interest in short-wave listening, is always able to produce a really fine log of stations.



G2IN's station at Southport.

He points out there is considerable activity on the 75-metre band. W3DQ, of Wilmington, made his first G contact when he worked with 5VL in Cornwall. G6LL, of London, contacted with Canadian VE1ET, while W3UD, of Philadelphia, is standing by every evening in the hope of working a G station on this band.

Anyone who is doubtful about top band DX work should make a note that G2LH, of Surbiton, successfully contacted a trawler 650 miles away. The same station also reports that he is being received in Palestine on 1.7 megacycles. G2VQ is also doing good work on the top band and reports that he has been received in Munich at good strength.

Mr. Preston mentions that CT1BY, of Lisbon, was heard working on 20-metres as late as 18.30. W stations on the 75-metre band are being received every evening from 22.00 onwards. W1DTK, of Rhode Island, was also heard on 1.7 megacycles, actually on the same frequency as that used by G2VQ.

It is possible that a duplex chain between 5NW, of Dundee, through 6FR, 6OM, 2VQ and 2LZ will shortly come into being. The details are being carefully considered.

VE1ET has been heard calling 2OV, 5NW and PAOWV quite consistently. 2LZ was heard working HB9B and made a recording of the Swiss transmission. He also made a record of W1EDW calling G6PY. 2LZ must certainly have some receiver.

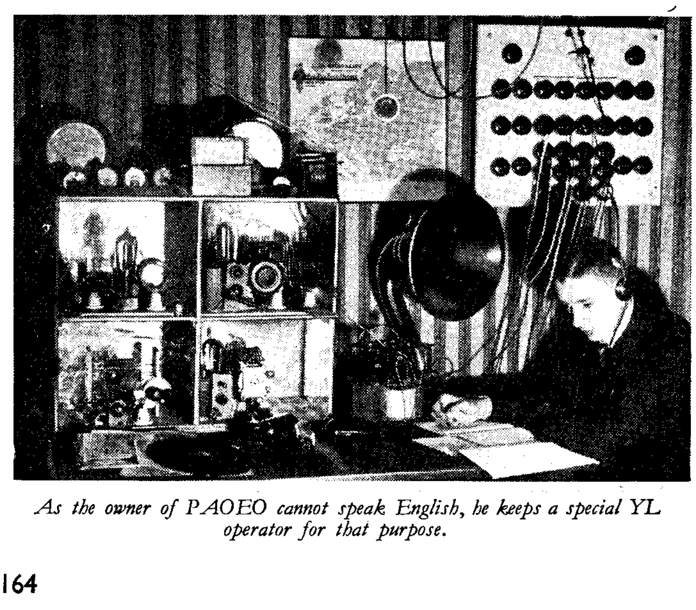
Why is it that the top band is being heard so well in Scotland? G6AV, of Forest Gate, is being heard up there at R6/7 with a power of only 8.5 watts. And I mean 8.5 watts.

F. A. Beane, of Ridgewell, Essex, has got a very nice log of South American stations. He mentions that the 49-metre band is really fine at the moment and only using a receiver with a detector and two low-frequency stages he has heard COC, Havana.

CT1AA can be heard testing on 50.16 metres and is being received at an average strength of R8.

20-metre amateur reception is very patchy according to R. D. Everard, of Standon. He finds that the best time for reception, with the minimum noise level, is between 16.30 and 17.30 with an occasional spread up to 20.15.

The star station on this band is W5ZS of Louisiana, which is in the same building as KWKH. Amongst the 20-metre phone stations logged at Standon were W8CLY, W1DBM, VE2EE, W9AIO, W4YC, W2AYA, W9BPK, W3NK, W2GWH.



As the owner of PAOEO cannot speak English, he keeps a special YL operator for that purpose.

Conditions on the 75-metre band are reasonably good with the exception of a very high noise level. It is particularly interesting to notice that W4AEZ, a portable station, W4COF, W2FLO, VE1EI, and W3UT have all been logged on this band using phone. The best time for reception is between 22.45 and midnight.

Mr. Everard's best bag of the month is VP6AP on the 40-metre band. DX does not seem very good on this waveband, and consists principally of Dutch, French and Spanish amateur stations. Mr. Everard mentions that he has a "veri" from D4XAA, the Technical College, of Stuttgart. Although this station is on the 40-metre band several readers commented that it is louder on 80 metres. His total list of "veries" now is up to 405. Incidentally VK3ME has been heard on the loud-speaker at Standon, while VK3LR was heard testing with Radio Nations.

E. Mitchell, of Scarborough, sent me a very nice report indeed. It is particularly welcome for Yorkshire listening stations seem to be conspicuous by their absence.

Although Mr. Mitchell is only using a 1-V-1 receiver with a badly screened aerial he has been able to log quite a number of American stations on the 20-metre band after 14.00. Amongst the stations heard were W2GON, W3EHY, W2KNA, W5ECL, W6ENE, W2MG, W2AIE, W2HFS, W2CQS, and W6UZ. Average strength of all these stations was R5. Mr. Mitchell also mentions that the 31- and 40-metre bands have been very unproductive of DX.

Listeners in Hull should make particular note that the conditions in that area have greatly improved. Mr. John A. Hay has been doing quite well, and on 20-metres was able to log W3CBO, W1DBB, W1YNJ, W1HNY, W1FFW, W1ATS and W4BPR. In addition he has logged our old friend K4SA and VK, VE, SU, ZC, ZP, ZD and ZS stations.

40 metres only produce the local F's, PA's, D's, DA's, CT's amounting to 150 altogether. Many thanks for the report John Hay.

I always like to receive reports from listeners in congested areas for it helps to tell whether the value of conditions are of any real detriment to DX reception BRS1,287, F. G. Sadler, of Stamford Hill, has not done very much on the 20-metres, but has quite a good log of G, DF, EA, FM, HA, and OK stations, on the 40-metre band.

BRS1,298 Bradford, has logged VK2LZ, VK2ME, on 20 metres, HB5R, OZ5H, OK1VG on 80 metres. On the top band G stations seems to be most prominent. These include 5PL, 2II, 6IZ, 6KO, 2UQ and 2LZ. Quite a number of new verifications have been added to Martin Railton's log, who, by the way, hails from Loughton, Essex. Amongst the countries added are ZC6, ZEI, ZTI, VK3 and VK5. On 20 metres Martin Railton has heard over 70 C.W. phone stations with a similar number on 40 metres.

Readers in Wales will be glad to have the opportunity of checking up their logs with a local receiving station, BRS1,060, Mr. C. E. Spillane, of Prestatyn, sent me a very fine log. He is using an 0-V-1 of conventional design. On this receiver on the 20-metre band he has heard over 60 stations at average strength of R6/9. Amongst some of the unusual calls he heard were K5AG, VP5EZ, W3BLQ and our old friend Lloyd Morse, W1CAA. BRS1,060 goes on to say the VK and ZL stations are quite reliable on 20 metres between 07.00 and 09.30. On 75 metres quite a number of stations has been heard including W3AXR, W9MM, W2AGA, W4BAC, W8AOM, W4ACZ, VE1EI, etc., etc.

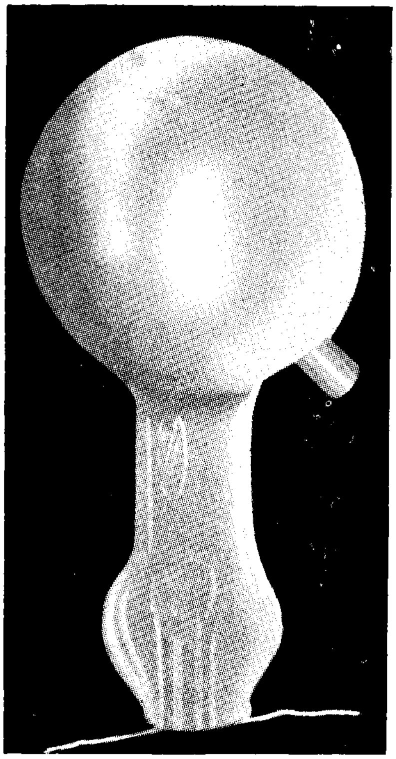
For the benefit of North Wales listeners the following times have proved to be the most productive. On 20 metres between 12.00 and 17.00 for the following stations: W, VE, K5, ZL, VK, VP5, YL, LY, OH and TF stations. On 40 metres between 06.30 to 09.30 for ZL, VK, K5, VE, LU, VK7, FM4, and W4, 5 and 6 district stations. On 75 metres between 23.00 and 06.00 the W and VE phone stations are coming through extremely well.

Schnabel and Television

In the course of a conversion with a representative, Arthur Schnabel, the great German pianist, expressed the view that when television became as widely an affair of the public as radio is to-day, the best results would be found, in the realm of staging musical works, to have pieces written and composed, and produced specially for the new medium. He instanced the Walt Disney sound-film creations as being specially adapted to the needs of that province of art, which to a considerable extent explained their universal success. By any other means these delightful extravaganzas of the Silly Symphonies and Mickey Mouse series would be just foolish. Conversely, to attempt to televise operas, or scenes from operas, such as those of Wagner, would be altogether bad art, even were it technically possible. They had been conceived for production under completely different circumstances, too vast ever to be intelligible in what must be, apparently, the comparatively restricted resources of television reception.

The Amplification of Photo-electric Currents

This is an informative article on the amplification of small direct currents with particular reference to photo-electric currents with some notes on their measurement.



ONE now common application of the thermionic valve is for the amplification of small direct currents, such as those produced by photo-electric cells in the invisible-ray burglar alarms. The valve is also used in scientific laboratories for measuring very small currents; photo-electric currents again provide a common example, while the small ionisation currents produced by X-rays provide another.

The principles underlying the use of valves with direct currents are, of course, the same as in wireless where rapidly varying currents are dealt with, but the details are naturally different. A description of some of the circuits used follows. To those to whom the behaviour of alternating currents is a little puzzling they will be more easily understood than wireless circuits, to which their relation is easily traced.

The General Circuit

For the sake of clearness, a photo-electric cell will be taken as the source of the current which is to be amplified. The basic circuit is shown in Fig. 1. C represents the photo-electric cell and A a milliammeter in the anode circuit of the valve. Suppose the grid bias battery G is two volts; the H.T. battery is, say, 60 volts, and the grid leak is 1 megohm. Assume for the moment that the photo-cell is disconnected. The potential of the grid of the valve with respect to the negative side of the filament is then minus two volts. Suppose the valve is such that it is then operating well on the straight part of the anode characteristic, and that the mutual conductance of the valve is 1 milliamp. per volt. If the photo-cell is now connected in, but kept in the dark, the condition of the valve remains unaltered because the cell is passing no current. Now let the cell be illuminated so that it passes a current of 1 microampere. This current will flow down the grid leak and the potential of the grid end of the leak will then become different from that of the other end. The difference is given by the formula $V = CR$. Since we have assumed the current C to be 1 microampere and R to be 1 megohm, the potential difference V will then be one volt. Also, the grid end of the leak will be negative with respect to the other end. The voltage on the grid, therefore, falls by one volt and the anode current falls by 1 milliamp.

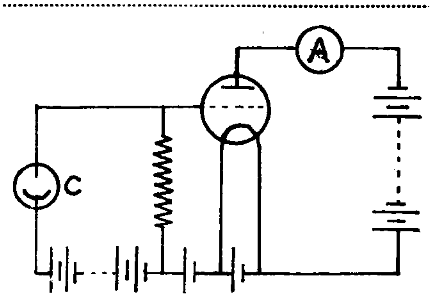


Fig. 1—A basic photo-electric circuit.

The result of a current of 1 microampere flowing in the photo-electric cell has thus been to vary the anode current by 1 milliampere: that is, the photo-electric current has been in effect amplified one thousand times. The factors which control the amplification of the current are clearly the value of the grid leak and the mutual conductance of the valve, provided that the resistance in the anode circuit is small. If a relay is connected in the anode circuit, the change of current of 1 milliamp. can be sufficient to cause it to operate, and thus if suitable relays are used this very simple circuit can control a large amount of power.

It will be noted that the current in the anode circuit decreases when that in the grid circuit increases, so that a " negative " amplification is obtained. This is obviously of no importance, however, and even if it were it would only be necessary to connect the cell and its battery the other way round. This is the way more generally used, in fact, because the H.T. battery of the valve can then be used for the cell, but the way shown is slightly clearer for describing the action of the circuit.

Measurement of Small Direct Currents

This kind of circuit can be adapted for the measurement of small currents, as distinct from their mere amplification for the operation of relays. It would hardly be used to measure currents as large as one microampere as in the example given above, however; currents as big as this can more conveniently be measured on a galvanometer. But suppose the current to be measured is only one thousandth of a microampere, in which case the use of a galvanometer is difficult. In the circuit of Fig. 1 the change in the anode current would be only one microampere in this case and this cannot be indicated on the milliammeter. If a microammeter is used instead of the milliammeter the current flowing when the cell is in the dark would throw the needle right off the scale.

The trouble is easily avoided, however, by using the circuit shown in Fig. 2. This differs from Fig. 1 only in that a current from the extra battery B is driven through the microammeter in a direction opposite to that given by the valve, and so adjusted by means of the resistance R that it is exactly equal to the cur-

(*Continued on page* 168)

HOW PHOTO-ELECTRIC CURRENTS ARE MEASURED

rent given by the valve when the photo-cell is giving no current. The microammeter does not then show any deflection until the photo-cell passes a current, and it will then indicate one microampere for every thousandth of a microampere given by the photo-cell.

A difficulty with the circuit is that any small change in any of the batteries will disturb this balance, so causing the microammeter to show a deflection even when there is no change in the photo-electric current. Any small change in the condition of the valve will have the same effect. A number of different methods of balancing out the current given when the cell is in the dark have been used; most of them are so designed that any such change in the working conditions shall be automatically compensated for, so that the microammeter shall only show deflections when the photo-electric current varies. Limitations of space forbid going into these here.

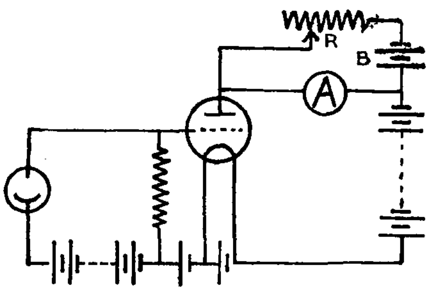


Fig. 2—A circuit for the measurement of photo-electric currents.

In the example given an amplification of 1,000 times was obtained by using a one megohm grid leak; since the amplification is proportional to the size of the grid leak it would seem, at first sight, desirable to use as large a value as possible. Actually though, with ordinary valves it is not convenient to use more than about 10 megohms. The reason is that the effective insulation of the grid is not constant owing to variations in the grid current, and this acts as a variable shunt to the grid leak. If the grid leak is much more than about 10 megohms this begins to be of importance with the result that the amplification becomes variable, the whole circuit becomes a little unsteady and the microammeter needle tends to develop a steady " drift."

Valves have been specially developed for this kind of work; their feature is a very high insulation of the grid, enabling very high value grid leaks to be used. Values of the order of 100,000 megohms can be used without any difficulty, so that very large amplifications can be obtained. The mutual conductance of these valves is low (about one-tenth of a milliamp. per volt), but the loss of amplification due to this is tremendously outweighed by the gain resulting from the use of the bigger grid resistance. It is interesting to note that 100,000 megohms represents perfect insulation in radio work.

Two-stage Amplification

There is usually no advantage in using more than one stage of amplification in measuring photo-electric currents, but when it is required that the amplified current should work a relay it is sometimes desirable to use two or even more stages. Fig. 3 shows a circuit for two stages. Its relation to the resistance-capacity coupled amplifier used in radio work is immediately obvious. The amplified voltage change at the anode of the first valve, consequent upon the voltage change on the grid due to the photo-electric current flowing down it, is applied to the grid of the next valve. If the connection between the anode of the first valve of the grid to the second is made directly, the latter will automatically be heavily positively biased—60 volts would be a reasonable amount. If the valve is such that minus 10 volts grid bias is suitable, then the battery B must be minus 70 volts. The same H.T. and L.T. batteries can be used for the two valves. Obviously the first valve should be one with a high amplification factor.

It is perhaps worth pointing out the rather obvious fact that if the photo-electric current is magnified 1,000 times by one stage of amplification, yet two stages do not give 1,000 × 1,000 times, but only 1,000 multiplied by the voltage amplification given by the first valve.

All these circuits, with minor modifications, can be run from a mains supply where the purpose is just to work a relay, but for the measurement of photo-electric currents it is almost essential to use batteries, as the inevitable fluctuations of the voltage produce a little unsteadiness of the indicating instrument and this is fatal to accurate measurement.

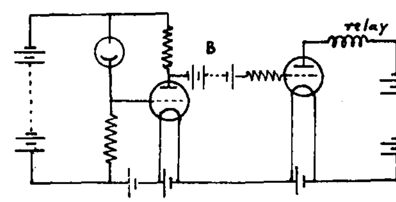


Fig. 3—A two-stage photo-electric amplifier for the operation of a relay.

The question of the type of valve most suitable for this kind of work has not been mentioned. It depends largely on the purpose for which the circuit is to be used, whether for measurement or for control: if the latter, upon the type of control required. Triodes have been shown in the diagrams for simplicity.

The Optical Principles of Television

An interesting course of lectures are being given at the Imperial College of Science and Technology, South Kensington, S.W.7.

The complete course consists of six lectures which are being given by Dr. W. D. Wright, D.Sc., A.R.C.S., D.I.C.

The syllabus has been designed to meet the needs of those engaged in television research and provides a critical analysis of the inherent optical problems in modern television practice.

These lectures are being given on Tuesdays and Thursdays at 4 p.m., and commenced on February 19, 1935. The fee for the complete course is 21s.

Further details and tickets can be obtained from the Registrar of the Imperial College, at the above address.

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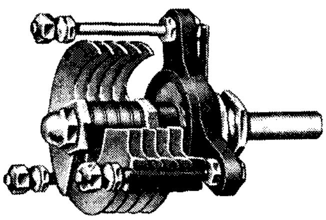

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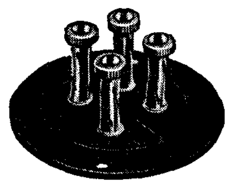

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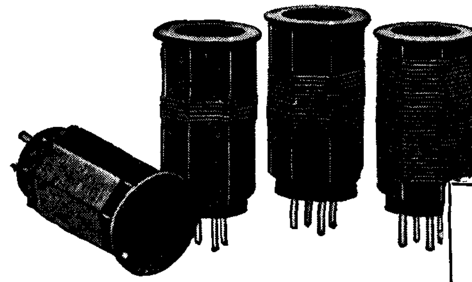

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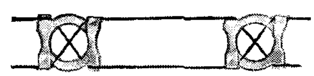

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"The Simplest Cathode-ray Receiver"

(*Continued from page* 154.)

ceiver will pick up the television satisfactorily, and it is only a question of a little patience and care in the adjustments before the scanning lines are set to frame correctly every time the receiver is switched on. During the running the temperature of the relays will alter slightly and a touch on the controls will be required to keep the picture steady if the synchronising is weak. The cathode of the tube should be operated at as low a temperature as possible consistent with sharp focus and should never be overrun.

Finally, remember that you are dealing with voltages higher than those to which you are accustomed and exercise the utmost care. The condensers will remain charged for a considerable time after switching off and they should never be touched until they have been made safe by discharging.

Cover the sides of the chassis with three-ply wood stained and varnished, leaving the controls at the back covered, but easily accessible. The receiver will then be a neat job without looking too bulky, and will serve as valuable experience on which to base a knowledge of cathode-ray tube reception.

Since the design of this receiver was undertaken the C.R.2 rectifier in the H.T. unit has been superseded by the M.U.2 type. This does not make any difference to the performance of the set and the price of the rectifier (15s.) is unaltered.

"A Multi-purpose 10-watt Transmitter"

(*Continued from page* 159.)

when used as oscillators. Of the old types still available, the PV625 and CT25X are very good, while the more modern Mazda P220A's are excellent for Q.R.P. work.

With indirectly-heated valves run from an A.C. supply, the cathodes should be joined to the slider of R1, all other connections remaining the same. The Mazda AC/P or AC/P1 are good valves in this class, the characteristics of the P650 coming somewhere between them. The disadvantage of using indirectly-heated valves is that, owing to the time-lag on the heaters, they cannot well be switched off between transmissions. If left on, it usually results in hum being induced in a sensitive receiver, especially if all the equipment is tied to a common earth. To run 1-amp. valves from batteries becomes wasteful, though it is done at some stations. If the hum difficulty can be overcome, however, they are very satisfactory.

In connection with pentode oscillators, it has been found that very good results are obtained by keying in the auxiliary grid(s). The circuit arrangement indicated at Fig. 4 can be used, the key being put in series with the voltage-dropping resistor R. The value of this depends on the type of valve and the total H.T. used, which should not be enough to cause secondary oscillation with the auxiliary grid circuit open. With Mazda AC/Pens, about 300 volts is permissible with 250 volts on the auxiliary grids. As the grid current is only about 7-10 mA under these conditions, it is a comparatively simple matter to get clean and clickless keying, as the current being broken is so small.

Baird Developments

Elsewhere in this issue we are able to disclose the advanced developments reached by the Baird interests; there is no doubt that they have gained considerably from their association with Gaumont-British. If this company were to be granted a private licence for television transmissions on a proper service basis they could, even to-morrow, put out an amazingly good show.

THE TELEVISION ENGINEER

MODERN PHYSICS AND TELEVISION RESEARCH—III

By J. C. Wilson, of the Baird Laboratories

This is the third article of a series on pure physics. It shows how desirable a conception of modern ideas is to the research engineer.

THE QUANTUM OF ACTION

Recapitulatory

IN the previous articles of this series, we have been examining some of the properties of space upon which the exact description of natural events rests. To do this, we examined particularly the way in which different observers would agree to differ about the results of their experiments with light, and we touched upon the new geometry of space resulting from all this. Especially we noted a consequence of that portion of relativity theory known as the General Theory: namely, that a few minutes measured by one moving observer might correspond with many years measured by another differently moving one.

We cannot, of course, in the compass of these brief notes explore all the consequences of relativity theory, but before passing on to the special parts of physics that more intimately concern television research, we may remark that in the light of the General Theory, gravitation manifests itself as an inevitable consequence of matter-infested space. In other words, it is not so much a subtle force exerted between bodies, capable of being cut off by some as yet unknown "insulator," and requiring a special ether of its own to provide the medium of action. Rather is it the effect of the properties of space in the neighbourhood of massive bodies, so that centrifugal force (such as that felt when a stone is whirled on the end of a string) and centripetal force (such as the so-called "attraction" of the earth on a stone, in causing it to fall) are really different aspects of a universal law.

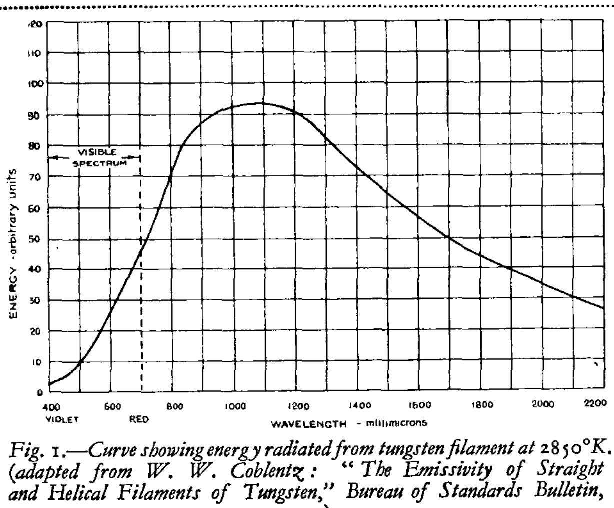

Fig. 1.—Curve showing energy radiated from tungsten filament at 2850°K. *(adapted from W. W. Coblentz: "The Emissivity of Straight and Helical Filaments of Tungsten," Bureau of Standards Bulletin,* 1919).

Moreover, the Universe containing all this matter is, as an inevitable consequence of the presence of the matter, Reimannian: that is, it is of such a nature that though unlimited, in the sense that it has no boundaries, it is not infinite in extent. The answer to the question which is often asked: "What is outside it, if it is finite?" is not "Nothing" but "There is no outside." Space, in fact, is curved; and the curvature is due to the matter in it. Yet strangely enough if one removed the matter, one would not be left with space uncurved, but with literally *nothing*.

Jeans has recently* put the matter very elegantly by pointing out that if a telescope sufficiently powerful to enable all the stars in space to be counted were increased slightly in power, some stars would be counted twice. The conception of this kind of space is no new thing, for Reimann in 1854 pointed out its properties,† and of it Helmholtz says:‡ "The strangest sight, however, in the spherical world would be the back of our own head, in which all visual lines not stopped by other objects would meet again, and which must fill the extreme background of the whole perspective picture."

The Necessity for the Quantum

One of the few ways in which relativity theory may be tested experimentally lies in its explanation of a peculiarity in the motion of the perihelion§ of Mercury, which was for some time an astronomical puzzle. On a huge scale, therefore, we have an obscurity in orbital motion engaging attention, while in the region of the extremely small another orbital motion was exhibiting queerness of an even stranger kind: I refer to the mysterious restriction of electrons to certain orbits in the Rutherford-Bohr atom model, to the nature of which we now must turn.

In 1913, Neils Bohr, who had for some time been actively engaged in atomic research with Rutherford, propounded in its early form his theory of the structure of the atom, in which the unit of matter was stated to comprise a small, compact nucleus (positively charged) with electrons gyrating around it in different set orbits. On this theory, so long as the electrons belonging to an atom continued to swing around in their respective orbits, no energy was either lost or gained by the atom: but if for some reason (perhaps under the impact of a fast-moving electron from outside) an electron left one orbit and took up its gyration in some other, usually at a different distance from the nucleus, then a certain amount of energy was gained or lost. If the electron jumped from a smaller orbit

(*Continued on page* 174.)

* Sir J. H. Jeans, "The Listener," Vol. xii, No. 307, p. 908.
† Abhandl. del Königl. Gesellsch. zu Göttingen, Bd. xiii.
‡ Popular Lectures (tr. Atkinson), 1898: "On Geometrical Axioms," p. 62.
§ The point on its orbit at which a planet is nearest to the sun.

THE TELEVISION ENGINEER :: (Continued from page 172.)

to a larger, energy was gained (for example, from the impacting electron, or from light, as in the case of selective absorption of light by gas); but if the jump occurred in the opposite sense, then energy was lost (as in the case of light radiation from a gas-discharge tube, or in fluorescence).

But the astonishing part of this theory, which fitted in very well with the line-spectra of those gases with which it could be tested, was that there appeared to be no valid reason for the electrons preferring certain orbits and eschewing all others. Moreover, since an electron is a particle of electricity, and therefore when moving is equivalent to an electric current, the orbital motions ought to give rise to oscillatory electric and magnetic fields with consequent continuous radiation and loss of energy possibly in the form of light: no such effect with stable atoms was known to occur.

Problem of Incandescent Radiation

Yet the clue to this extraordinary behaviour of particles in very small orbits was already extant, and to trace its inception we must go back to the years 1900 and 1901, when Max Planck* suggested an explanation of an equally puzzling yet perhaps not so widely known phenomenon. It is well known nowadays that there is a certain law of correspondence between the amount of energy radiated as light and heat by an incandescent body, and the wavelength (or colour) of that energy; that is to say, an incandescent body has a certain distribution of the energy radiated in different parts of the spectrum. The wavelength at which the maximum radiation occurs depends upon the temperature of the body, but so long as it is closely akin to a " black body," or perfect radiator, the shape of the energy-distribution curve is practically the same for all materials capable of withstanding temperatures of incandescence.

The curve for a tungsten filament at 2,850° K. is shown in Fig. 1; as a guide to the general order of energies in question, Walsh† gives the total radiation from 1 sq. cm. of palladium at its melting point (about 1,830° K.) to be nearly 64 watts.

Now it was early pointed out by Rayleigh that, on the principles of classical mechanics, the energy radiated at the shorter wavelengths ought to be considerably more than it is; in fact, the law connecting radiation with wavelength ought to be:

$$E\lambda = 8\pi RT/\lambda^4$$

where E_λ is the energy radiated per unit range at wavelength λ

R is a constant called the " gas-constant."

T is the absolute or thermodynamic temperature.

This is known as the Rayleigh-Jeans formula, and shows that the energy-content of the radiation ought to be infinite for waves of infinitesimal length; the formula clearly does not correspond with the actual radiation law illustrated in Fig. 1.

To overcome this difficulty, Planck suggested that the trouble lay in the manner in which energy is exchanged, and put forward the hypothesis that energy can only be gained or lost in amounts corresponding with units called *quanta*; the *quantum is the least* amount of action, or change in momentum, which it is physically possible to produce. Its value is 6.554×10^{-27} erg.-sec., and this quantity, designated by h and termed Planck's constant, is so small that according to Russell it would require in the region of a billion billion of them all at once to make their effect sensible without the aid of instruments of precision.

Atomic Quanta

Owing to the introduction of an element of chance or probability into the procedure of generating radiant energy at the shorter wavelengths, where the energy per single wave is so large that the radiator has, as it were, to wait for quanta to put into them, this hypothesis led to the new formula:

$$E\lambda = 8\pi hc/\lambda^3 \ (e^{hc/2kt}-1)$$

where k is a constant equal to the " gas-constant " per molecule.

This is in conformity with the curve of Fig. 1; but this does not represent the outstanding success of the introduction of the new constant of Nature, h, for Bohr, when the time came, seized upon it for the explanation of his theory of intra-atomic behaviour of electrons. It had for a long time been known that the wavelength-positions of the coloured lines in the hydrogen spectrum (caused, if Bohr's hypothesis was correct, by millions and millions of little electron-jumps from one orbit to another) lay in a relationship derived from the formula:

$$1/\lambda = R(1/n^2 - 1/k^2)$$

by giving n and k small positive integral value successively. Here R is an empirical constant found by Rydberg and equal to about 109,700 waves per centimetre. But now, by Planck's principle, the energy radiated at one of these wavelengths had to correspond with the loss of a whole number of quanta of action, so that the energy-difference between electrons in successively larger orbits must correspond with a quantum *at least*. This means that some orbits are quite impossible, and in fact we can very easily calculate those which *are* possible, leading to a theoretical value for Rydberg's constant which is in very close agreement with the measured one (see Appendix 1).

Application to Television

Like most researches in pure physics, this introduction of the quantum of action appears to have little practical significance for the engineer, for all large-scale mechanical experiments involve so many quanta at once that it is quite immaterial whether energy is continuously or discontinuously exchanged: for example, every stroke of a petrol-engine involves so many uncounted billions of quanta that the mind staggers at the thought. At the same time, it must be remembered that whereas relativity theory is a kind of generalisation or refinement of the older classical mechanics, quantum theory is a radical departure.

(To be continued.)

* Deut. Phys. Gesell., Verhand. 2, 1900, pp. 202 and 237; Ann. d. Phys., 4, 1901, p. 553.

† J. W. T. Walsh, " Photometry " (Constable), p. 37.

THE MIHALY-TRAUB TELEVISION RECEIVER

READERS will remember that a few months ago we gave a description of the Mihaly receiver in which the essential features are a stationary mirror-drum of which the mirrors face inwards and a plane mirror revolving in the centre. This type of receiver was quite satisfactory for a low number of scanning lines, but when the number exceeded ninety the stationary mirror-drum was of necessity large, and the accurate setting of a number of mirrors occasioned a great deal of detail work.

We were recently shown a modification of this receiver which obviates these defects. This modification is due to Mr. E. Traub, who is a frequent contributor to this Journal. We are not at liberty to disclose the exact details at the present time, but it will suffice to say that the entire apparatus has been so reduced in size that an instrument with a scanning frequency of 180-lines does not occupy a space of more than about a foot square. Also much less work is entailed in the setting of the mirrors, for by means of a multiplying arrangement they are comparatively few in number. No less important is the fact that it is obvious that the apparatus could be produced at a very low price.

We were recently given a demonstration of the Mihaly-Traub receiver. This particular machine was scanning 120 lines and a remarkably good picture was produced with a screen about nine inches wide. A feature was the brightness of the picture and we were amazed to learn that the light source was only a 32-watt lamp of the ordinary incandescent type. The transmission was by line from a Scophony transmitter, but examination of the apparatus made it abundantly clear that the same results would be obtainable via radio were such a transmission available.

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