Electronic Engineering

INCORPORATING ELECTRONICS, TELEVISION AND SHORT WAVE WORLD

PRINCIPAL CONTENTS

2/- JAN., 1946

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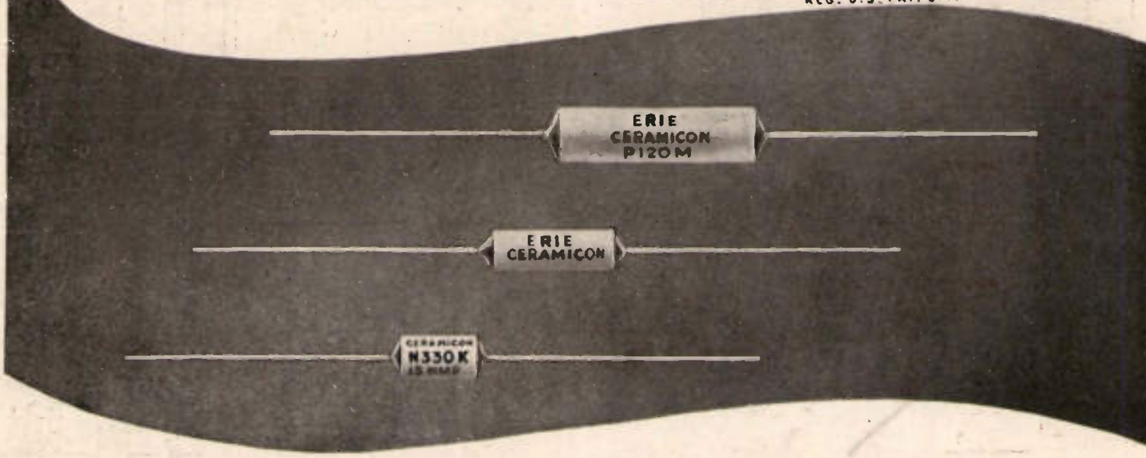

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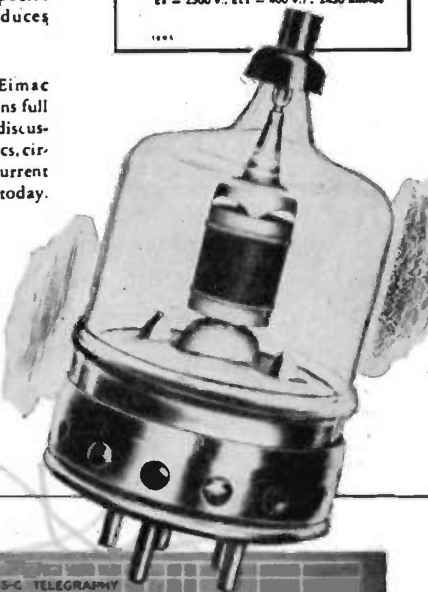

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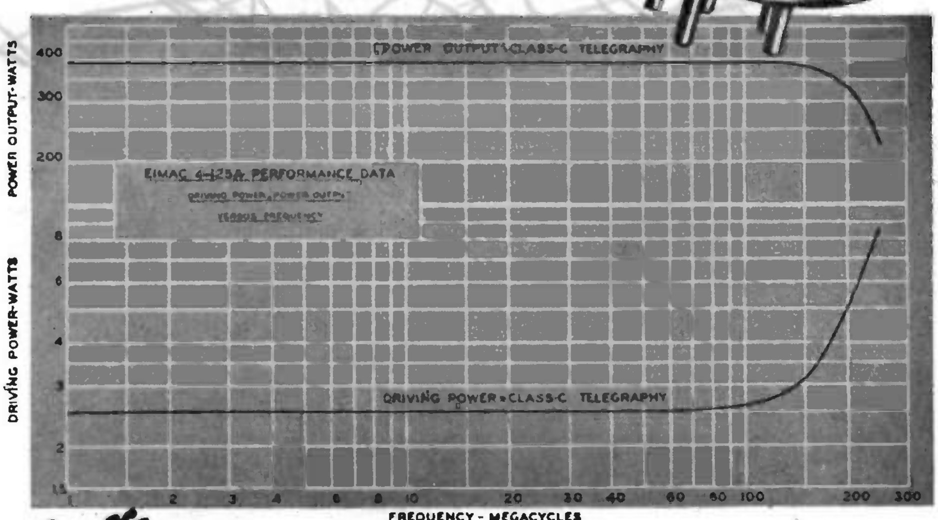

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TELEGRAMS
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The Physical Society's Exhibition

By A Fellow of The Society

THIS annual function, the Exhibition of the Physical Society, has become a tradition in the scientific world, as much as the Lord Mayor's Show has in other quarters. There is the more serious business of launching " new models," the pleasant College atmosphere in which one meets so many old friends as not to leave sufficient time to examine the exhibits, and the pomp of the dressed-up apparatus put out on plush and baize for the less critical to be fascinated by the chromium plating and the lacquer.

We should congratulate all concerned on the heroic efforts which, despite innumerable difficulties and trials that surely must have beset them, succeeded in producing an exhibition bursting with interest, and an even bigger and better catalogue than the last one (1939).

Among several new exhibitors will be noticed manufacturers of electronic devices and to these especially, and the many who must be visiting a Physical Society Exhibition for the first time, we would say a word about the origin and spirit of these functions. It was some forty years ago that the late MR. R. W. PAUL and others first arranged the Society's Annual Conversazione at which instrument makers and others were invited to show their latest scientific products to Fellows of the Society and their guests ; the main interest was to be scientific and not commercial. Sad to say, this spirit gradually waned and some came to regard the exhibition as the annual trade show of the scientific instrument industry, abusing the high privilege of being guests of the Society and of the Imperial College, where the exhibition is held. To limit this, rigid rules about the nature of the exhibits and stands had to be imposed, for it was no longer possible to leave these matters to firms' good taste. Not the least important was the need for exhibitors to staff their stands with competent scientists able and willing to answer relevant technical and scientific questions.

Let us hope, then, that both old and new exhibitors will have entered into the proper spirit of this the first exhibition after the war and that they will continue in the tradition for which the Society's exhibitions have always been noted.

THE PHYSICAL SOCIETY'S EXHIBITION

The 30th Exhibition of Scientific Instruments, and the first to be held after the war, will be opened on January 1, 1946, at 2.30 p.m. at the Imperial College, South Kensington, S.W.1, and will remain open until Thursday evening, January 3.

Admission on Wednesday, January 2, between 2 and 4 p.m., is restricted to members of the Physical Society.

Admission is by ticket only, obtainable from the Society at 1 Lowther Gardens, South Kensington, S.W.1, or from any of the participating firms.

Radar in A.A. Defence

By H. G. Foster, B.Sc., A.M.I.E.E.*

BEFORE describing in detail the operation of a Radar set as a position finder, it may be convenient briefly to study the elementary ballistics of projectiles and to decide what information is required concerning the target itself, so that the ground defence system can engage.

Take the simple case of a stationary target in space at the point A to be engaged by a gun position B as shown in Fig. 1. In addition to the bearing (azimuth) of a stationary target its exact location in space with respect to the gun position can be completely defined in terms of either the rectangular co-ordinates of ground range and height, or the polar co-ordinates of slant range and angle of elevation.

Now, since the path or trajectory of the projectile in flight is not straight but parabolic, the gun cannot be aimed directly at the target, and due allowance must be made in the elevation of the gun (known as Quadrant Elevation and abbreviated to *QE*), so that the trajectory will pass through the point A.

In A.A. gunnery projectiles are fitted not with fuses which detonate on impact, but with time fuses, so that, in addition to the correct bearing and *QE* of the guns, the time of flight of the projectile must be known in order that it may explode on reaching its target.

The calculation of *QE* and time of flight is a complicated problem of projectile ballistics which obviously cannot be worked out at each engagement, and use is made either of tables or a trajectory chart, shown in Fig. 2, which gives all the relevant data required.

Conditions are, however, radically changed when the target is no longer stationary, but is a fast-moving one such as an aeroplane. It is no longer possible to compute the necessary gunnery data from a single measurement of height and ground range, and, in fact, the target must be under continuous observation.

The speed and direction of the target must be known, we must be able to predict the future course of the target, and in general arrange matters so that the projectiles and the target moving at their separate speeds simultaneously arrive at the same point in space.

Position Finder Radar Set

A modern position finder Radar set of the type which has seen considerable service with A.A. Command is shown in the picture above. This set, operating on a selected frequency between 55 and 85 Mc/s. (5.46 to 3.53 metres), is capable of measuring range between 2,000 to 14,000 yd. to an

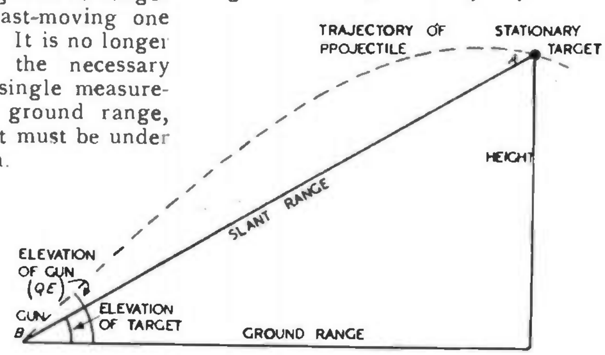


Fig. 1. Diagram showing stationary target at *A*, gun at *B*, and parabolic trajectory of projectile.

* Electrical Engineering Dept., University of Birmingham.

accuracy of ± 25 yd., while bearing and elevation can be measured to within ± 1°.

The transmitter and receiver units are housed in separate cabins which, with their respective aerial systems, can be rotated bodily about the vertical axis, so that the aerial systems can be placed broadside on to the target.

In the preliminary searching for the target, both transmitter and receiver employ aerials having a wide beam in the horizontal plane. The "search" of the transmitter consists of a single horizontal dipole, while the search aerial system of the receiver makes use of the upper elevation aerial and the range aerial with the addition of a reflector behind the upper elevation aerial, so that the ambiguity of sense is avoided.

As soon as the target is picked up, both transmitter and receiver switch over to their "follow" aerial systems. The "follow" aerial system of the transmitter consists of four horizontal in-phase half-wave aerials in an end-on position, with a wire netting reflector system. The "follow" aerial system on the receiver cabin is more complex and consists of separate aerials for range, bearing and elevation, the determination of which is carried out on separate cathode-ray tubes.

A single receiver suffices for the three cathode-ray tubes, and the system of connexions is shown in block schematic form in Fig. 3. The receiver proper is a superheterodyne comprising five R.F. stages followed by an oscillator and a diode mixer. The I.F. portion of the receiver comprises five stages and a diode second detector feeding into two output valves, one of which operates the range cathode-ray tube, and the other operates the bearing and elevation cathode-ray tubes and the A.V.C. circuits.

The range aerial is permanently connected to the R.F. input, while the bearing and elevation aerials are connected through a phasing box and goniometer respectively, to a motor-driven switch by means of which the signals from them are combined with those of the range aerial.

The sequence of switching for each

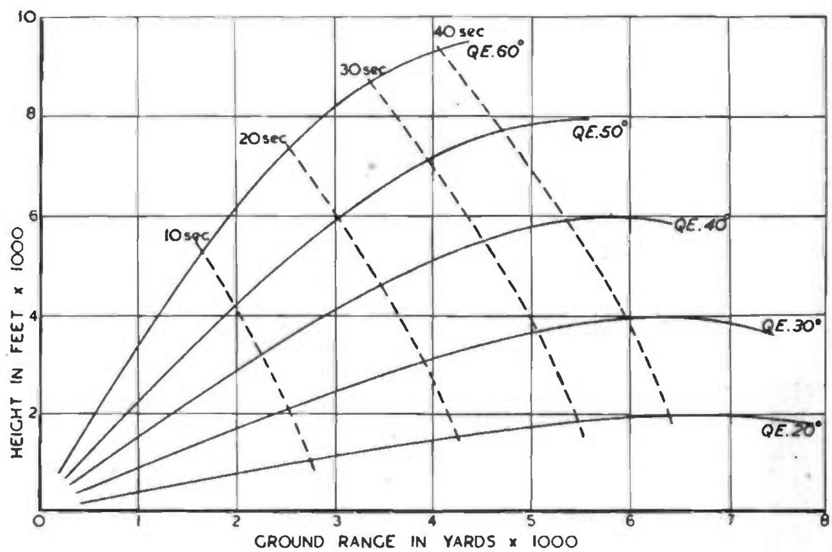


Fig. 2 (above). Imaginary trajectory chart showing correct angle of elevation (QE) of gun and time of flight of projectile for a target of given height and ground range. The projectile fuse will be set to explode at the end of the given time of flight.

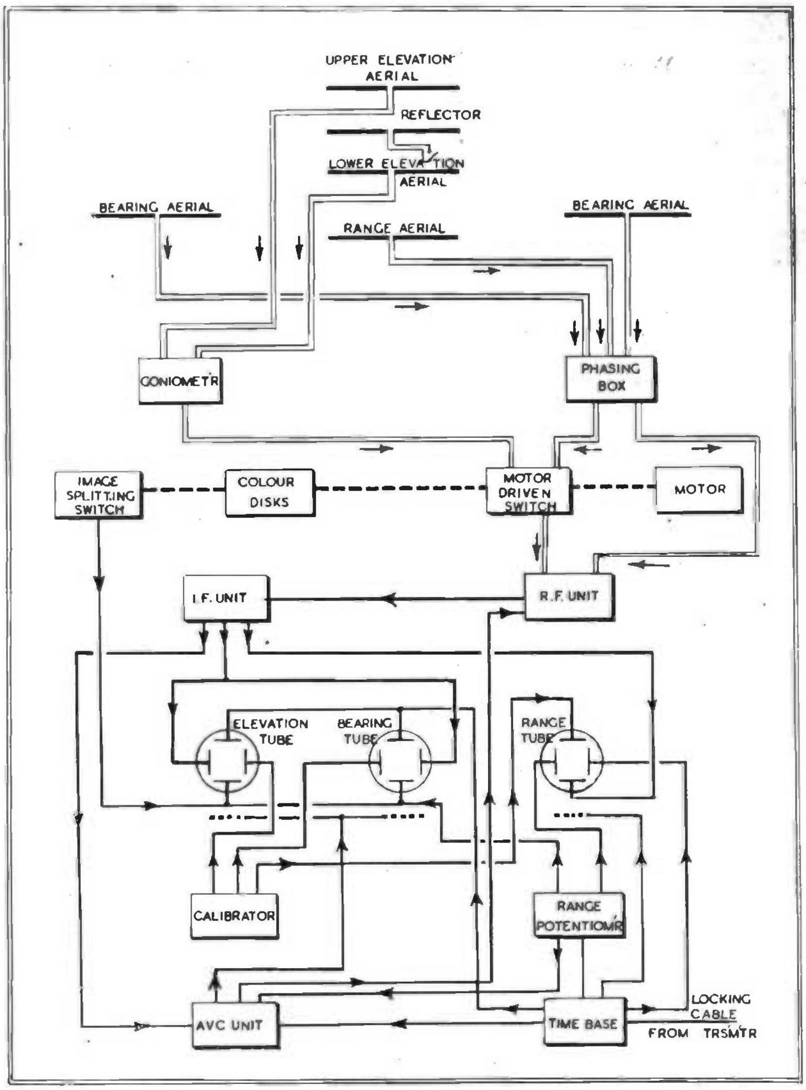


Fig. 3 (below). Schematic diagram of a Mark II Radar receiver unit.

revolution is given in the table as follows:

Sector of revolution	Input applied to receiver
First quarter revolution	Range aerial output + resultant from elevation aerials.
Second ,, ,,	Range aerial output + resultant from bearing aerials.
Third ,, ,,	Range aerial output — resultant from elevation aerials.
Fourth ,, ,,	Range aerial output — resultant from bearing aerial.

In order that the bearing and elevation cathode-ray tubes shall be visible only while working on their own respective functions, a disk is made to rotate in front of each tube, each disk being driven at the same speed as the rotary switch, and each having two apertures of 45° placed diametrically opposite each other.

These disks are so synchronised with the motor-driven R.F. switch that the bearing tube is exposed only while the bearing aerials are connected to the receiver, and the elevation tube is exposed only while the elevation aerials are connected to the receiver. A small rotary switch, or image-splitting switch, synchronised with the disk gear provides electrical pulses which give the displays on the bearing and elevation tubes a small shift, or displacement, along the time base at every alternative half revolution.

Having described the main details of the receiver unit of the Radar set, let us see now how the actual measurements of bearing, elevation and range are carried out.

Bearing

We have seen that when the bearing tube is exposed, the input to the receiver comprises the signal from the range aerial and the resultant from the two bearing aerials.

It will be appreciated that when the receiver aerials are not broadside on to the target there will be a resultant signal due to the phase difference between the signals in the separate bearing aerials. This resultant signal is alternatively added to and subtracted from the range signal by means of the motor-driven rotary switch, and by means of the image-splitting switch two images of the rectified receiver output will appear side by side on the screen of the bearing tube.

Thus, one image or " break " will be due to the sum of the two signals, while the other will be due to the difference, and these breaks will be of unequal amplitude of height when the receiver is off bearing.

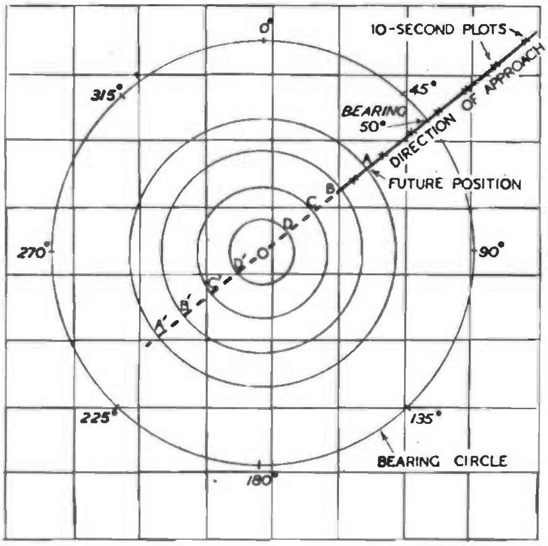


Fig. 5. Layout of plotting table showing grid map of area with gun site located at the centre O. Aircraft is making a direct approach to the site at a bearing of 50°.

When the aerials are truly broadside on, the resultant of the bearing aerials is zero, and the two breaks will be of equal height, each being due to the signal from the range aerial only.

By means of a Selsyn transmission system the bearing of the target is indicated to the operator in the transmitter cabin, who rotates the transmitter cabin to the same bearing.

A bearing dial is also operated in the command post, the purpose of which will be decribed later.

Elevation

The method of determining elevation is based on the fact that a horizontal dipole at a given height above ground has different sensitivities to wave fronts arriving at different angles of elevation to the ground. The law connecting sensitivity with elevation depends upon the height of the dipole above ground level, and on the wavelength, since the total effect is the resultant of the direct wave and the reflected wave from the ground.

Thus, two dipoles at different heights above ground will have different sensitivities at various angles of elevation, so that by comparing their respective signals by a calibrated goniometer, the angle of elevation of the incident wave may be determined.

The upper and lower elevation aerials of the receiver are fixed at heights of $3/2\lambda$ and λ above ground, and their vertical polar diagrams, based on the assumption of a perfectly level and conducting ground, are shown in Fig 4. These aerials are fed through screened cables to the stator coils of a goniometer, the rotor winding of which is connected to the receiver unit through the motor-driven switch.

The stator coils are placed at right angles to each other, and when the rotor, which is located symmetrically with respect to the stators, is rotated so that the resultant signal induced in it is zero, the angular setting of the rotor gives a measure of the relative signals induced in the two elevation aerials. Hence, when the elevation tube is exposed, the input to the receiver comprises the signal from the range aerial and the resultant from the elevation aerials, which is alternately added to, and subtracted from, the range-aerial signal by means of the motor-driven switch. Thus, again two " breaks " will appear on the elevation tube, and these will be of equal height when the rotor is set to give zero resultant from the elevation aerials. The elevation of the incoming signal therefore can be read directly in degrees from a calibrated dial attached to the rotor shaft of the goniometer.

Range

The measurement of range is, in fact, a measurement of the time interval for the pulse of radio energy to do the journey from the transmitter to the reflecting medium or target and back to the receiver.

At each pulse of energy radiated by the transmitter a locking pulse is fed from the transmitter to the time base circuits of the receiver unit. This pulse causes the time bases to execute a single sweep for each pulse of

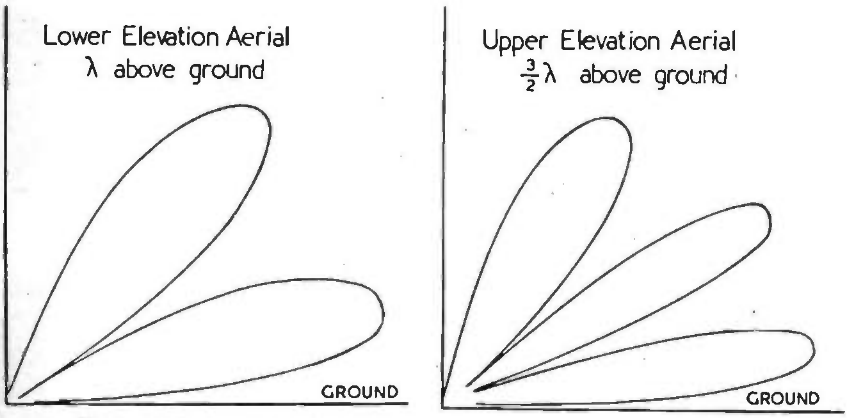


Fig. 4. Vertical polar diagrams of lower elevation and upper elevation aerials.

energy radiated, and each sweep is completed before the next pulse is radiated.

The range tube is continuously exposed, and since the image-splitting switch is not applied to the range tube, a single break only will appear, its position on the time base depending on the time interval. A potentiometer control which corresponds in effect to the "X shift" control of a normal cathode-ray oscillograph applies a voltage to the X plates of the range tube, which shifts the break across the tube until the leading edge of the break coincides with a vertical cross wire placed in front of the tube.

The range potentiometer has a calibrated dial attached to it so that when the break on the range tube has been brought to the correct position the slant range can be read. The range potentiometer is also connected by a remote control system to a range dial in the Command Post.

Command Post

Beween the Radar set and the actual gun site is the Command Post, whose function is to control the tactics of the engagement and to supply the gunnery data from the information received from the Radar set.

On heavy anti-aircraft (H.A.A.) gun sites, the Vickers or Sperry predictor is the normal equipment for prediction and for ballistic computations, but a description of this apparatus is beyond the scope of this article, and the underlying principles of operational procedure in the Command Post may be best understood by reference to the semi-automatic plotter. This semi-automatic plotter has, of course, been largely superseded and is now used only for stand-by purposes in case of predictor failure.

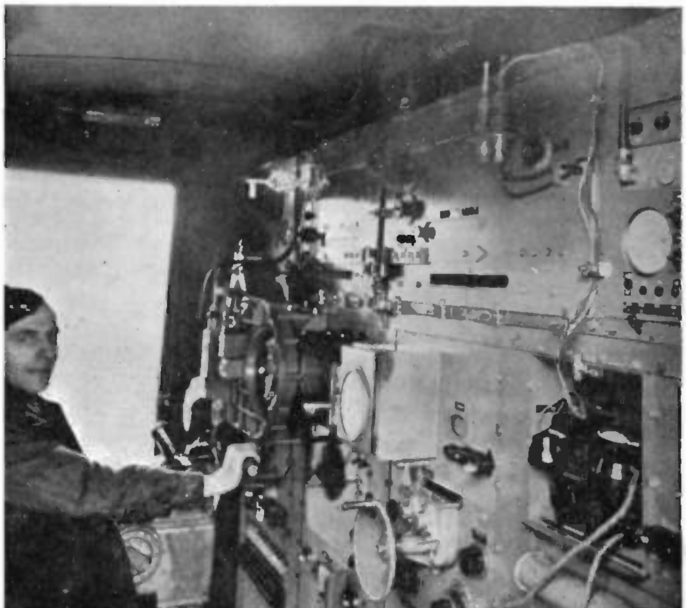
The equipment is relatively simple, and consists mainly of a translucent glass-topped plotting table, on which is fixed a grid map of the district with the gun site located at the centre, the map being illuminated from beneath.

Below the map, and pivoted at the centre of it, is an arm carrying an electric lamp which is arranged to throw a small spot of light on to the map. This arm is connected to the Radar set by a remote control system, and is arranged to follow the bearing dial of the Radar set, and in consequence the bearing of the target.

The ground range of the target is indicated by the relative movement along the arm of the bracket carrying the lamp, the movement being conveyed through an auxiliary piece of apparatus known as a height convertor. This apparatus—which is in essence an adjustable right angle triangle—translates the slant range and height as supplied by the Radar set into ground range, and controls the motion of the spot of light so that position of the target can be marked on the grid map. For speedy determination of the fuse and *QE* values, points of engagement are restricted to fixed intervals of ground range, usually of 1,000 yd. These fixed intervals will therefore appear as *circles* on the plotting table, with the gun site as the centre, each range circle as it is known differing in radius from its neighbours by 1,000 yd. Since the height of engagement will vary with ground range, against each range circle on the plotting table is marked the maximum height at which the target may be engaged.

Example of Procedure in Command Post

The operational procedure involved in engaging a target may



Interior view of the Mark II Receiver Unit.

To the right is the range cathode-ray tube with its range scale and hand wheel, while in front of the bearing operator are the elevation and bearing tubes with their rotating colour disks. Above the three tubes are mounted the R.F. and I.F. units of the receiver.

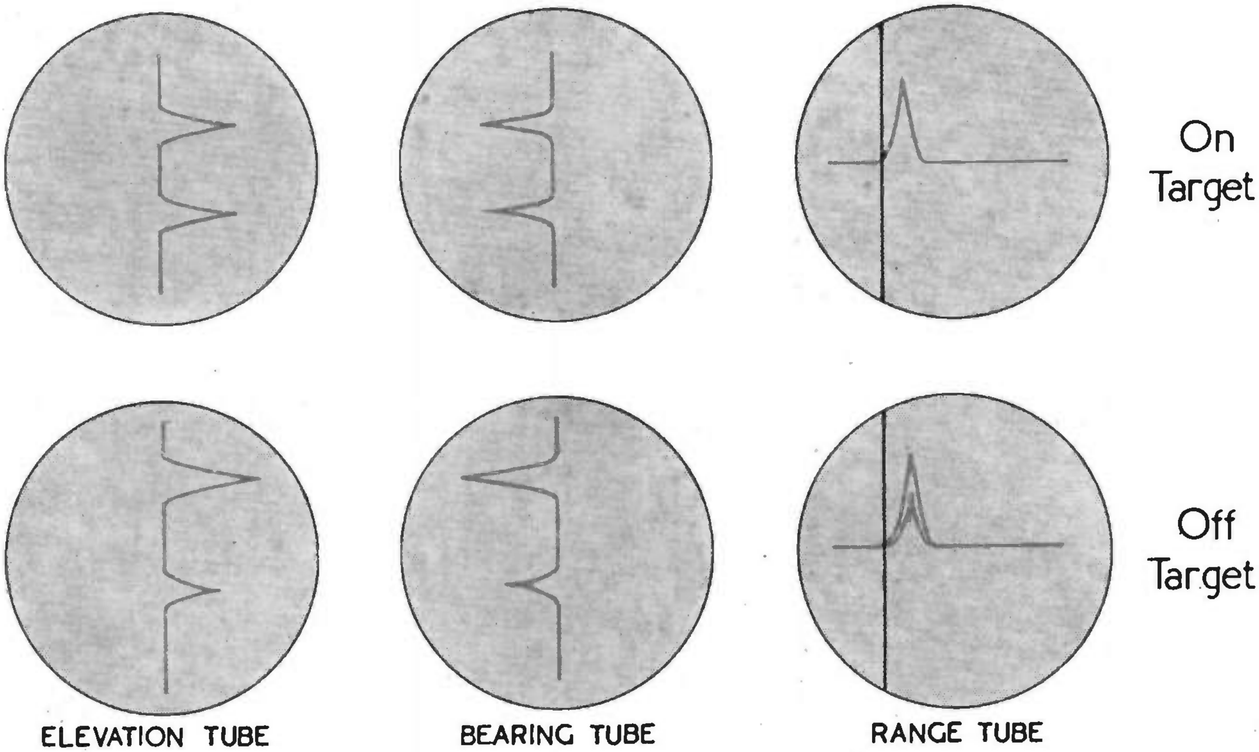


Fig. 7. Display of Cathode-Ray Tubes.

(a) Receiver correctly " on target"—the breaks on the elevation and bearing tubes are of equal height and break on range tube is brought to correct position behind cross wire.

(b) Receiver " off target "—the breaks on the elevation and bearing tubes are of unequal height.

best be studied by taking the simple case of an aircraft flying at a uniform speed and height, and directly towards the gun site.

As soon as the Radar set is " on target " and is continuously following it, changes in bearing (if any) and ground range of the target will, as previously explained, cause a displacement of the spot of light below the plotting table, and will indicate the course of the target.

At fixed intervals of time—usually 5 or 10 seconds—which are indicated by a time broadcast system, the position of the target on the grid map is marked or plotted, and against the first of the plots is set the height.

After not less than three plots, the future course of the target can be predicted, and if this cuts the range circles, an engagement by the gun site is possible. The intersection of the future course of the aircraft with the chosen range circle will be the future position or the engagement point, and while the aircraft is flying towards its future position, all the necessary gunnery data must be worked out by the Plotting Room team, so that the guns may be loaded and fired at the correct instant.

Correct Choice of Range Circle

There are several factors governing the correct choice of range circle, and from Fig. 5 it would appear that since the predicted future course of the direct approaching target cuts all the four range circles shown, the future position could be at A B C and D, and also A′ B′ C′ D′.

For tactical considerations, however, it is advisable to engage the aircraft as soon as possible, and unless conditions arise which make this impossible, the aircraft should be engaged as an approaching rather than a receding target.

For this reason the future positions A′ B′ C′ and D′ will be ruled out for the present, and the final future position will be selected from A B C or D.

Now early engagement of the target implies that adequate early warning has been given. Moreover, reference to the trajectory chart (Fig. 2) shows that maximum height at which the aircraft can be engaged decreases with increase of ground range, so that the height of the aircraft is a governing factor in the choice of range circle.

In the example given it will be assumed that the aircraft is flying at a height which precludes an engagement at the outer range circle. The choice of future positions is now at B, C and D, and for the reasons already given B is the first choice.

It will be shown later on that above a certain angle of elevation, the Radar set at present described is " blind," and this, in conjunction with the height of the target, may rule out the use of C and D as possible future positions.

Having decided on B as the future position, the ground range of the aircraft at the future position is known. The height of the aircraft being supplied by the Radar, the correct fuse-setting of the projectiles can be quickly determined by reference to the trajectory chart shown in Fig. 2.

This is the first information required by the gun crew, and it enables them to fuse the projectiles and load them into the guns in readiness, while the Plotting Room is occupied with the remaining data.

Further reference to the trajectory chart will now give the correct *QE* of the guns, and a preliminary bearing of the future position can be obtained from the Plotting Table. This bearing can be obtained by drawing a line from the centre O of the range circles through the future position B, to meet a bearing circle marked in degrees which is placed at the edge of the Plotting Table.

Data regarding the final bearing are usually withheld as long as possible so that any small deviations in the course of the aircraft, or errors in the early prediction can be corrected.

All that is required now to complete the engagement is the instant at which the guns must be fired.

If the speed of the aircraft is known a simple calculation will decide how far from the future position the aircraft must be at the instant the guns are fired. The speed of the aircraft can be determined with sufficient accuracy by measuring the distance covered by the spot of light on the Plotting Table in a given time interval—usually 40 seconds. This distance is supplied to a member of the Plotting Team, who calculates with the aid of a "back distance calculator," how far from the future position the spot of light must be the instant the guns are to be fired. This "back distance" is marked on the predicted course on the Plotting Table and, as the spot of light approaches the firing point, final adjustments of bearing are made to correct for any deviation in the course of the aircraft.

As soon as the spot of light arrives at the firing point the signal to fire is given, and, if the prediction data have been correctly worked out, and the aircraft continues along the predicted course with no change of speed and height, the aircraft and the projectiles will arrive simultaneously at the same point in space.

Limitation of the Mark II Radar Set

One of the most serious limitations of the Radar set just described is the restricted range over which measurements would be taken with a reasonable degree of accuracy.

It can be seen from Fig. 4 that at low angles of elevation the sensitivity or pick up of the lower elevation aerial is poor, and similarly for the upper elevation aerial at high angles, and in consequence the range over which the angle of elevation can be measured with accuracy is limited.

Furthermore, it will be appreciated that there is a possibility that low flying aircraft could approach undetected, but the more serious feature is that there is a considerable arc in which the Radar set is "blind." This latter disadvantage virtually rules out the possibility of engaging a receding target at close range.

Improvement in this direction could not be expected with the existing aerial system using comparatively long wavelengths, and accuracy in determination of elevation, etc., demanded aerial arrays having a very much narrower beam. A further disadvantage is that the accuracy of the Radar set depends very largely on the surrounding topography, and it is frequently necessary to provide an artificial flat earth by placing the receiver cabin at the centre of a large mat of wire netting supported on poles.

This fact, combined with the comparative bulkiness of the Radar set, did not allow a great degree of mobility, and development was directed towards systems using much shorter wavelengths, and with aerial arrays of smaller physical dimensions. It would be advantageous, too, if the Radar set could be made into a self-contained unit.

Any substantial decrease in wavelength was not to be expected with valves of conventional design, but a vast and an entirely new field was opened up by the development of the special magnetron valve by Dr. J. T. Randall and Dr. H. A. H. Boot, of Birmingham University. This valve was capable of generating considerable power under pulse conditions at wavelengths of a few centimetres, and with the centimetric wavelengths came aerials of much smaller dimensions. Concentration of the radiated energy into a very narrow beam was made possible by the use of parabolic reflectors, and with still shorter centimetric wavelengths came wave guides.

Mention should also be made of the special type of receiving valve, known as the reflector klystron, which was developed by Dr. R. W. Sutton, of the Admiralty Signals Establishment, and which made the superheterodyne principle of reception still possible.

Modern Radar Set

A modern range-finding Radar set known as the Mark III Radar equipment is shown in Fig. 8, and a brief outline of its operation will be given here. This set employs the new magnetron valve in the transmitter circuit with the reflector klystron in the receiver. The whole unit is mounted on a single chassis with a self-contained power unit giving a high degree of mobility,

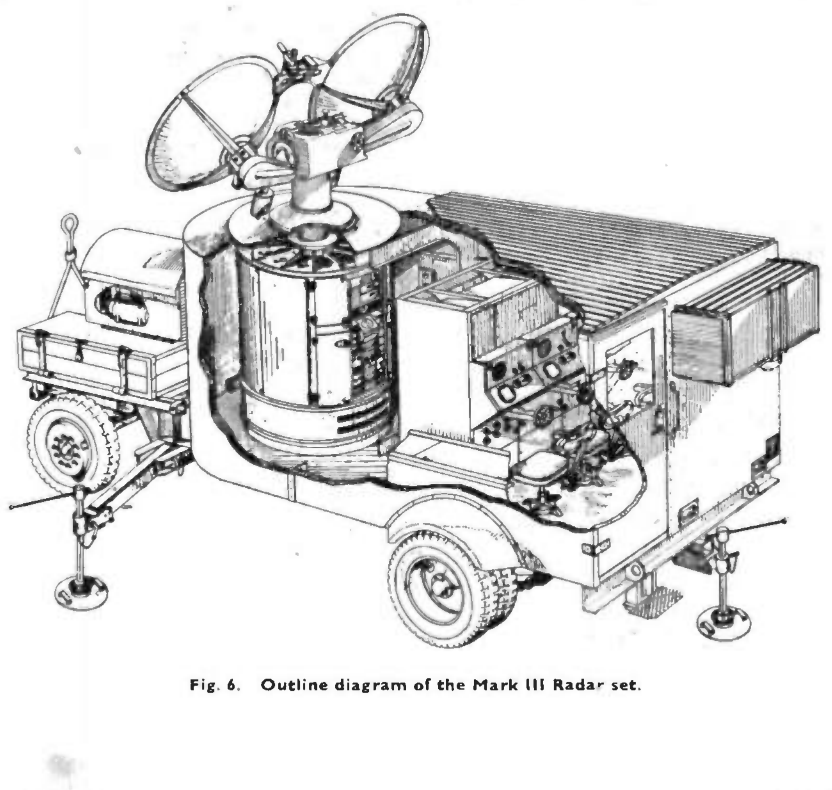


Fig. 6. Outline diagram of the Mark III Radar set.

an all-round improvement on performance and accuracy, and capable of operating independently of the surrounding topography.

An indication of the improved performance may be gathered from the fact that this equipment will measure range up to 36,000 yd. with an accuracy of ± 25 yd., while bearing and elevation can be measured at extreme range to an accuracy of ± 10 min. This is equivalent to stating that at the extreme range the target may be considered as being contained in a sphere of diameter of 50 yd.!

The transmitter and receiver units, together with the necessary control gear, are housed in a circular turret or rotor on top of which, and projecting through the roof of the cabin, are the aerial systems and parabolic reflectors. The presentation unit is also housed in the cabin and contains the various circuits for displaying the signals on the cathode-ray tubes. Separate parabolic reflectors, 4 ft. in diameter, are used for transmission and reception, and both are mounted on the same elevating gear. For the determination of bearing the aerial system and rotor are moved bodily round by a power system controlled by bearing controls on the presentation unit.

The transmitter aerial is fixed on the axis of its parabolic reflector while the receiver aerial, consisting of a half-wave dipole with parasitic reflector, is offset from the axis of the parabolic reflector by an angle of about 2°, and is rotated at a speed of 6,000 r.p.m.

Elevation and bearing are determined primarily by pointing the parabolic reflectors directly at the target, the parabolic reflectors being elevated by a power system similarly controlled by the elevation controls of the presentation unit. Indication is given on the elevation and bearing cathode-ray tubes as follows:

When the target is located, the screen of each tube will show a side-by-side display of two breaks similar in form to the breaks which occur in the time base on the screen of the range tube. One of these represents the signal when the axis of reception is displaced by a small angle to one side of the direction in which the parabolic reflectors are pointing, and the other represents the signal when the axis of reception is displaced by an equal angle to the opposite side of the direction in which the reflectors are pointing, this successive angular displacement being accomplished by the rotation of the receiving aerial. When the two breaks in the time base are of equal height on the elevation and bearing tubes, the parabolic reflectors are pointing directly at the target, the elevation and bearing of which will be indicated by the position of the reflectors, and by dials in the cabin and plotting room.

The measurement of range is similar in operation to that of the Mark II equipment, and consists fundamentally in measuring the time interval as before, but a circuit arrangement of considerably improved design is used which requires two cathode-ray tubes—one for coarse measurement and one for fine measurement—with their associated control gear.

Conclusion

The equipments just described have seen considerable service but, under the stress of war, development has proceeded at a rapid pace, and they are almost outmoded to-day in certain directions.

Much of the improved equipment, particularly that designed to combat high-speed targets like the V1 and V2 weapons, is still on the secret list, and only brief reference to it can be made. Among the latest may be mentioned:

(a) The automatic following Radar equipment.

(b) Fully automatic predictor equipment of the command post.

(c) "Radio proximity" fused projectiles.

It is beyond the scope of this article to forecast the peace-time applications of the range-finding Radar quipment of the type described, but reference should be made to an article on this subject by Sir Robert Watson-Watt in *Nature* (Sept. 15, 1945). It is encouraging to learn that birds in flight have been successfully followed by Radar, and, as a result, it may yet be possible for ornithologists to solve some of the problems of bird migration.

In conclusion, the writer gratefully acknowledges the co-operation given by the Telecommunications Engineering Wing, R.E.M.E. School, Petersham, in allowing access to official documents, and for permission to publish the various photographs.

Atomic Bombs and the Future

From an address by Dr. Edward U. Condon, Associate Director of the Westinghouse Research Laboratories, Pittsburgh

There may be vastly simpler ways of doing the job than we have used. Already, I suspect, a large part of the plants we have built are obsolete. We know so little about this subject that we do not know for sure that the making of atomic bombs requires the vast industrial plants which we have erected for the purpose.

It is conceivable, for example, that in the years to come some small group of Nazi scientists working in some remote haven, say in South America or perhaps in Spain, may find a way to do this thing with only small, inexpensive and inconspicuous equipment. That is one of the most important reasons why we must continue the most careful and thorough investigation of atomic physics and why we must set up a world order that really covers the entire world—one which does not leave us unaware of what is going on in any remote valley in Spain. With this power in man's hands, world co-operation must come. It is peace or death.

Let us recapitulate:

(a) Man is now in possession of a new kind of energy source vastly more powerful than anything used before.

(b) It is the culmination of a war effort, built on decades of free exchange of scientific knowledge.

(c) While we produced the atomic bomb first, other national groups working independently may not be far behind right now.

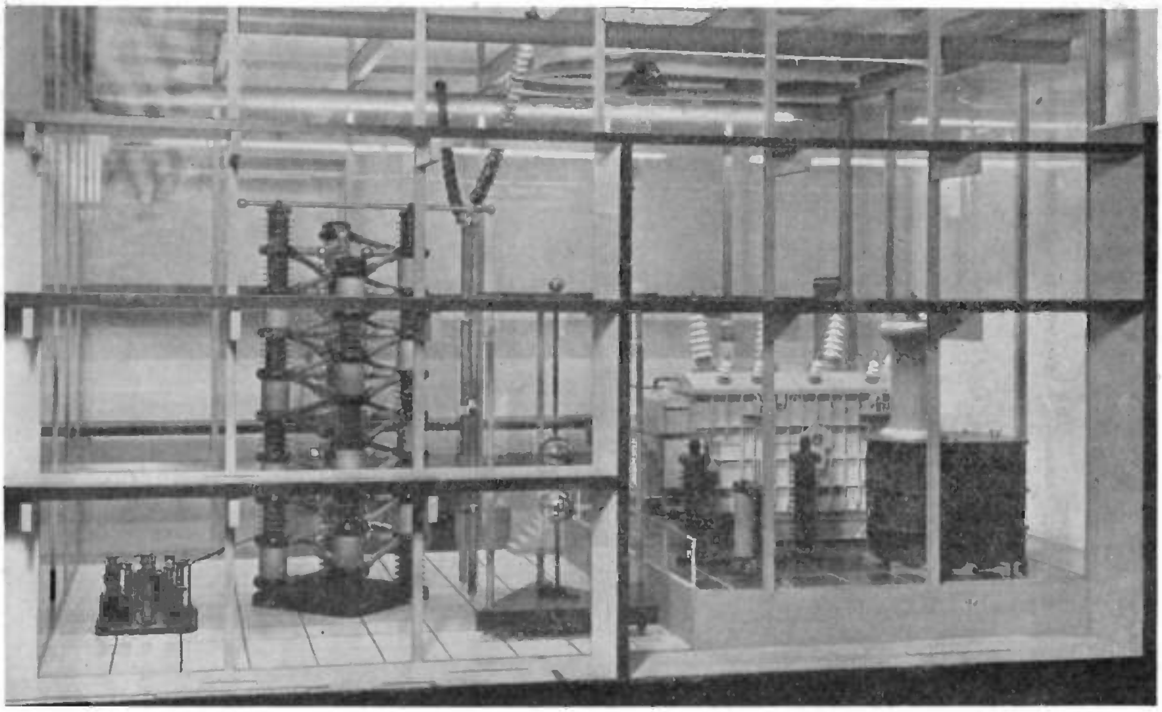
(d) It is a certainty that, spurred by the knowledge that the thing can be done, any major national group could, without aid from us, and without benefit of espionage, at least do what we have done within a few years.

(e) Our knowledge in this field is very incomplete and it may be possible to do what we have done in vastly simpler ways than the only way known to us at present.

Therefore,

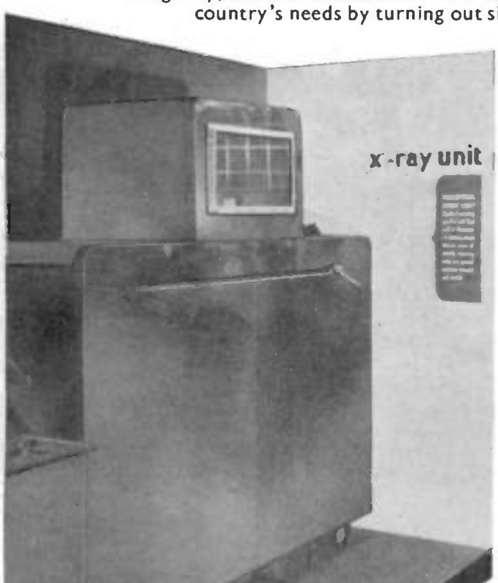
(1) We must set up a world order including all peoples to make certain that atomic power is used only for peaceful purposes, and

(2) We must continue intensive cultivation of fundamental research in atomic physics to the end that we may really know all about this tremendous new source of power so that we may apply it to useful purposes in the years of peace that lie before us.



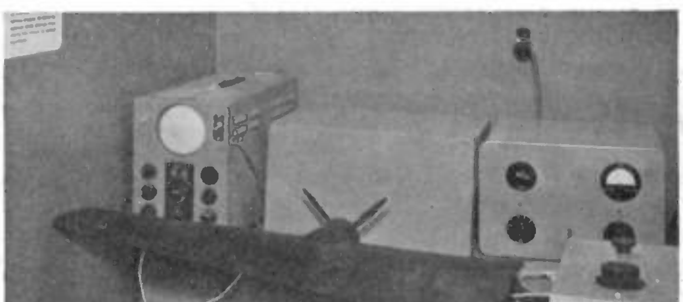
The English Electric Company's Exhibition

The English Electric Company's "War Activities" Exhibition, held in November, at their London showrooms, Queen's House, Kingsway, showed in miniature how the Company's four works at Stafford, Rugby, Bradford and Preston met the country's needs by turning out sixty million pounds' worth of war-time products in addition to an increased output of normal equipment.



The photographs show some of the display in the Research Section, which included an X-ray Unit for examination of materials and a C.R.O. for use with strain gauge measurements, with a miniature aeroplane wing to demonstrate the action.

A large scale model of the High-Voltage Laboratory at Stafford (above), formed the largest exhibit in the Research Section. Visitors were invited to use a press button which caused a miniature flash-over.



A Continuous Film-Recording Camera

for use with Standard Cathode-Ray Oscilloscopes

By A. H. SIMONS

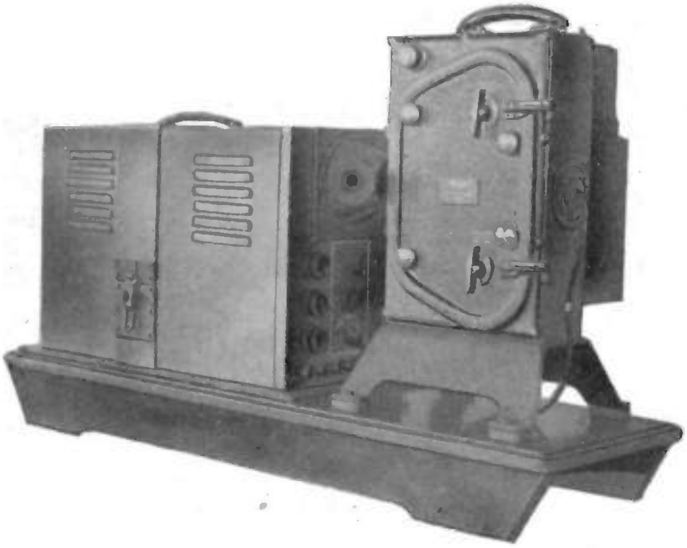


Fig. 3. View of film camera fitted to a standard Cossor oscilloscope.

THE cathode-ray oscilloscope is finding many important applications in engineering research, particularly in relation to high-speed internal-combustion engines and the study of vibration problems. Its usefulness has, however, been handicapped by the fact that few reliable continuous film cameras, specifically and well designed for cathode-ray recording, have been available. This is partly accounted for by the diversity of film speeds, length of run and auxiliary markings required for different purposes; in consequence of which it has usually been considered most economical in time and cost to rig up the simplest possible arrangement for each job, as it is required. After considerable experience of such laboratory rigs used continuously on a variety of engineering problems, the camera to be described was developed, from the author's suggestions, by Avimo, Ltd., Taunton. It is hoped that this will form the first of a series of cameras specially designed for cathode-ray recording purposes.

Performance

The camera is designed for use with 85 mm. film or paper, either perforated or unperforated, in maximum lengths of 100 feet. The film speed is continuously variable, in two ranges, from $12\frac{1}{2}$ in. a second to 50 in. a second, enabling components up to 5,000 c/s. to be analysed in complex records; at the same time a maximum run of 24 sec. is obtained at the highest film speed. A built-in driving motor is provided which is normally a universal A.C.-D.C. motor to suit the mains voltage, but a 24-volt 0.5 amp. D.C. motor can be fitted. Two miniature hot cathode mercury discharge lamps are fitted to record timing marks on each edge of the film; two timing marks are provided primarily for high-speed engine work, where it is convenient to have both a fork-operated time scale and a crank-angle scale. The overall dimensions of the camera are 10 in. long, 9 in. wide and 13 in. high; the weight is 28 lb.

Construction

The general construction is evident from Figs. 1 and 2. The main body of the camera is an aluminium casting which houses the gate, friction drive rollers, and film magazines, as shown in Fig. 1. Access to this compartment is by means of a cast aluminium door, held down on a machined seating by four locks, making the door light-tight when closed. The cast lens mount, which also houses the two mercury vapour timing lamps, is fixed to the front of the main body: a knob, provided with a lock, at the top of the lens mount adjusts the lens for optical focusing. An f4.5 lens of 1 in. focal length is used, without a shutter or stop as these are not needed in a continuous film camera. A hole, provided with a light-tight cover, at the back of the main body, opposite the lens, takes a simple microscope for viewing the back of the film during focusing. The use of this microscope, while not essential, enables a fine focus to be achieved. This microscope is supplied as an extra if required; it can be used with the scanning table shown in Fig. 4 and described below.

The driving motor, reduction gears and controls are mounted at the side of the camera proper, as shown in Fig. 2, and are provided with a sheet aluminium cover. The motor is fitted with a centrifugal switch, cutting a resistance in and out of circuit and operating as a governor, keeping the motor speed constant within ± 1 per cent. The drive is taken from the lower end of the motor shaft through a two-speed gear giving the two speed ranges. The continuously variable reduction gear, seen immediately to the right of the lower end of the motor in Fig. 2, consists of a hardened steel disk, friction driven by a hardened steel roller; the roller is driven from the two-speed gear and is mounted on a frame which can be moved along an axis parallel to a diameter of the face of the disk, so varying the reduction ratio. The frame is moved by means of a screw operated through a flexible shaft and reduction gear from the speed control knob on top of the case. A pointer attached to the frame slides along a scale fixed to the outside of the cover and indicates the approximate setting of the roller, *i.e.*, the speed. Means are provided for lifting the roller in order to run the motor without the film, if required. The frame is spring-loaded to maintain the friction between the roller and the disk.

The friction disk of the variable speed gear drives the film drive rollers in the gate through gears, while the take-up spool is driven from the motor through a separate worm reduction gear, belt drive and friction clutch. The latter slips when the spool is rotating faster than the film is coming through the gate. The unexposed film spool runs on a shaft fitted with a friction brake, actuated by a solenoid, to prevent over-running of the film. The film coming off this spool passes over a guide roller which drives a footage indicator mounted on the top of the case.

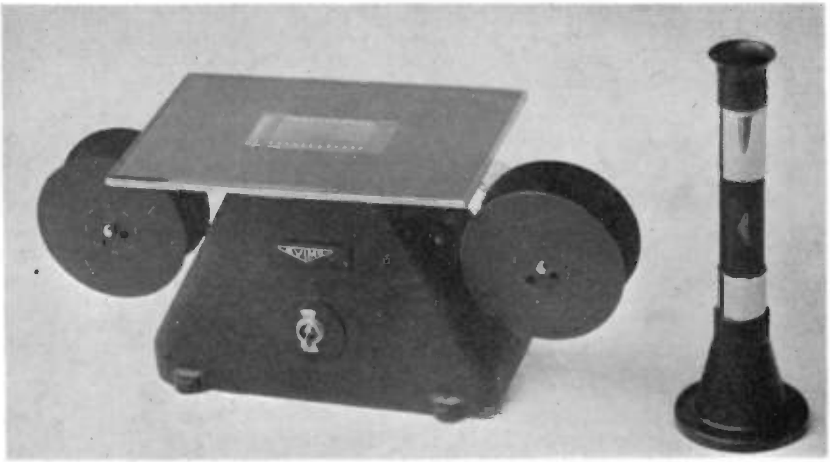


Fig. 4. The " Avimo " scanning table and microscope, for visual examination of film records.

Light-tight magazines, shown in place in Fig. 1, are fitted. These are opened and closed by means of the two knobs carried in the door and operated from outside; they can be taken apart for rapid loading. The camera is designed to take 100 ft. " Eyemo " daylight loading spools, however, and it is not normally necessary to

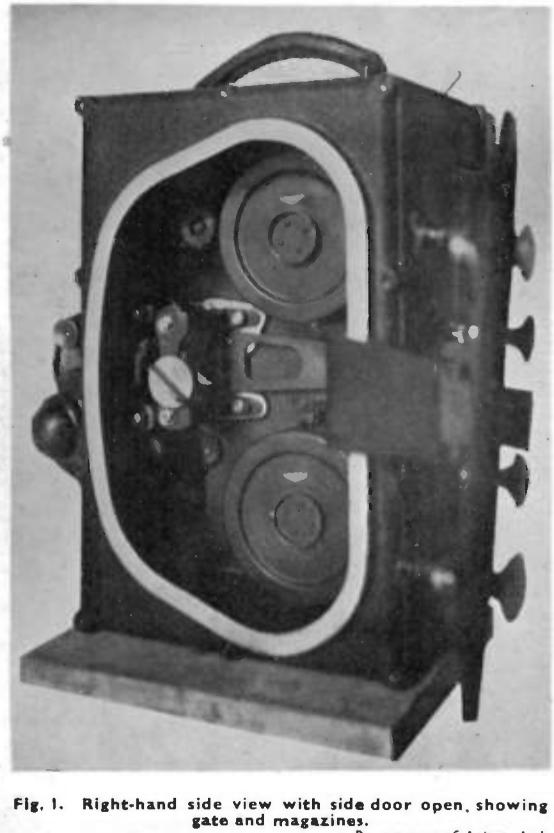


Fig. 1. Right-hand side view with side door open, showing gate and magazines.
—By courtesy of Avimo, Ltd.

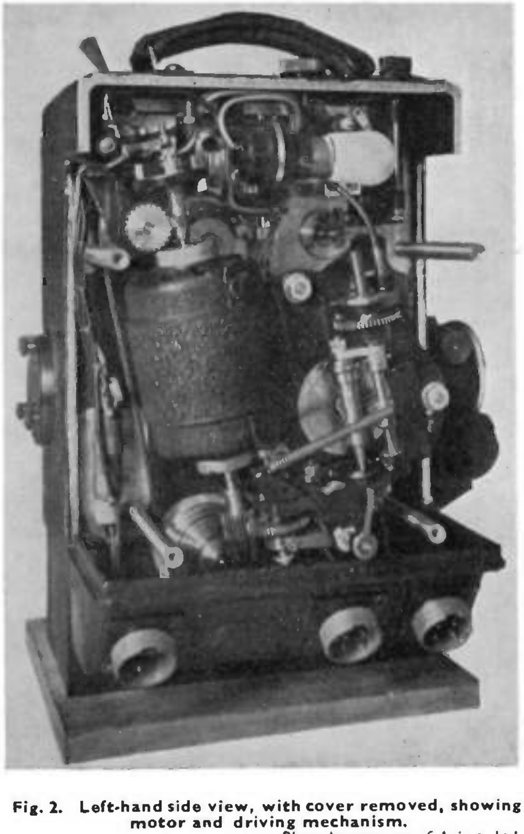


Fig. 2. Left-hand side view, with cover removed, showing motor and driving mechanism.
—Photo by courtesy of Avimo, Ltd.

use the magazines, provided either the whole spool is used before opening the door, or some 5 ft. of film are allowed at the end of each record to make the take-up spool light-tight.

Three input sockets are shown at the bottom of the camera in the side view, Fig. 2; that on the left is for the power input to the motor, while the two on the right are for the inputs to the timing lamps. The latter each requires 2 volts 0.5 amp. for the cathodes and a suitably interrupted 24-volt D.C. supply for the anodes.

Controls

The main operating controls are conveniently located on the top of the case, beside the carrying handle. They consist of the continuously variable speed control knob and the footage indicator, which have already been described, together with the on-off switch controlling the motor and the exposure indicator. This latter is operated whenever the on-off switch is moved to the "on" position and consists of a narrow drum having a knurled edge carrying numbers from 1 to 12 on its periphery. The drum projects slightly through a slot in the top of the case and is reset to "1" by hand on reloading. When the exposure indicator operates, a lamp and subsidiary optical system print the exposure number on the film, before it starts to move.

Application of the Camera

The camera is primarily intended for use with standard commercial oscilloscopes and this fact determined its general layout. In addition, however, it can be used as a built-in unit in specially constructed cathode-ray recording equipment, as, for example, in cathode-ray engine indicators.

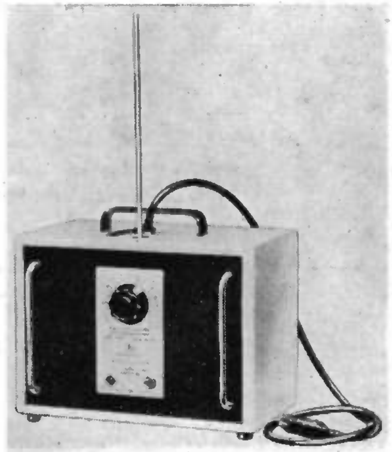
Fig. 3 shows an early model of the camera in use with a "Cossor" double beam oscilloscope, model 339. The camera and oscilloscope are mounted on a polished wood baseboard to form one unit. The oscilloscope is located by means of an aluminium plate having four holes to take the metal pins which normally carry the rubber feet of the oscilloscope and is held in place by means of the split metal clamp fitted with fasteners. The camera is mounted on a metal stand to bring its optical axis in line with the axis of the cathode-ray tube screen and is coupled to the oscilloscope by means of the conical metal hood shown. This hood carries a viewing tube fitted with a rubber eye ring, as shown, for viewing the spot in setting up and during operation. The viewing tube and hood are finished optical flat black internally and there is no fogging from light entering the viewing tube, which is provided with a shutter and is slanted away from the camera lens. The distance between the cathode-ray tube screen and the lens is 4 in., giving a record occupying the full available width on 35 mm. perforated film, for a cathode-ray trace $3\frac{1}{4}$ in. long. Accessibility of the oscilloscope controls is reduced but is as great as can be achieved when using a standard oscilloscope primarily designed for visual observation.

The construction of the "Avimo" camera is based on sound mechanical principles, while the special requirements of cathode-ray oscillography have been taken into consideration in its design. It forms a versatile, compact and self-contained unit with all its controls readily accessible, and should find wide application in the field of electronic measurement.

Scanning Table

Fig. 4 shows the "Avimo" scanning table for use in analysing 35 mm. film records. It consists of a cast aluminium base housing an electric lamp and fitted with a simple gate, carrying a flashed opal glass screen at the top. A hinged metal frame carries a plate glass table which covers the gate. Two fixed arms are provided to take the film spools. A small conical stand, fitted with three ball feet, carries a simple microscope, as shown to the right in Fig. 4. The microscope, which can also be used for accurate adjustment of the optical focus of the camera, has a magnification of 24 × and can be fitted with a graticule reading in thousandths of an inch if required. This scanning table and microscope provide a convenient means of making accurate measurements of film records with the minimum of fatigue. When opaque paper records have to be analysed, the microscope can be fitted with a small conical stand having an internal electric lamp for surface illumination.

A Television Signal Generator



The television signal generator developed by Messrs. E. K. Cole has been specially designed to enable a receiver to be checked at a time when the broadcast signal is not available.

It provides facilities for testing the vision circuits, sound circuits, and the aerial system.

The pattern seen on the screen, when adjustments have been correctly made, is a white background crossed by two vertical black bars and a horizontal grey bar.

Construction

The chassis is housed in a cream-coloured case measuring $12\frac{1}{2}$ in. by $9\frac{1}{2}$ in. by 8 in. high. At the rear of the case are spring clips to hold two 6-in. aerial rods which screw together and into a socket at the top of the case. A pair of radio-frequency output sockets are also provided at the top of the case, with an 80-ohm output cable.

The frequency of the generator is set by means of a tuning dial on which the sound and vision frequencies are marked.

Operation

The aerial is capable of radiating a good signal at a distance of 70 to 100 ft. with both rods in place. For distances below this, only one aerial rod is necessary, provided there is no local screening. The sound output from the generator gives a low burring noise in the loudspeaker of the set if it is functioning correctly.

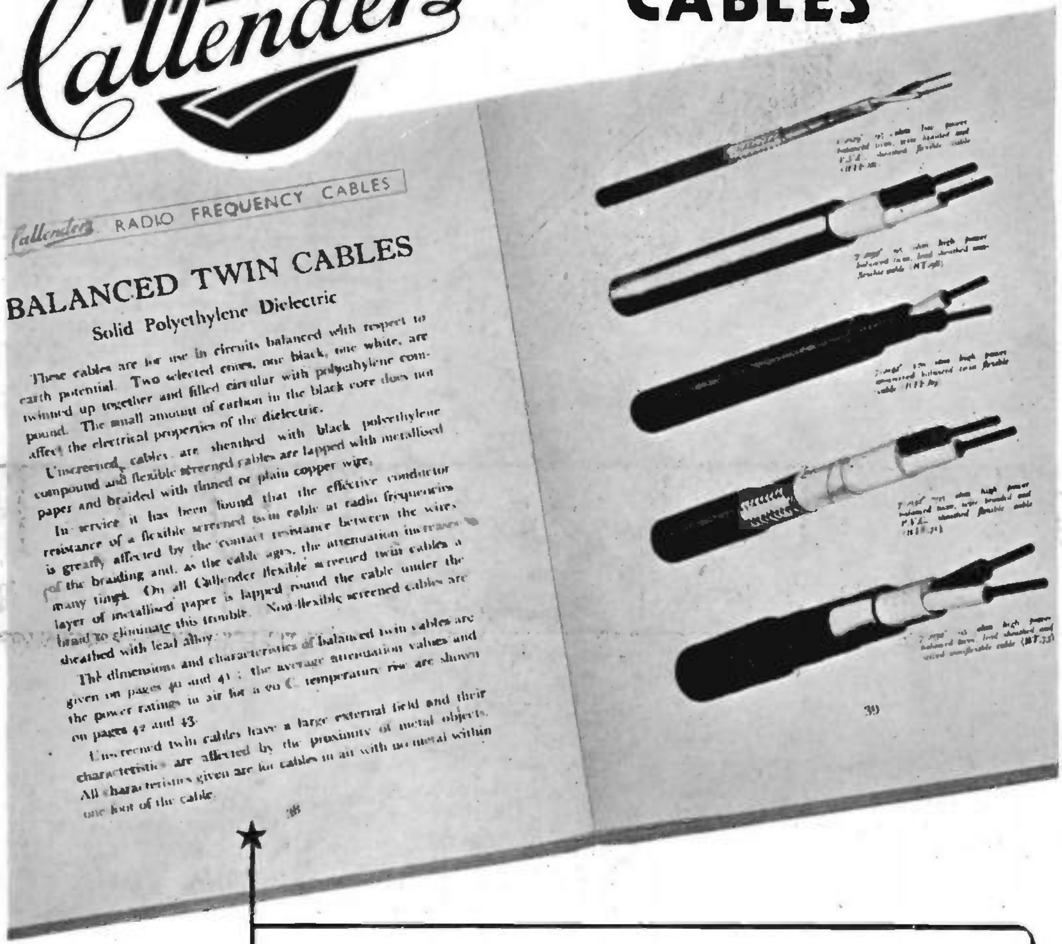
In testing the vision receiver, no notice is taken of the flyback lines, as the generator is not radiating flyback suppression pulses.

Price

Complete with cable and aerial rods, approximately £10 10s.

B.I. Callender's

RADIO FREQUENCY CABLES



Have you had a copy of this new book—the first of its kind giving comprehensive technical and catalogue data on radio frequency cables?

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Electronics at the Physical Society's Exhibition

The following items of electronic interest shown at the Physical Society's Exhibition have been compiled from information kindly supplied by the firms concerned. This list is classified in alphabetical order, but it must not be taken by any means as covering everything of interest to be seen. It is hoped to describe further items, which have been omitted for lack of space, in a later issue

Bridges

The multi-ratio R.F. bridge, type D-297-A, is a commercial development of a design by the B.B.C. Research Department. It will measure a wide range of impedances, whether inductive or capacitive, under practically all conditions. The range of measurement is 0-20,000 *pF* and 10 ohms-10 megohms; over the whole of the range an accuracy of 2 per cent. or better is maintained at all frequencies between 15 kc/s. and 2 Mc/s.

The type D-101-A bridge employs the Wien Bridge circuit and is made to read frequency direct in terms of two decade dials and a third dial which is continuously variable and covers the interval between adjacent steps on the second decade. This frequency bridge is accurate to ± 0.25 per cent. and the reading accuracy is always better than 0.05 per cent. Two ranges of frequency are provided—range 1 covers 100 c/s. to 1,210 c/s.; range 2 covers 1,000 c/s. to 12,100 c/s. The input impedance varies between 400 ohms and 1,500 ohms according to the bridge setting.

Muirhead and Co., Ltd.

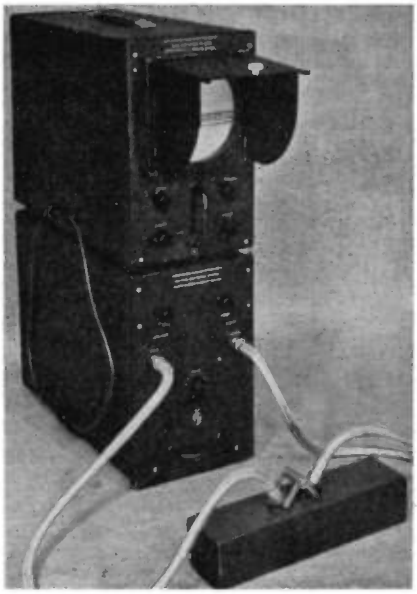
Chemical Research Apparatus

The T.E.P meter (Titration End Point) is designed as a valve voltmeter and uses a "magic eye" as indicator. Changes of potential of suitable magnitude cause the eye to open and to indicate the end point of a reaction. The eye "announces" the approach of such an end point due to the addition of the titrant, by opening and closing repeatedly ("winking") when the equilibrium point has been nearly reached. The sensitivity of the magic eye can be adjusted by a control, minimum sensitivity being approximately ·150 mV maximum sensitivity approximately 50 mV (for 45° opening up of the magic eye).

Griffin and Tatlock, Ltd.

Electrometric titration apparatus type E920 is a self-contained potentiometric titration apparatus operated from the 50-cycle supply mains. The end point is detected by a "magic eye" indicator, and a special circuit eliminates all possibility of drift during a titration. The value of the applied potential difference is then read off directly from the calibrated scale. A sensitivity control is provided and at maximum sensitivity a P.D. of 2 millivolts can be detected. The main dial covers the range to be extended to a maximum of 2 volts. A switch controls a subsidiary circuit which provides a polarising voltage for one electrode of a monometallic system.

Baird and Tatlock, Ltd.



Supersonic Flaw Detector.
—Henry Hughes & Son

Direct Reading pH Meter

For full description of this instrument, which has been developed in conjunction with Mr. R. H. Thorp, of the Wellcome Physiological Research Laboratories, *see* ELECTRONIC ENGINEERING, September, 1945, p. 671.

Muirhead and Co., Ltd.

Ink-Recording Polarograph

An instrument for rapid micro-analysis with a dropping mercury electrode. The equipment consists of a polarograph unit with a voltage range of 0.5 to − 3 volts, and current range for the electrolysis cell adjustable to give maximum readings from 0.2 to 200 microamps.

H. Tinsley and Co., Ltd.

See also:

The Cambridge Instrument Co.

Condensers

"Micropack" tubular dry electrolytic capacitors. A range of electrolytic capacitors of plain foil construction sealed into aluminium tubes with synthetic rubber-faced end disks. They are fully tropical.

Tubular paper capacitors in glass tubes. For use where a component with a metal case is undesirable. The efficient seal and long external leakage path are demonstrated by measurements of insulation resistance after prolonged immersion of the capacitors in water.

Tubular ceramic capacitors in glass tubes.

Cathode-ray capacitors. Paper dielectric capacitors suitable for high voltages and high temperatures; may be employed for smoothing D.C. supplies to cathode-ray tubes. Fully tropical.

Telegraph Condenser Co., Ltd.

Condensers, Silvered Mica

Silver films approximately 0.0025 in. thick applied to mica plates 0.001 in. to 0.005 in. thick. Suitable for use at radio and audio-frequencies for the construction of wave-filters and other components necessitating low losses.

Johnson, Matthey and Co., Ltd.

Decade Capacitance Units

Precision mica decade condenser of very small size.

H. Tinsley and Co., Ltd.
Muirhead and Co., Ltd.

Counters

The cold cathode counter is a unit which may be operated by a photocell, or other low-power source; it has a great advantage over existing devices of a similar nature which employ hot cathode valves in that during idle periods there is no deterioration and there is no heater or filament to fail. The speed of counting may vary from a maximum of 15,000 per hour down to one operation over a period of weeks.

See ELECTRONIC ENGINEERING, June, 1945.

Ferranti, Ltd.

Electrical Contacts

Examples of the many types of headed, turned and composite contacts in silver, platinum, palladium and their alloys, suitable for use in instruments where contact resistances must be kept to a minimum.

Johnson, Matthey and Co., Ltd.

Electro-Medical Apparatus

"Theratherm" Ultra-Short Wave Therapy Equipment, Type MME.12

The power output, in the region of 350 watts, is suitable for either cable or condenser technique. Every precaution has been taken against the possibility of burning the patient despite the increased working efficiency afforded by the Theratherm.

Marconi Instruments, Ltd.

Electronic Stimulator

See ELECTRONIC ENGINEERING, July, 1945.

Edison Swan Electric Co., Ltd.

Electrocardiograph

This is a transportable instrument in two units, one being the recorder and the other the independent A.C. mains power supply unit. The instrument uses a cathode-ray oscillograph and enables, in addition to the usual photographic recording, the long period direct visual observation of the cardiogram by means of a recurrent single stroke traverse released by means of a push-button switch by the operator as often as required. Continuous records up to 5 or 10 ft. can be taken and automatic time and lead markings are provided.

A. C. Cossor, Ltd.

(*For full description of this apparatus see* ELECTRONIC ENGINEERING, *February*, 1945.)

A portable form of electrocardiograph completely contained in a case measuring 20 × 11½ × 9 inches, using a string galvanometer and recording camera, is also shown.

Cambridge Instrument Co., Ltd.

Flaw Detector, Supersonic

This is a portable non-destructive test equipment capable of detecting flaws such as hair-line cracks, pinhole, pipe, micro-porosity, slag inclusions, lamination and welding defects in ferrous or non-ferrous metals or in any other solid. The instrument makes use of the reflection of supersonic waves which occur at any discontinuity in the transmitting medium; short pulses of supersonic energy are used and the time of travel is indicated on a cathode-ray tube. The maximum range of the standard equipment is 12 ft.

Henry Hughes and Son, Ltd.

Gauges, Vacuum

Pirani Direct Reading Gauges

New models are available covering the following ranges: (a) 2 mm.-0.1 mm., 0.1 mm.-0.001 mm.; (b) 10 mm.-1.0 mm., 1.0 mm.-0.05 mm.; (c) 0.03 mm.-0.0001 mm.; (a) and (b) are dual range instruments, and attention in all models has been given to interchangeability of heads and ease of manipulation.

Vacustat Gauge, Enclosed Industrial Model

This is a small self-contained vacuum gauge covering the range 10 mm.-0.01 mm. It is mounted in an enclosed metal case suitable for wall or flush panel mounting.

New Type Philips Vacuum Gauge

Research in permanent magnets has made it possible to reduce the dimensions of the gauge unit and increase the sensitivity. The gauge unit now available is only a little larger than a Pirani gauge head.

W. Edwards and Co. (London), Ltd.

Instruments, Indicating

Power Level Indicators

These are a standard of reference of power levels and resemble thermocouples in that they can be standardised on direct current and subsequently used on alternating current over a wide range of frequencies, irrespective of waveform and with the same degree of accuracy.

Muirhead and Co., Ltd.

Miniature Instruments, hermetically sealed to withstand the most severe tropical conditions, are shown. A new moving iron instrument with very light movement is also exhibited in which the irons are shorter than usual.

High-Voltage Indicator

An indicator of the electrostatic type giving direct readings and voltages to earth up to 11 kV.

Ferranti, Ltd.

High-Vacuum Type Electrostatic Voltmeter

The high torque associated with this instrument is obtained by the use of a high vacuum as the insulating medium. With this arrangement the voltage gradient between the vanes may be raised to 100 kV/cm. or more.

Metropolitan-Vickers Electrical Co., Ltd.

Alarm Voltmeter

Consists of an ordinary moving-coil voltmeter with an adjustable pointer set by hand so that when a certain voltage is reached a contact is made which can ring a bell, etc. The usual contact troubles are overcome by the use of a cold cathode tube. The control grid of this has its potential raised to a striking value by means of a tapping on a transformer secondary via the pointer contact and through a resistance of up to 10 megohms.

Record Electrical Co., Ltd.

Multi-Range Meters

A new British multi-range meter having a sensitivity of 20,000 ohms per volt on the D.C. ranges. The meter is designed round a specially built 45-microamp. meter movement which is particularly robust notwithstanding its sensitivity.

Leland Instruments, Ltd.

New Multi-Range Testing Instruments

This instrument, complete in case, with the following accessories: 120-amp. shunt; 480-amp. shunt; 60/240-amp. transformer and 3,600-volt multiplier, can be used for measurements of A.C. and D.C. voltages of all values up to 3,600 volts, A.C. current up to 240 amps. and D.C. current likewise up to 480 amps.

The Automatic Coil Winder and Electrical Equipment Co., Ltd.

See also:
Sangamo-Weston, Ltd.
Everett Edgcumbe and Co., Ltd.
Elliott Bros., etc.

Galvanometers

A new type, 4237-A, voltammeter is a multi-range instrument having 10 ranges covering 10 microamps. to 100 milliamps. and 10 millivolts to 100 volts. It is fitted with an overload protection switch and has the very high resistance of 100,000 ohms per volt.

H. Tinsley and Co., Ltd.

Modifications have been made in the design and performance of the Cambridge spot galvanometer. The linear relationship between current and deflection is considerably improved.

Cambridge Instrument Co., Ltd.

Instruments, Measuring

Wave Analyser

A high-speed visual electric waveform analyser capable of making a complete analysis in 1/10 second.

Standard Telephones and Cables, Ltd.

Insulation Testing Equipment

Zenith Electric Co., Ltd.

Automatic Ohmmeter

Leland Instruments, Ltd.

New Multi-Range Electronic Testmeter

This instrument consists of a highly stable thermionic D.C. millivolt meter with suitable additional circuit switching to enable D.C. and A.C. current, resistance, capacity and power measurements to be made over a very wide range. A special illuminated meter scale is provided.

Transmission Measuring Kit 74330

Self-contained, portable equipment for measurements on voice frequency telephone circuits. The associated 12 frequency oscillator, sending and attenuator unit, and decibel meter, fitted in attaché case, provide full facilities for determining transmission characteristics of telephone lines and equipment over the frequency range 300 to 3,000 c/s.

Standard Telephones and Cables, Ltd.

" Avo " Valve Tester, Model II

This is a recently developed instrument incorporating the salient principles of the existing valve tester, but considerably widening the scope and accuracy of the valve measurements available.

Automatic Coil Winder Co., Ltd.

Valve Voltmeter

For full details, *see* ELECTRONIC ENGINEERING, September, 1941.

Salford Electrical Instruments, Ltd.

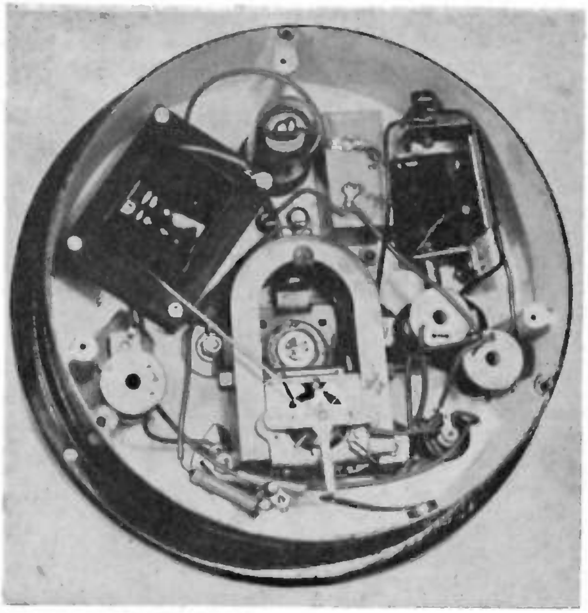
" Selectest," a new multi-range portable test meter that will measure D.C. and A.C. voltages at power and audio frequencies and also D.C. resistances.

Salford Electrical Instruments, Ltd.

Insulators, Metallised Ceramic Terminal

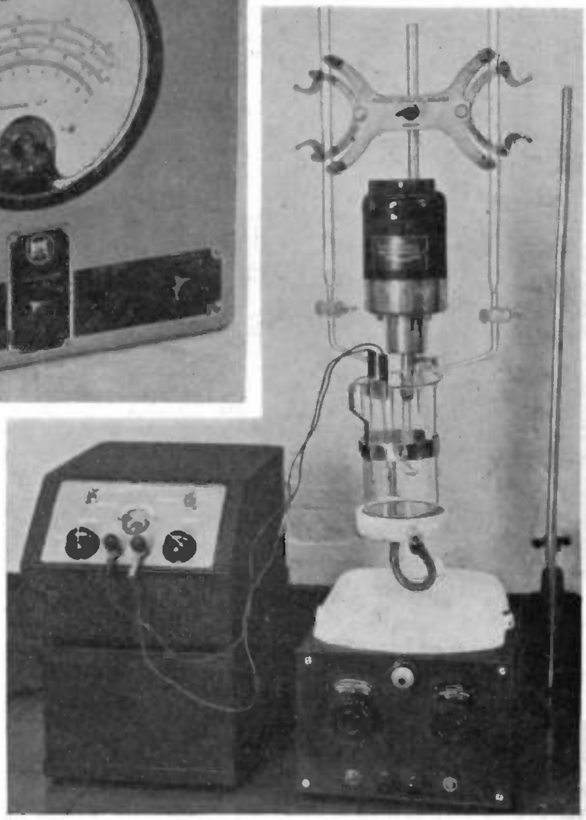
Electrical terminal insulators in ceramic material metallised for soldering to metal components. Used for air-tight and oil-tight sealing of electrical assemblies such as transformers and capacitors. Suitable for pressures up to 40-50 lb./sq. in.

Johnson, Matthey and Co., Ltd.



Alarm Voltmeter, showing cold cathode discharge tube and relay.
—Record Electrical Co.

Instrument for determining moisture in grain.
—Mullard Wireless Service Co.



Electro-Chemical Analysis Apparatus.
—Griffin & Tatlock Ltd.

Laboratory Apparatus

Cathode-Ray Oscillographs

The double-beam oscillograph, Model 339, is a portable unit which includes the original Cossor hard valve time base giving a range of from 5 to at least 250,000 c/s. It contains two amplifiers (gain 28) which can be operated independently on each beam or in cascade for one beam with either a high gain (900) or a wide band width (2,500,000 c/s.).

A. C. Cossor, Ltd.

The Mullard E800 operates direct from the 50-cycle supply mains and contains a 3½-in. high vacuum cathode-ray tube operated at 1,250 volts, a linear time base and a vertical deflection amplifier, together with the necessary high-tension supply units. The E800 was especially developed for use at very low frequencies; it extends the low-frequency spectrum to below 1 c/s., the amplifier response being 2 db. down at 0.1 c/s.

Type E805. This instrument has been designed for the investigation of high-frequency phenomena. It covers the whole frequency spectrum used in television application and is equally well suited for research work, production testing or transmission monitoring.

Mullard Wireless Service Co., Ltd.

Electron Microscope, 50 kV

This instrument employs three magnetic lenses for focusing the 50 kV electron beams. The objective lens forms an image of the specimen magnified 60 times at an intermediate plane. The projector lens further magnifies this image 180 times, forming an image on a fluorescent screen situated at the bottom of the tube. The resolving power (better than 100 Angstrom units) is such as to allow a further enlargement of the photographic image of two to five times, giving an overall magnification up to 50,000 times.

Metropolitan-Vickers Electrical Co., Ltd.

Laboratory Power Supply Unit

A mains-driven source of extremely smooth continuously variable D.C. An H.T. transformer feeding two U.23 valves arranged for full-wave rectification is supplied by a variac (variable ratio transformer), making it possible to reduce the D.C. output voltage to zero or to increase it up to 1,500 volts when the load is comparatively small.

Leland Instruments, Ltd.

4-Channel Pen Recorder.
—*Henry Hughes and Son*

Recording Apparatus

Four-pen oscillograph recorder. This incorporates four compact moving coil galvanometer systems side by side, each providing a clear black trace with a maximum amplitude of 1.5 cm., on dry electrical recording paper. Timing signals are provided by separate fixed pens. The frequency-response is level up to about 100 c/s., and the coils may be of either high or low impedance, requiring 6 mA and 150 mA respectively for full deflection, with a power input of 0.15 watt.

Henry Hughes and Son, Ltd.

Multiple Recorder

This equipment comprises a Model 440 twin double-beam tube unit mounted on the same bedplate with a Model 423 70 mm. film camera and its Model 430 drive unit to provide a transportable outfit for all types of multiple recording with oscillographs, including field tests such as are encountered in traction, naval and engine tests.

A. C. Cossor, Ltd.

Reflectometer

This instrument will permit rapid and accurate comparisons of light reflected from surfaces. Incorporation of a set of filters, any one of which may be brought into position by operating a knurled ring, allows critical comparison of coloured surfaces.

Evans Electroselenium, Ltd.

Resistance Thermometer Controller

This is a highly sensitive controller for creep test equipment and other laboratory and industrial purposes. It is electronic in operation and has no moving parts, except the final vacuum switch.

Sunvic Controls, Ltd.

Resonator, SR. 1152

Used to measure the attenuation and other constants of cable at U.H.F in much the same way that a Q meter is used to measure the quality of coils at lower frequencies. The resonator consists of an air-spaced coaxial line of known characteristics provided with a short-circuiting plunger, the position of which can be set to a high degree of accuracy.

Standard Telephones and Cables, Ltd.

Signal Generator

Designed for operation in the range 6—300 Mc/s., this instrument has been evolved to have as wide an application as possible in the testing of radio receivers. Provision has been made for all types of amplitude modulation with wide R.F. coverage directly calibrated in frequency; there is also facility for narrow or wide band modulation, fine tuning control for communication receiver investigations and patented contactless waveband selection which eliminates the variable factor of R.F. contact resistance.

Marconi Instruments, Ltd.

Thermostat

Various types operated by bimetal helices are shown. The type TS6 has a fine and coarse adjustment of setting to enable the instrument to be set to within less than 1° C. at all temperatures up to 500° C.

Sunvic Controls, Ltd.

Tuning Forks, Valve-Maintained

Muirhead and Co., Ltd.

Lamps, High-Intensity

Kodatron

For full description of this apparatus, *see* ELECTRONIC ENGINEERING, June, 1944.

Kodak, Ltd.

High-intensity flash discharge lamps, operated by the discharge of a 150 mfd. capacitor charged to 2,000 volts.

Salford Electrical Instruments, Ltd.

Micro-second photographic apparatus, using a high intensity gas-filled discharge lamp. The lamp gives an intense flash of 2-5 micro-second duration which can be synchronised to occur at any point in the action. The unit consists of a rectifier unit for charging a 1/μF condenser to 8 kV and a control tube for discharging the condenser through the lamp. The control tube may be tripped by a make-or-break contact or by a photocell or microphone amplifier.

Ferranti, Ltd.

Moisture Indicators

This instrument has been developed especially to meet the need of the miller and farmer in establishing a rapid and accurate determination of the moisture content of grain. It makes use of the capacity change produced between two plates of an electrical condenser by the insertion of a weighed quantity of grain. As the dielectric constant is dependent on the moisture content of the grain, the measurement of the capacity with the grain *in situ* is an indication of how much moisture is present. The instrument is calibrated directly in percentage moisture content, four scales being provided, two for wheat and one each for oats and barley.

Mullard Wireless Service Co., Ltd.

This moisture-in-grain meter provides instantaneous and accurate determination of the moisture percentage contained in wheat, oats and barley. Available for either mains or battery operation.

Marconi Instruments, Ltd.

Moisture Meter for the Cotton Industry

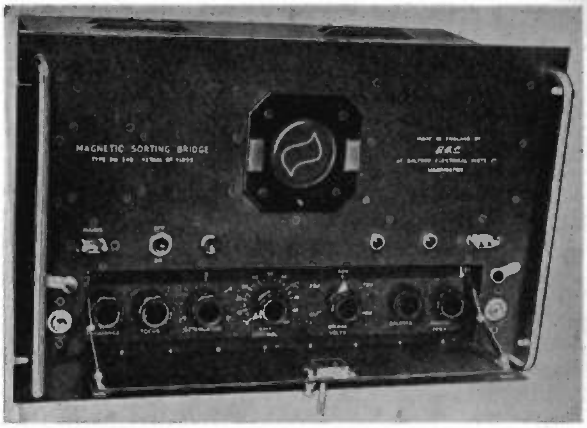
The sample of moist cotton has a special pair of circular electrodes pressed upon it and the resistance of this is a part of the resistance of a circuit the potential at a point of which is applied to the grid of an amplifying valve. The anode circuit of this valve has one or other of two milliammeters in circuit. Changes in this anode current are directly read as moisture regain in three ranges—dry, normal and damp.

Record Electrical Co., Ltd.

Oscillators

Muirhead-Wigan Decade Oscillator; Audio-frequency Oscillator; Low-frequency Decade Oscillator.

Muirhead and Co., Ltd.



Magnetic Sorting Bridge which enables any ferromagnetic materials to be tested and compared.
—*Salford Electrical Instruments, Ltd.*

Ganging Oscillator, Model 343

This instrument is a beat-frequency modulated H.F. signal generator covering a range of from 20 Mc/s. to 60 kc/s. in five ranges with only a few gaps. The instrument was designed for use with the model 339 double-beam oscillograph for the visual alignment of radio receivers, particularly I.F. stages.

A. C. Cossor, Ltd.

Beat-Frequency Oscillators

The type E810 provides a convenient power source for studying the characteristics of amplifiers, transformers, telephone transmission lines and similar equipment at audio frequencies. It may also be used to provide modulation for radio frequency signal generators and "time marking" calibration for electrical time bases.

Mullard Wireless Service Co., Ltd.

A compact light-weight mains-driven oscillator, providing an output signal of low distortion at frequencies between 10 and 20,000 c/s. in two ranges. Distortion is less than 2.5 per cent. throughout the range above 50 cycles, provided the load does not exceed 50 milliwatts. The maximum output is 125 milliwatts and hum is 50 db. below signal voltage at maximum output.

Leland Instruments, Ltd.

Oscillator and Absorption Wave-Meter

British Thomson-Houston Co. Ltd.

Photo-Cells

" Eel " MI Photo-Cell

A selenium multiple photo-cell for use with thermionic valve amplifiers and triggering circuits, consisting essentially of a number of small selenium barrier layer elements connected in series, all being contained in a single unit. The output current is largely independent of the load resistance, due to the relatively high internal resistance of the photo-cell.

Evans Electroselenium, Ltd.

Photo-Electric Equipment

A unit for automatic control of street lighting, factory loading yards, railway sidings, traffic signs, etc. This equipment is not affected by mains voltage fluctuations, and retains its sensitivity between 150 and 270 V A.C.

Londex, Ltd.

Potentiometers

During the last five years considerable changes of design of " Berco " wire-wound potentiometers have taken place. Methods of ganging and concentric operation have been improved and the brush mechanism has been redesigned to give higher precision and greater endurance. Several different types are exhibited.

Sealed Rotary Controls

These components have been developed for use under tropical conditions. The general construction is a standard potentiometer mounted in a plated brass container which is sealed by soldering or other suitable means and provided with terminals of the glass-to-metal type. The shaft bushing is also sealed by neoprene rings.

British Electric Resistance Co., Ltd.

Rectifiers

" Westalite " Rectifier Unit

This is an improved double-voltage type which operates at twice the reverse voltage per element with practically the same forward voltage drop.

Westinghouse Brake and Signal Co., Ltd.

SenTerCel

Standard Telephones and Cables, Ltd.

Rectifiers, copper-oxide, for incorporation in measuring instruments.

Selenium

Salford Electrical Instruments, Ltd.

Midget

Midget high-voltage rectifiers, providing up to 30 kV at 15 m/a.

Ferranti, Ltd.

Relays

Aerial changeover relays for radio frequency, designed to keep the capacity to the minimum and provide ample clearance to prevent leakage. They are for more or less universal high frequency use, *i.e.*, antenna transfer, band switching and keying.

Electromagnetic Relay, Type L.F.

A heavy-duty type for A.C. and D.C. which is noiseless in working and has a 2 VA coil consumption.

Midget Relays

Type ML for D.C. only. Spring controlled, works in any position and the coil consumption is 0.1 VA.

Londex, Ltd.

Moving Coil Relays

The S54 shown by Sangamo Weston is a permanent magnet moving coil relay which is unaffected by external magnetic fields. It is fitted with contacts which once adjusted cannot be altered unless the cover is removed. A pinion drive is provided for varying the mean operating point of the relay and a fine screw adjustment for changing the position of the fixed contacts.

Model S55 Relay

All adjustments are made externally and a slipping clutch prevents damage by overturning. Contact adjustment is facilitated by a rack-type adjustment which provides smooth, low-geared operation. The relay can be reset by hand by depressing a button, or remote control may be effected by closing the circuit of an electrical releasing device which requires an energising current of approximately 50 milliamperes. Both this and the S54 can be made to operate on currents as low as 5 microamperes.

Sangamo Weston, Ltd.

Miniature Relays

Similar to the Post Office type in sealed glass cases for withstanding severe tropical conditions.

Ferranti, Ltd.

Relays, Bimetal and Electronic

Sunvic Controls, Ltd.

Resistances

Resistance Box, Constant Inductance R.F.

Muirhead and Co., Ltd.

Resistances, Laboratory

Zenith Electric Co., Ltd.

See also :

The Cambridge Instrument Co., Ltd.
Gambrell Bros., Ltd.
H. Tinsley and Co., etc.

Resistors, Wire-Wound Vitreous Enamelled

Several examples are exhibited of the latest type of wire-wound resistor, having the windings embedded in a new ceramic material which is impervious to moisture or corrosive atmospheres. The ceramic embedding material has been specially developed to enable this component to be used at sea, in the air and under drastic climatic and atmospheric conditions without fear of breakdown.

Zenith Electric Co., Ltd.
Muirhead and Co., Ltd.
British Electric Resistance Co., Ltd.

Thermistors

Resistors with a high negative temperature coefficient of resistance. Applications include temperature measurement and control, time control relays, surge suppression, automatic voltage control and R.F. power measurement.

Standard Telephones and Cables, Ltd.

Switches, Rotary

British Electric Resistance Co., Ltd.
Muirhead and Co., Ltd.

Thermocouples

Both 10 per cent. and 13 per cent. rhodium-platinum thermocouples in the form of continuous lengths of coil and as couples with the wires welded together at the hot junction are shown.

Pallador Thermocouples

A palladium-gold, iridium-platinum thermocouple giving a high e.m.f. and particularly suitable for use in high-frequency measuring instruments.

Johnson, Matthey and Co., Ltd.
Everett Edgcumbe & Elliott Bros.

Transformers

Wide-range transformers.

Muirhead and Co., Ltd.

" Variac " Voltage-Regulating Transformers

A few alternative types are exhibited incorporating the latest designs. They are shown in various stages of completion which illustrate the most interesting features.

Zenith Electric Co., Ltd.

Vacuum Tubes, Special

Reflector Klystrons

These tubes consist of a single rhumbatrom through which a beam of electrons passes, this beam being reflected back by a negative electrode through the same rhumbatrom which, therefore, acts as both buncher and catcher. The tubes produce ¼ to ½ watt at wavelengths around 10 cm.

Ferranti, Ltd.

Klystron

This valve delivers upwards of 100 W at frequencies of 3,000 Mc/s. and above. It is water-cooled and may be operated C.W. or grid-modulated. The anode supply required is 6,000 V, 250 mA.

Magnetrons

The development of the multi-resonator magnetron for Radar purposes has led to a variety of types being produced. By the use of pulsing technique, very high peak powers have been achieved, and the very solid structure has allowed the mean power level to be raised enormously.

British Thomson-Houston Co., Ltd.

V.H.F. triodes, velocity-modulated coaxial line oscillators in centimetric band and H.F. radiation and air blast cooled transmitting triodes.

Standard Telephones and Cables, Ltd.

Transmission Reception Switches

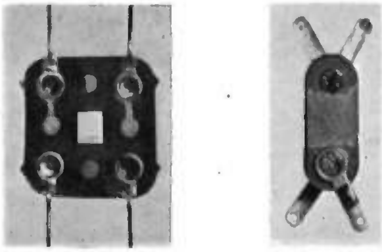
A rhumbatrom in which the voltage developed across the central gap by fed-in R.F. power is used to initiate a discharge in a gas at low pressure, this discharge effectively short-circuiting the resonator. Hence the use for receiver protection in centimetre wavebands. Three types are shown illustrating different wavelengths and different methods of coupling.

Electrometer Valve

The single electrometer valve already developed has similar electrical characteristics to the F.P.54 and can be used in the conventional circuits as described by Du Bridge and Brown (*Rev. Sci. Inst.* (4), 1933, 533). The design of the double valve exhibited was suggested by Dr. Brentano. This is a double tetrode tube in which both tetrode sections draw their emission from a single filament and each section resembles the F.P.54 in electrical characteristics.

Ferranti, Ltd.

Miniature Rectifiers.
—*Standard Telephones & Cables, Ltd.*



Miniature Quartz Crystal in bulb.
—*S. T. & C., Ltd.*

Wires

Resistance Wires

Precision drawn fine wires in nickel-chromium and copper-nickel down to 0.0005 in. diameter.

Minalpha Constant Resistance Wire

Minalpha manganese-nickel-copper alloy, developed to replace manganin, and having a temperature coefficient of ±0.000003 over the range 10° to 40° C. with a thermal e.m.f. against copper of 0.30 microvolt per ° C.

Johnson, Matthey and Co., Ltd

X-Rays

X-Ray Dosemeter

This equipment incorporates in the counter clock a preset mechanism for switching off the X-ray beam when a predetermined dosage has been given. The basis of the design is an ionisation chamber.

Marconi Instruments, Ltd.

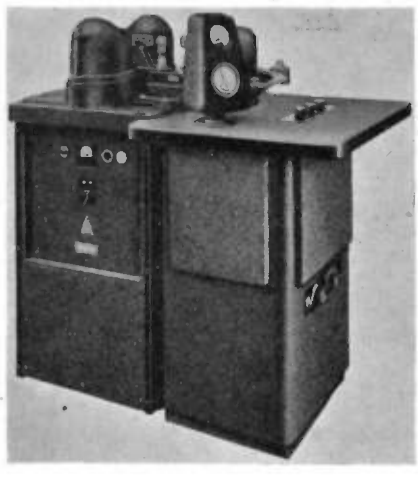
Cameras, Diffraction

While, in general appearance, the Finch Electron Diffraction Camera has not changed, some considerable attention has been given to the design with a view to incorporating modern vacuum engineering principles. All vacuum joints, both fixed and moving, have been redesigned to ensure perfect vacuum tightness with a minimum of maintenance. Maximum pattern definition, reliability and speed of operation have been the main considerations. A third plate holder is now available, known as the " Book " type, in which a number of plates can be inserted and exposed one at a time.

W. Edwards and Co. (London), Ltd.

X-Ray Diffraction Unit

For full details *see* ELECTRONIC ENGINEERING, November, 1945.

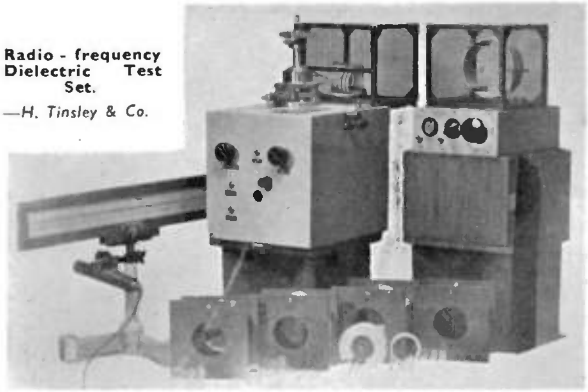


Geiger-Counter X-Ray Spectrometer

This unit enables quantitative and qualitative analyses of crystalline and certain amorphous substances to be made by X-ray analysis.

Philips Metalix (Philips Lamps, Ltd.).

Radio - frequency Dielectric Test Set.
—H. Tinsley & Co.



Electronic Frequency Meter, 0·45 kc/s.
—General Electric Co., Ltd.

Miscellaneous

An automatic V.H.F. direction finder using a fixed H-type Adcock antenna system, single-receiver channel, and cathode-ray oscillograph bearing indicator.

Standard Telephones and Cables, Ltd.

Electronic Water-in-Petrol Detector

See ELECTRONIC ENGINEERING, October, 1944, p. 184.

Leland Instruments, Ltd.

Quartz Crystals in Glass Envelopes, Miniature

Standard Telephones and Cables, Ltd.

Books

The latest books on Physics, Astronomy, Electrical and Radio Engineering, Chemistry and related sciences, will be shown by various technical publishers, among whom are:

H. K. Lewis and Co., Ltd.
Sir Isaac Pitman and Son, Ltd.
Macmillan and Co., Ltd.

Navigational Instrument

A Homing Indicator with two sensitive movements operating in common magnetic circuit and · blind landing indicator with two separate movements for use with beam landings

Ferranti, Ltd.

Regulators, Voltage

Automatic voltage regulator which comprises a toroidal transformer providing a multiplicity of tappings, with a motor-controlled selector mechanism operated by a voltage sensitive relay.

Zenith Electric Co., Ltd.

A hand-operated type of regulator consists of an auto-transformer whose output voltage may be varied continuously by moving a copper-graphite brush along the winding, from which the insulation has been removed to form a contact surface. Although a certain number of turns are short-circuited by the brush, the type of brush and the voltage between turns are so chosen that the heating caused by the current in the short-circuited turns is well below that which would damage the winding insulation. The winding former is specially designed to conduct the heat rapidly from the region of the short-circuited turns.

British Electric Resistance Co., Ltd.

Strain Gauges

A set range of strain gauges is shown suitable for use in aircraft work and in all other kinds of structural problems. Special miniature gauges are also exhibited which can be used for measuring very localised strains. A demonstration of the manufacture of strain gauges by a special machine is given.

H. Tinsley and Co., Ltd.

Strain Gauge Amplifier

Salford Electrical Instruments, Ltd.

Projection Apparatus

A number of epidiascopes will be shown. Small models have a field of 5½ in. square for small theatres and a larger model, the N.A.50, gives a picture from 3 ft. to 12 ft. square.

Newton and Co., Ltd.

Sputtering Apparatus

Features of the apparatus exhibited are portability, compactness and speed of operation. Designed to stand on desk or bench the unit is complete with vacuum pump, high voltage D.C. supply, vacuum chamber and special automatic devices to ensure safety in operation. This unit presents the latest design in small commercial cathodic sputtering apparatus.

W. Edwards and Co. (London), Ltd.

Stroboscopic Equipment

The Strobomite is an electronic tachometer in which a cold cathode discharge tube is driven by a high stability resistance capacitance oscillator. The speed range is from 350 to 21,000 r.p.m., with an accuracy of ± 1 per cent. without need of standardisation against mains frequency.

Henry Hughes and Son, Ltd.
See also *Ferranti, Ltd.*

Electric Micrometer Thickness Gauge

Designed for use on steel rolling mills and for application to metals having a low compressibility factor. The strip or sheet leaving the rollers of the mill passes between two steel roller jaws, one fixed and the other floating. Thickness variations in the strip cause movements of the floating roller which are communicated to the armature of an electric gauge, producing corresponding variations in electric current which are registered on an indicator either of the pointer type of the illuminated moving scale type, or on a recorder.

The Cambridge Instrument Co., Ltd.

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A Single Sweep Time Base

Part I

By D. McMULLAN, B.A.(Cantab), Grad.I.E.E.

Introduction

IN the past the single sweep linear time base has not received so much attention as the free running linear time base.* This is unfortunate, as the single sweep time base can often be utilised not only in those cases where its use is essential (*e.g.*, the observation of random transients) but also with advantage in applications where the free running type is usually employed. Two examples of the latter use may be cited; the automatic synchronisation of the time base with a wide range of frequencies and sweep expansion which enables any part of the trace to be opened out, so that only a fraction of a cycle of the waveform under observation occupies the whole width of the screen of the cathode-ray tube.

Several types of single sweep time base have been described, but most of them suffer from one or more disadvantages. The most usual fault is that an appreciable time elapses after the application of the synchronising or actuating signal before the time base starts its working stroke. This is comparatively unimportant when controllable phenomena are being studied, for arrangements can generally be made to trigger the time base some time before the external circuits. But when the phenomena are outside the control of the worker (*e.g.*, switching transients), the time base has to be triggered by the actual signal being observed, and it is essential that there should be the minimum of time delay between the arrival of the signal and the start of the time base, or else the first part of the signal (which is often the most important) will not be shown on the screen of the tube. It is also sometimes convenient, even in the case of controllable phenomena, for the time base to be actuated by the signal under observation, or else by the pulse that starts the external circuits.

Another disadvantage associated with some types of single sweep time base is that the actuating pulse has to be of a certain fixed amplitude and duration, which is not always easy to arrange without a special pulse generator.

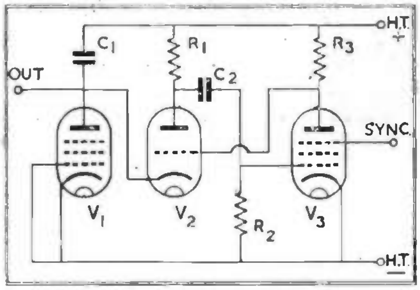


Fig. 1.1. The Puckle time base. (The suppressor grid of V_3 is often connected to C_2, R_2 instead of the control grid which is then used for synchronising.)

It is proposed to describe a time base which does not suffer from these defects and to show how it may be used not only for single sweep working, but also for sweep expansion and for operation as a normal free running time base.

In this article the signal or transient under observation is called "the signal" and the pulse which triggers the time base is called "the pulse."

The Puckle Time Base

It will be convenient to examine the operation of the Puckle time base in the normal free running condition.

The condenser C_1 (*see* Fig. 1.1) is charged through the pentode V_1 used as a constant current device. V_2, the discharge valve, is cut off due to the voltage drop across R_3 produced by the anode current of V_3, the auxiliary trigger valve. As C_1 charges, the cathode of V_2 is carried negative until it approaches the grid potential and V_2 commences to conduct. As soon as this occurs, a voltage drop is produced across R_1 which is applied through C_2 to the grid of V_3 in the form of a negative pulse which reduces the anode current. This causes the anode of V_3, and also the grid of V_2, to become more positive, increasing the rapidity of the discharge of C_1 through V_2 and causing a further reduction in the anode current of V_3, the action being cumulative. When C_1 becomes discharged, due to the fall of anode current in V_2 which applies a positive pulse to the grid of V_3, V_2 is cut off and the cycle repeated.

This time base may be used for single sweep working by omitting C_2 and applying the actuating pulse to the grid of V_3. In the static condition C_1 is charged to a potential approximately equal to the voltage drop across R_3 produced by the anode current of V_3. V_2 passes a current equal to the anode current of V_1. When a negative pulse of sufficient amplitude and duration is applied to V_3, the grid of V_2 is driven positive discharging C_1. As soon as the negative pulse ceases, anode current is restored in V_3 and C_1 commences to charge at a controlled rate through V_1 giving the effective working stroke.

The Puckle time base used in this way for single sweep working suffers from both the disadvantages mentioned above; time is lost before the working stroke starts while the condenser C_1 is discharged and the actuating pulse has to be of sufficient amplitude to cut off V_3 and of the right duration, just to discharge C_1. Thus it is generally necessary, except where mechanically operated switches are used, to employ some form of external pulse generator to control the time base. The time base will also work with negative bias on V_3 and a

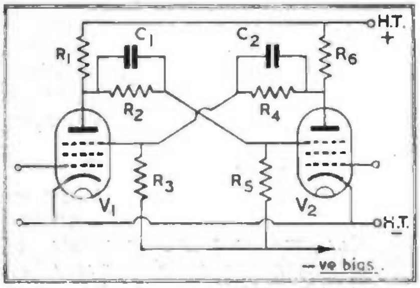


Fig. 1.2. The Eccles-Jordan circuit modified. In the original circuit the control grids of V_1 and V_2 were connected together.

* "Free running" is used in the sense that no external signal is required to actuate the time base although a synchronising signal will probably be used to lock the time base to the waveform under observation.

positive actuating pulse of the correct duration. With this arrangement there is no appreciable time delay.

The Eccles-Jordan Circuit

These disadvantages may be overcome by replacing the auxiliary trigger valve V_3 in the Puckle circuit by a trigger circuit of the Eccles Jordan type. It will be simplest to consider the Eccles-Jordan circuit separately; this is shown on Fig. 1.2, using pentodes (an improvement due to Reich). When V_2 is conducting, V_1 will be cut off and *vice versa*, due to the drop across the anode load of the valve which is conducting being applied by the potentiometer R_2R_5 or R_4R_3 to the suppressor grid of the opposite valve, causing it to become very negative and cutting off the anode current. If a negative pulse is applied to the grid of the valve which happens to be conducting (say V_2), the circuit will change over to the other condition (where V_1 conducts and V_2 is cut off) until another negative pulse is applied to the grid of V_1 when the circuit once more changes back to its original condition. The time taken for the change-over from one regime to the other is very short and may be still further reduced by adding condensers C_1 and C_2 to counteract the effects of stray capacitance.

The Single Sweep Time Base

The circuit of the time base using this trigger circuit is shown in Fig. 1.3. In the static condition V_4 is conducting and V_3 is cut off causing V_2 to hold condenser C_1 discharged. When a negative pulse is applied to the control grid of V_4, the trigger circuit at once starts to change over to the other regime. As soon as anode current starts in V_3, the grid of V_2 is driven negative and C_1 commences to charge through V_1 giving the working stroke. When C_1 has been charged to a potential approximately equal to the voltage drop across R_3, V_2 commences to conduct, and a negative pulse is applied to the grid of V_3 through C_2 causing the Eccles-Jordan circuit to change back to its original condition. C_1 is discharged and held discharged by V_2.

Since the trigger circuit takes only a few microseconds to change from one regime to the other and the condenser C_1 starts to charge as soon as anode current begins in V_3, the time delay between the application of the trigger pulse to V_4 and the commencement of the time base working stroke is only a fraction of a microsecond. As the length of the working stroke is unlikely to be less than one microsecond, this time delay is inappreciable and for most purposes the time base may be said to start as soon as the trigger pulse is applied.

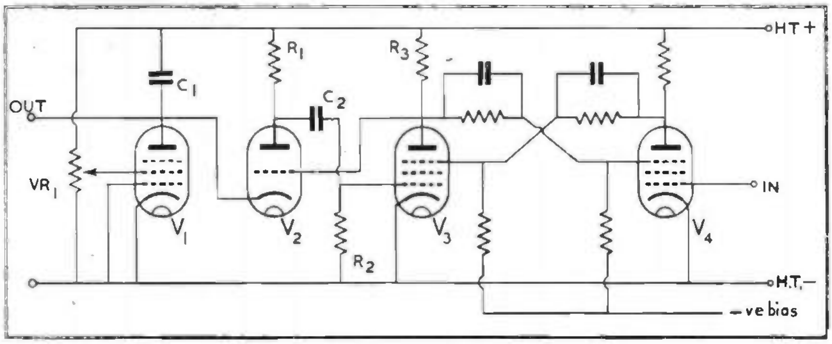


Fig. 1.3. The single sweep time base described in the text.

The length of the trigger pulse is unimportant as long as its duration is not greater than that of the working stroke of the time base or else the time base will make more than one stroke for each signal and the trace will be difficult to interpret.

The time base as described will only trigger with negative pulses. If it is desired to work with positive pulses, one or other of the following methods may be used. The positive pulse may be fed on to the grid of V_4 through a differentiating circuit, in which case the time base will be triggered by the back edge of the pulse. This arrangement will only be satisfactory in those applications where the pulse ends before the signal begins.

The second method, which is the better, is to change the positive pulse into a negative, by passing it through a phase reversing stage. This generally means an extra valve, but it is worth incorporating, as it is needed if the time base is to be used for sweep expansion. If the time base is to be triggered by either negative or positive pulses from the same source, it is necessary to separate the negative and the positive pulses and to apply them to the appropriate valves. Diodes may be used for this purpose.

Application of the Time Base

Transients may be divided into two main classes. Those which repeat at regular or irregular intervals and those which occur only once. For observing transients of the second type either photography or a long persistence screen is necessary. The time base is required to make only one sweep and to be reset manually. For this purpose C_2 is open circuited. To reset it is only necessary to apply a negative pulse to the grid of V_3. With transients of the first type, the time base must reset automatically and it must again be stressed that the length of the actuating pulse must not be longer than the working stroke or else the time base will make two or more strokes for each transient. This may generally be avoided by applying the actuating pulse through a short time constant circuit, although when the signal is used to trigger the time base difficulty may sometimes be encountered, as, for example, when the amplitude of the end of the transient is much greater than that of the beginning and the transient lasts longer than one sweep of the time base.

When single transients are being photographed it is necessary that the spot shall be made invisible except during the working stroke. The beam may be brilliancy-modulated or else deflected off the screen until the start of the time base. For all except very high sweep velocities the second method would seem to be the easiest as it is only necessary to connect the free X plate of the tube to the anode of V_4 through a suitable potentiometer. The potentiometer is adjusted so that the spot is initially off the screen and as soon as the actuating pulse is applied to the time base the anode of V_4 moves positive very fast bringing the spot on to the screen for the working stroke. It is obvious that this can only be used when the changeover time of V_3 and V_4 is a fraction of the working stroke. The length of the working stroke is made greater than the width of the screen so that the spot is again invisible after the transient is over.

It is not essential to employ beam modulation when repeating transients are being observed although it is sometimes desirable, especially with high spot velocities and low repetition rates.

Attention must be drawn to the fact that a D.C. connexion must be made between the output of the time base and the X plates of the tube. If this is not done the spot will start from a different point on the X axis for each stroke if irregularly spaced transients are applied.

Sweep Expansion

In order to expand one part of a cycle of a recurring waveform, the time base must start at the appropriate part of the cycle. The amount of expansion obtained depends on the length of the working stroke relative to the length of the cycle.

The time base may be made to start at the correct time by arranging that it is triggered by a peak of the signal waveform through a time delay circuit. By adjusting the time delay it is possible to start the time base at the correct part of the cycle. In practice, this may be arranged by triggering the time base from an auxiliary time base which is running in synchronism with the signal.

A suitable circuit is shown in Fig. 1.4. The triode section of V_5 acts as a cathode follower and the output of the auxiliary time base is applied to the grid. During the working stroke of the auxiliary time base the potential of the grid, and also that of the cathode, falls until it is below the potential of the diode (set by VR_2). When this occurs the diode conducts and applies a negative pulse to the grid of V_4, starting the main time base. The start of the time base is adjusted by VR_2. The main time base is reset by a negative pulse derived from the discharging circuit of the auxiliary time base and applied to the grid of V_3. This is necessary to prevent the main time base making

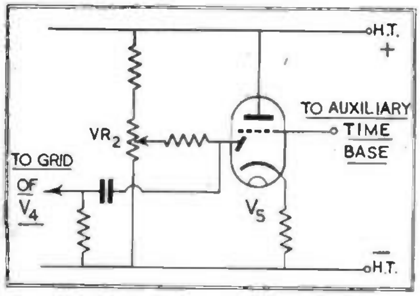


Fig. 1.4. The circuit for use with single sweep time base to provide sweep expansion.

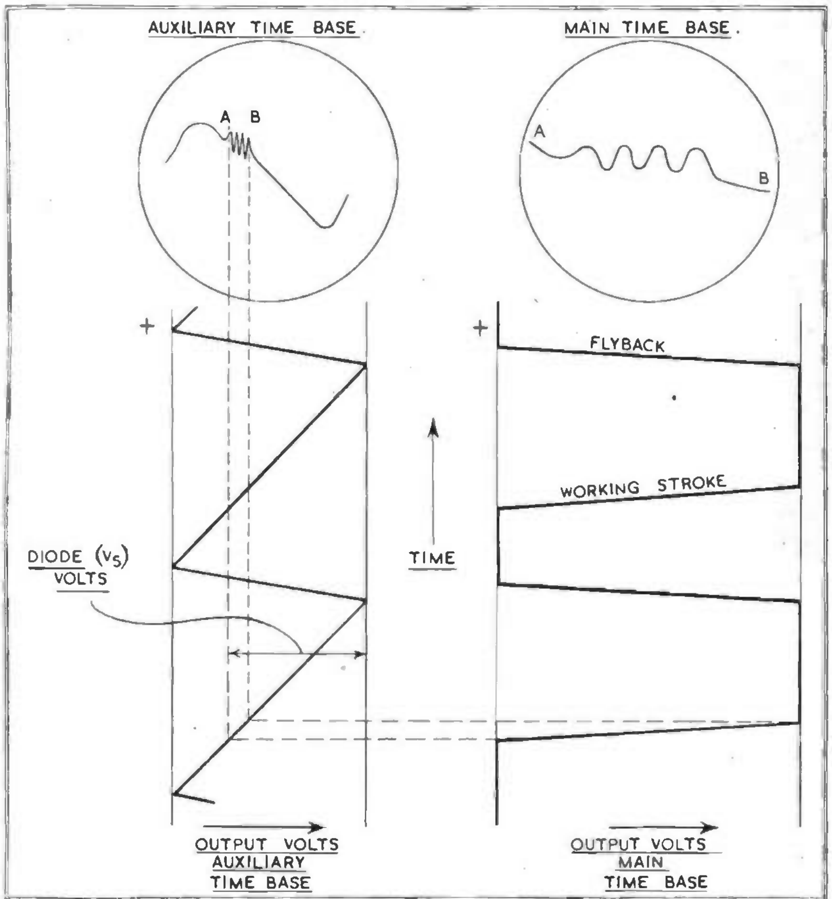


Fig. 1.5. Diagram illustrating the working of the sweep expansion circuit. The figure in the left-hand circle represents the waveform of the signal, and that in the right, the portion AB is expanded.

several sweeps for each sweep of the auxiliary time base.

In practice, the auxiliary time base is connected to a cathode-ray tube and is adjusted so that one or two cycles of the signal are visible. It is essential that the time base is closely synchronised to the signal. Any fraction of a cycle of the signal may be opened by adjusting VR_2 and VR_1 on the main time base. In order to determine which part of the cycle is being expanded VR_2 may be calibrated in fractions of the auxiliary time base sweep, or if a double beam cathode-ray can be left connected to the output of the auxiliary time base, the signal fed to one Y plate and a pulse derived from the anode of V_4 fed to the other Y plate then a definite indication is given of the start of the main time base. As VR_2 is adjusted the marker pip will move across the screen of the double beam tube, which is thus used as an indicator for determining the point of commencement of expansion of the main trace. The main trace should be depicted on a separate tube, or a switching device can be used to connect the X plates either to the auxiliary or to the main time base, while at the same time switching the marker signal from the anode of V_4 on and off one of the Y plates.

The working of the sweep expansion circuit is shown diagrammatically in Fig. 1.5. The length of the working stroke of the main time base should be made slightly greater than the width of the tube or else two vertical lines will be visible, one at each end of the sweep. These lines will be very bright if the degree of expansion is at all large and will make the regional brightness of the trace appear low in comparison.

In the second part of this article practical details will be given of a time base designed on the lines indicated in this part, together with some examples of its use.

(*To be continued.*)

H.F. Band-Pass Filters

Part I.—General Properties

By H. PAUL WILLIAMS, Ph.D., A.M.I.E.E.*

Introduction

WHEN designing radio equipment the engineer has two distinct lines along which he may work. One line of approach is to rely entirely on "cut and try" methods, the other extreme is to make a complete theoretical calculation of the problem. In many cases, of course, a middle course is followed, so that experimental trials are combined with rough calculations. However, the design of H.F. band-pass filters ranks among the problems for which complete calculations can be made with great certainty and satisfaction. This reason (together with the fact that they are such a common feature of radio design) makes it well worth while acquiring a good theoretical knowledge of such filters.

The qualification H.F. is used to distinguish them from L.F. band-pass filters and includes what are commonly called I.F. frequencies, *i.e.*, we are concerned with radio frequencies only. At radio frequencies we are normally dealing with coils whose amplification factor Q is at least of the order of 20. As a result the theory of these band-pass filters can be developed in quite a simple manner. There is no need to go through the usual network theory.

Although a large number of articles on band-pass filters are in existence, it is not easy to correlate conveniently the information they contain. They often have different methods of approach and somehow always succeed in using different symbols! In the following discussion the various aspects of the theory have been worked with a consistent set of symbols. The material is based on an internal monograph issued a few years ago and therefore has had the advantage of criticism by other engineers.

The equations have not been rationalised since this makes them appear more formidable than they really are. Furthermore, by leaving them in the complex form, the phase relationships may also be calculated. To avoid unnecessary calculations on the part of the designer, a large selection of graphs has been included. In addition, an extensive summary of the properties of band-pass filters precedes the main text. Thus a useful overall picture of band-pass filters can be obtained before the detailed argument is studied.

* Standard Telephones & Cables, Ltd.

List of Symbols Used

K = Coupling factor.
This factor equals the common coupling impedance (i.e., ωM or X_0) divided by the geometric mean of the series resistance of the two circuits.
e.g., for mutually coupled circuits with unequal damping and series resistances R_1 and R_2 $$K = \frac{\omega M}{\sqrt{R_1 R_2}}$$
In the case of equal circuits K is unity for critical coupling and greater than unity for over-coupled circuits (which give a response curve with two peaks). Also K is then equal to the "percentage coupling" multiplied by the Q of a single circuit.

q = Amount off tune in terms of band-width.
e.g., if the circuits have a band-width of 10 kc/s. at 1,000 kc/s., then
985 kc/s. = $-$ 1.5 q
1,025 kc/s. = $+$ 2.5 q
(See also Section 2.11.)
With unequally damped circuits the band-width of the broader circuit has been taken as q_1 and that of the sharper circuit as q_2. Then in formulae q_2 is replaced by $k^2 q_1$, where k has the meaning given below.

k = Square root of the ratio of the series resistances of the two tuned circuits.
e.g., $R_1 = k^2 R_2$, where R_1 and R_2 are the series resistances.
(See also Section 2.21.)

Q = Magnification of a circuit on tune.
This is the conventional meaning, i.e., $Q = \frac{\omega L}{R}$

X_0 = Common bottom-end coupling reactance.

f_0 = Mid-band frequency of band-pass response curve.
Also referred to in the text as the "on tune" frequency.

q_0 = Separation between frequencies to which staggered circuits are tuned (in terms of q).

q_m = Value of q at peaks of response curve.

q_s = Value of q at which the response is equal to that on tune.

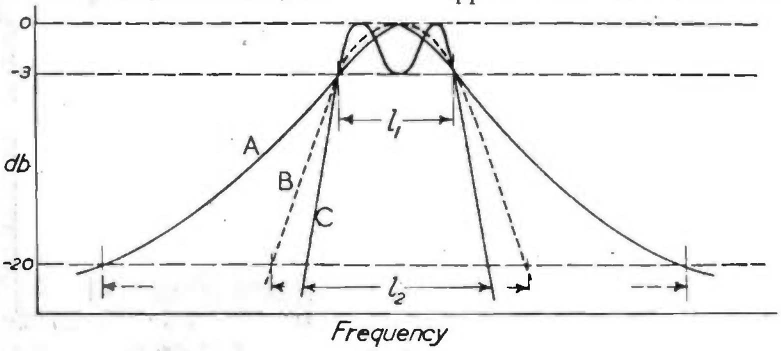


Fig. 1.

1. Summary of General Properties

1.1 Selectivity

(a) Variation with Type of Coupling

If the two circuits are identical, all types of coupling (*i.e.*, whether mutual, top end, bottom end or link coupling) lead to the same shape of response curve.

The choice of coupling depends merely on practical considerations such as layout, method of trimming, or stray capacities.

(b) Comparison with Single Circuit

As a basis for comparison we shall assume that equal band-widths are required at 3 db. down from the maximum response and that at no point within the pass-band should the response be more than 3 db. down, *i.e.*, the maximum dip in the case of the band-pass circuit shall be 3 db.

With the above stipulation we obtain Table 1.

(c) Variation with Unequal Circuits

(i) Unequal L to C Ratios.

This results in similar response curves to those obtained with circuits of different dampings (*see* (ii) below). The only difference lies in the transformer action of the unequal inductances.

(ii) Unequal Dampings.

This results in a symmetrical response curve whose shape approximates closely to that given by two equal circuits whose Q equals $\sqrt{Q_1Q_2}$.

(iii) Unequal Tuning (Staggering).

This produces a symmetrical response curve of identical shape to that given by equal circuits whose coupling factor K equals $\sqrt{K^2 + q_0^2}$.

(iv) Unequal Tuning plus Unequal Damping.

This produces an unsymmetrical response curve in all cases. If the frequencies to which the two circuits are tuned are interchanged, then the curve has the same shape as before except for a reversal in the frequency scale (*i.e.*, it does not matter whether the primary or the secondary has the greater damping).

1.2 Gain

(a) Variation with Coupling Factor K

The gain on tune varies with K in the manner shown in Fig. 2. The *maximum* gain remains constant for values of $K \geqslant 1$. When $K > 1$ the response curve has two peaks at which the gain is half that obtained on tune by a single circuit of equal Q.

(b) Variation with Unequal Circuits

(i) Unequal L to C Ratios.

By having $L_1 \neq L_2$, a transformer action may be obtained. This does not mean, however, that an increase in voltage output may be achieved in this manner.

Assuming that L_1 and L_2, the primary and secondary inductances respectively, have approximately equal Qs, then there is no object in attempting to increase the gain by reducing L_1. Although the transformer effect steps up the voltage by $\sqrt{\frac{L_2}{L_1}}$ (*see* Section 2.24), the overall gain is actually less due to the reduction in the primary impedance with the consequent reduction in the effective series voltage *e* (*see* Sections 2.12 and 2.31). Thus the best result is still obtained by using two equal circuits each having the highest inductance available commensurate with a good Q.

(ii) Unequal Dampings.

The gain on tune is exactly the same as in the case of two circuits of equal Q whose $Q = \sqrt{Q_1Q_2}$, where Q_1 refers to the primary and includes the damping due to the valve and Q_2 refers to the secondary.

If, for example, we had two equal circuits and the primary had its Q halved by the valve (a possible but not likely state of affairs) then the gain is that of two circuits whose $Q = \sqrt{Q_1Q_2} = \sqrt{2}Q_1$. So that although there is a loss of 6 db. over a single circuit of magnification Q_1, the fact that the primary alone has a magnification of only Q_1 must be taken into account. As a result the loss of gain over a single anode circuit is only 3 db. and not 6 db.

The above case is rather exceptional but the same argument holds for the general case. Consequently the loss is always less than 6 db. in actual practice.

(iii) Unequal Tuning (Staggering).

In this case the gain on tune is reduced by a factor $K/\sqrt{K^2 + q_0^2}$ as compared with the gain obtained by the same circuits not staggered (even if in the non-staggered case the coupling factor is increased to give the same shaped response curve as for the staggered case).

The more one staggers the circuits, the more one loses gain as compared with the same circuits not staggered but merely coupled more closely. For example, if a coupling factor of $K = 1$ is increased by staggering to an "effective" coupling factor $K_e = 2$ $(= \sqrt{K^2 + q_0^2})$, then the loss of gain is 2 : 1 in comparison with the same circuits simply coupled more closely until $K = 2$. In the example quoted $q_0 = 1.73$, which means that the separation between the two tuning points is 1.73 times the band-width of a single circuit.

(iv) Unequal Tuning plus Unequal Damping.

The effect of unequal damping alters the gain on tune in the manner indicated in paragraph (ii). In addition, there is a loss of gain due to the staggering. The latter loss is indeed even greater than in the case of staggered equal circuits. The formula

TABLE 1

	A Single circuit	B Band-pass (each circuit has same Q as in A)	C Band-pass (optimum shape to meet requirements given above)
Selectivity ratio $\frac{l_2}{l_1}$ (See Fig. 1)	10	3.7	2.75
Relative gain on tune	1	.46	1.1 (N.B.—circuits have higher Q)
Relative Q of individual circuits	1	1	3.1
Coupling factor, K	—	.67	2.42

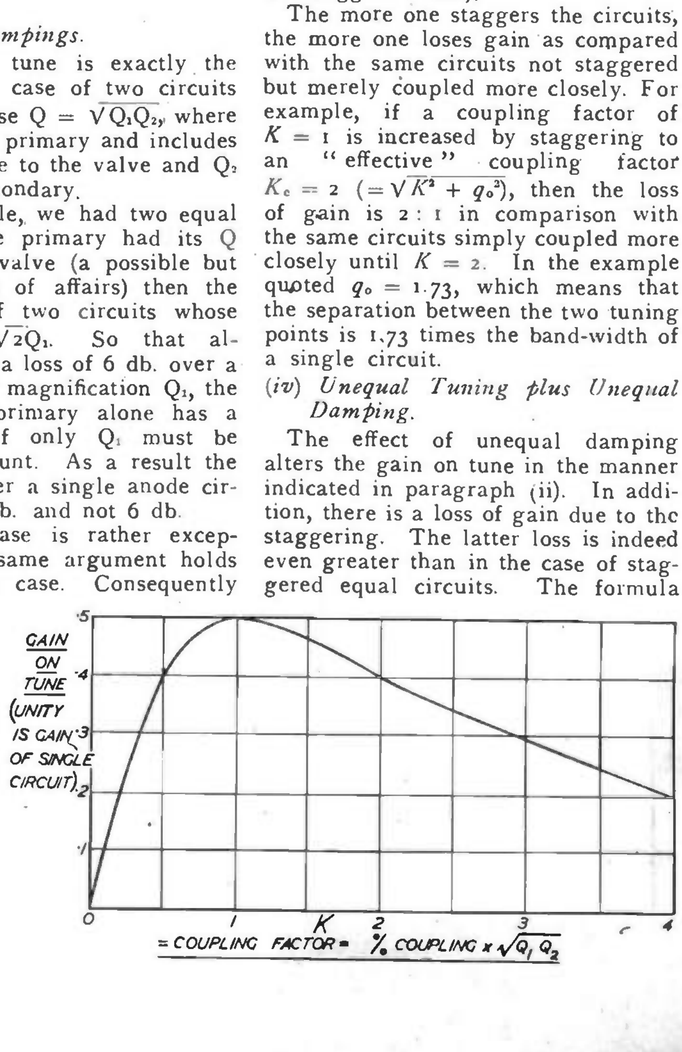


Fig. 2.

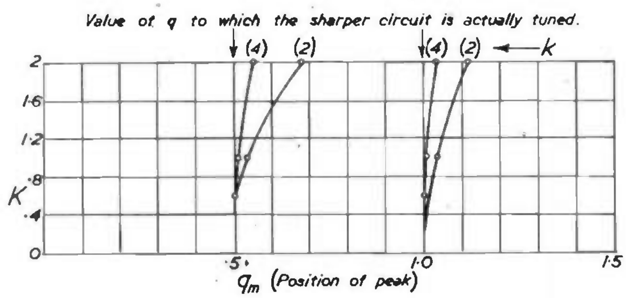


Fig. 3.

for this case is rather complicated but will be given in Section 2.23.

1.3 Impedances

The impedance (on tune) which a critically coupled band-pass circuit presents to the anode circuit of a pentode is half that presented by a single circuit.

With over-coupled circuits the impedance decreases even further, the exact relationship being

$$\text{Impedance on tune} = \frac{\text{Parallel impedance of primary}}{(1 + K^2)}$$

1.4. Trimming

The simplest circuits to trim are those with only mutual coupling. Moreover, varying the coupling in the mutual case does not move the curve bodily along the frequency scale as with other couplings.

(a) Mutually Coupled Circuits

If the coupling is below critical both circuits may be trimmed for maximum output straight away.

If the coupling is variable it may first be reduced until below critical, then the circuits are trimmed to maximum output, and finally the coupling is increased again to the desired value.

The method of damping each circuit in turn (while trimming the other) again uses the fact that the coupling is below critical during the trimming operation.

Now damping and changing the coupling both involve alterations to the circuits. There is, however, a third method which may sometimes be used that does not require any circuit alterations. This method consists of detuning one circuit to its maximum extent and then trimming the other. The detuned circuit may then be brought on tune by simple trial and error on the overall curve while the first tuned circuit is left fixed. For this method to be used, the trimmers must have a wide enough tuning range. The necessary amount of detuning can be estimated as follows:—

Consider the method as a case of staggering with a separation in the tuning frequencies of q_0 (*see* Section 2.22). Then the peaks occur at

$$q_m = \pm \sqrt{\frac{(K + q_0)^2 - 1}{4}}$$

If q_0 is much greater than either unity or K, then

$$q_m = \pm q_0/2$$

i.e., the peaks occur exactly at the tuning frequencies.

If $q_0 = 10$, the error is quite small. This means one circuit must be detunable by 10 times the bandwidth of a single circuit.

$$\therefore \delta f = f_0/Q \times 10 \quad \text{or} \quad \frac{\delta f}{f_0} = \frac{10}{Q}$$

$$\therefore \frac{\delta C}{C} \approx \frac{20}{Q} \quad (Q \geqslant 10)$$

So we may say that the method holds good if the percentage change in trimming capacity is at least (2,000/Q) per cent.

Obviously the higher the Q of the circuits, the more readily may the detuning method be used.

(b) Bottom End Coupling

If the coupling is below critical the circuits may be trimmed directly.

The method of a temporary reduction in coupling will not work in this case, for when the coupling is increased again the two peaks are not symmetrical about the tuning point (*see* Sections 2.13 and 2.14). Our aim must be to trim each circuit to resonance with X_0 in circuit without altering X_0 or causing X_0 to be in shunt with too sharp a series resonant circuit.

The necessary damping that must be applied to the circuit which is not being trimmed can be found from the curves of unequally damped and staggered circuits. Examination of these curves shows that damping the second circuit so that its dynamic impedance is divided by 4 (*i.e.*, $k=2$) is quite sufficient for all cases where the original K was not greater than 2. It is to be noted that the effective K after damping is reduced by the factor k for:—

$$\text{Original } K = \frac{X_0}{\sqrt{R_1 R_2}}$$

$$\text{On damping } K^1 = \frac{X_0}{\sqrt{k^2 R_1 R_2}} = \frac{K}{k}$$

In reading the curves the appropriate value of K^1 should be used. The results of these curves, in so far as they affect trimming, have been summarised in Fig. 3.

The reason that the curves we need are both unequally damped and staggered is, of course, that the circuit which is not being trimmed (also referred to as the "second" circuit) may be untuned as yet. In such cases the response curve can be found by taking a staggering coefficient q, which is equal to the frequency difference between the untuned circuit and the desired f_0 value. The desired f_0 value is then represented by the $q_0/2$ value corresponding to the sharper peak, and the difference between the actual position of these sharper peaks and the value of $q_0/2$ is a direct measure of the trimming error made.

This equivalence can be better understood after reading Section 2.23. In this summary it is sufficient to refer to Fig. 3. It will be noticed that the greatest error arises with tight coupling and a *moderate* amount of staggering between the two circuits—increasing the staggering beyond this point causes the error to be reduced again.

(c) Top End Coupling

This form of coupling can be shown to be equivalent to bottom end coupling. Consequently the curves of Fig. 3 may be used in assessing the amount of damping required for good accuracy.

It is interesting to note that, taking the equivalent circuit usually given, it would appear to be quite wrong to damp one circuit in order to trim the other. This curious result is a consequence of the approximation usually made which leaves the tuning condensers unchanged in the equivalent bottom end circuit.

A further anomaly caused by this approximation is in regard to the position of the second peak on increasing the coupling above the transitional value. In other respects the approximation is quite valid and it will be used later in Section 2.14, where the matter will be discussed more fully.

(*To be continued.*)

Directive Optical Systems

AN interesting device for the photo-electric control of fluid flow has already been described* in which was illustrated a method of directing light to the control position by means of Plexiglas rods.

In most photo-electric applications of this nature light is directed from a fixed light source to the photo-cell or groups of cells by means of optical systems employing condenser lenses, focusing lenses, field lenses, mirrors, prisms, and half-silvered mirrors. Considerable design problems arise, in that the components of the optical system have to be rigidly mounted in respect to each other and to the controlling apparatus. A small deviation or vibration from the mean optical path of any component may produce a large change in illumination, which may give fictitious operating signals or produce an undesirable modulation.

By employing the principle of total internal reflexion within bars of transparent material a great simplification and rigidity may be obtained.

This is not a new principle in optics, but with the introduction of transparent plastics such as Perspex, Transpex, Lucite and Plexiglas, considerably wider application might be made in instruments wherein light has simply to be directed from one place to another and is not required to be formed into sharply defined images.

In the past use has been made of truncated pyramids and rectangular boxes built up from mirrors silvered on the inner walls to direct light in certain photo-cell applications where the optics could be solved by such a simple system, but more possibilities come to mind when one considers the employment of these new materials.

Perspex can be obtained in sheets and rods and can be readily machined and hand polished and can be bent to any shape since it readily softens in boiling water. Pieces can also be cemented together by using chloroform or carbon triethylene as a

* *Electronics*, September, 1944.

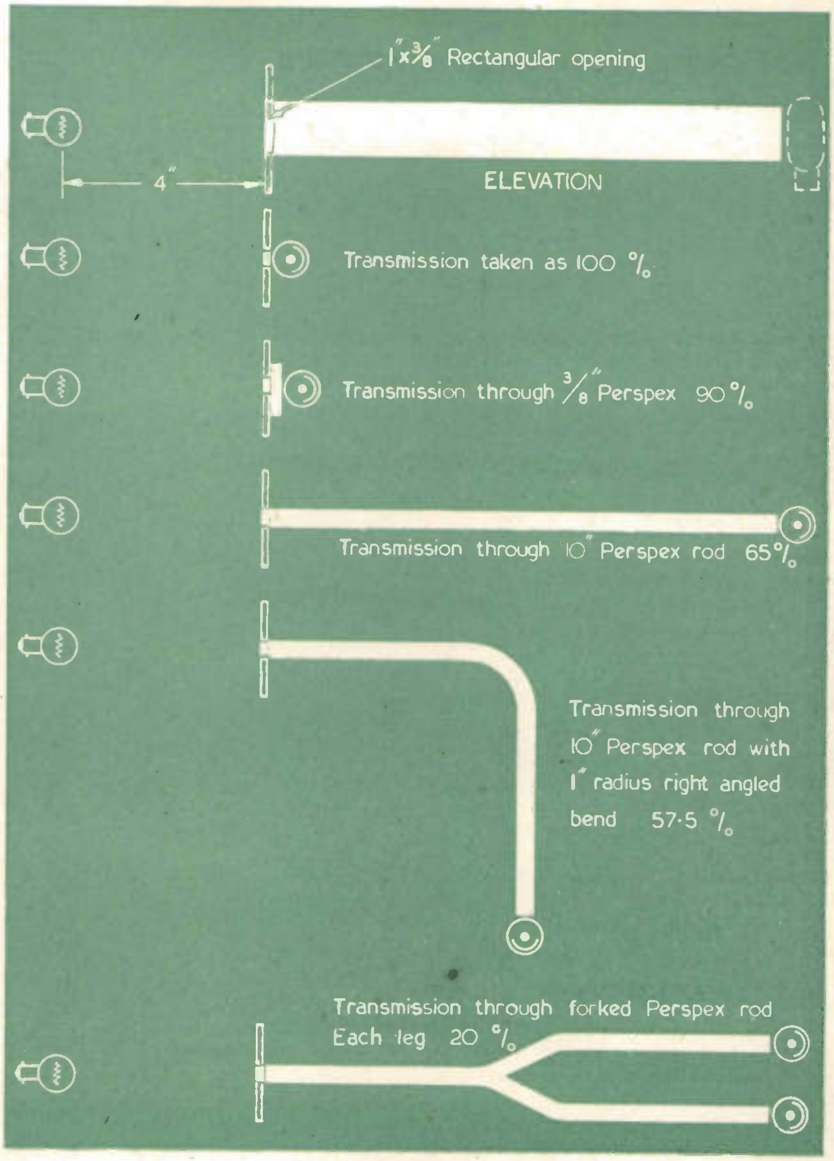


Diagram showing relative light transmission through Perspex rods of various types.

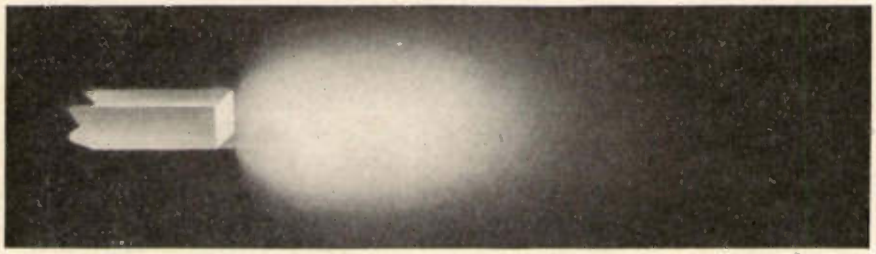
solvent so that branches can be arranged in the optical system for those cases where balanced photo-cells are used or where one cell receives light signals from two or more controls along different paths.

Opaque or black Perspex can also be obtained and it is suggested that by cementing blocks of this to the transparent portions of the optical system complete rigidity could be obtained. This might prove a useful way of bridging a gap where a moving flag, float, shutter or other device controls the light by moving so as to vary the obscuration of the main beam of light.

Some measurements have been made to determine the efficiency of these light-directing rods and the results are shown in the accompanying diagram. The distribution of light at the end of the rod where the light leaves the Perspex is shown in the photographs. With polished rods the effects of multi-reflexions are clearly seen in the photographs.

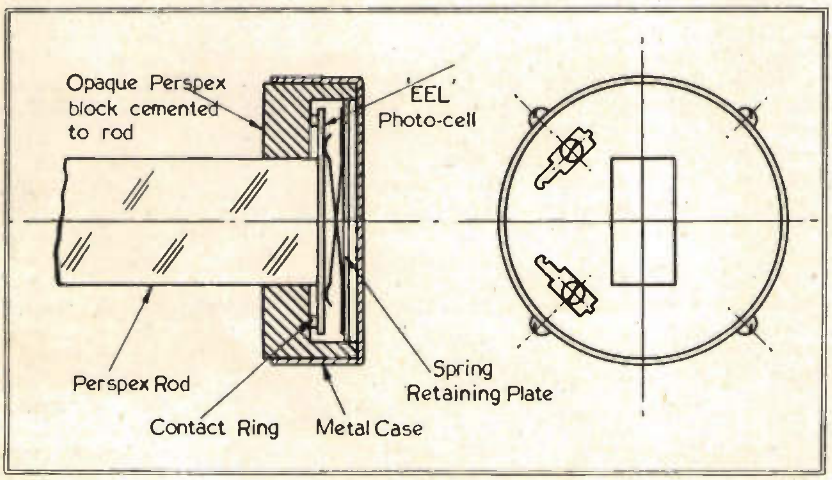
This latter effect becomes serious with short rods where the length is small compared with the distance from the light source to the end of the rod, but is not serious when barrier layer cells of the Eel or Weston Photronic type are used, which can be directly attached to the ends of the transparent rod in close

Distribution of light at end of a 10-inch Perspex rod with the lamp 1 inch from other end. Ends of rod polished.



Distribution of light as above but with the output end lightly roughened by sandpaper.

Distribution of light at the end of a 10-inch rod with the lamp 4 inches from other end.



contact with the material (*see* sketch above).

Many other similar uses for this principle can be thought out having interest in general electronic engineering problems. Two examples are for bezel indicators where the lamp cannot be positioned on the front panel of the apparatus, or for tuning indicators for radio receivers where the transparent rod is made to rotate about a fixed lamp and illuminate the figures on a circular scale.

Concentrated light in narrow bands, points or circles can easily be produced by tapering the rods and suitably shaping the ends. It must be remembered, however, that the rays are only totally internally reflected at the surfaces of the material if the glancing angle is less than the critical angle.

The critical angle is $\sin^{-1}(1/\mu)$ where μ is the refractive index of the material. In the case of Perspex $\mu = 1.49$ so the critical angle is 42°.

Radio Control of Models

The control of model boats and aeroplanes by radio signals has been the subject of experiment almost from the earliest days of radio. Many readers will remember the demonstration of Raymond Phillips' wireless-controlled airship which featured on the programme of a London variety theatre even before the last war.

The subject has been enthusiastically studied in America and there are several references to equipment and technique in the radio journals from 1937 onwards.

That year also saw the first radio-controlled model aeroplane event at the Championship meeting at Detroit, and since then meetings have been held regularly until the outbreak of war.

The manufacture of radio-control gear was started in 1938 at Radio Control Headquarters in New Jersey —a firm of specialists in lightweight equipment for models, and kits of parts and full constructional details are issued for amateur model enthusiasts.

The equipment includes lightweight transmitter, receiver, sensitive relay, and escapements for rudder control by twisted rubber power. A set of five booklets is published for $3.75 by the Radio Control Headquarters, P.O. 214, Deal, New Jersey, and they provide interesting new material for the amateur constructor whose hands are temporarily idle through war-time restrictions.

Electronic Telesis

This is the intriguing title of a booklet published by the Eitel-McCullough Corporation of California, and a footnote to the title explains that telesis is the term for progress consciously planned and produced by intelligently directed effort.

After describing the various applications of electronics in simple language the book then deals with the vacuum tube and its manufacture, with particular reference to Eimac tubes. A particular feature is the series of illustrations which accompany the text—some fanciful or symbolic but all well designed and attractive. It is stated that a copy of the booklet will be sent on request to business people interested in the applications of electronics, but we would also like to see copies in the hands of youngsters who are interested in the future of the things they are beginning to notice.

NOTES FROM THE INDUSTRY

New Addresses

Multicore Solders, Ltd., have changed their address to Mellier House, Albemarle Street, London, W.1. The new telephone number is REGent 1411.

On November 16, British Brown-Boveri moved their offices to Artillery Mansions, 75 Victoria Street, London, S.W.1. Telephone: ABBey 5777.

Mycalex Co., Ltd.

The Mycalex Company, Ltd., of Ashcroft Road, Cirencester, Glos., announce that their three directors who were in H.M. Forces have now safely returned. Mr. M. W. Ingram is now taking over the post of Managing Director of the company.

Appointments

Mr. G. A. Marriott

Mr. G. A. Marriott, manager of the valve department of the General Electric Co., Ltd., has been appointed to the board of the Marconi-Osram Valve Co., Ltd.

Dr. James Greig

Dr. James Greig has been appointed to the University chair of electrical engineering tenable at King's College, London, as from October 1. During 1926-39 Dr. Greig was lecturer in electrical engineering at the University of Birmingham, and since 1939 he has been head of the Engineering Department at Northampton Polytechnic.

The Science Museum

The Ministry of Education has announced the appointment of Dr. Herman Shaw as director and secretary of the Science Museum as from December 1 in succession to Colonel E. E. B. Mackintosh. The appointment of a professional man of science to this important office is a departure from past practice, and will be generally welcomed.

Electronics and Plastic Moulding

"A Year's Experience of Radielectric Pre-heating" is the title of an interesting booklet written by Mr. J. E. Beard of the Streetly Manufacturing Co., Ltd. This company have had considerable experience of using radielectric pre-heating in moulding and the booklet contains a few of the observations and opinions which have been made after a year's experimental work and six months practical application on an industrial scale in a British moulding factory. Although written primarily for plastic moulders, copies of the booklet are available to interested readers on application to British Industrial Plastics, Ltd., 1 Argyll Street, London, W.1.

Electronic Relay

Sunvic Controls, Ltd., Stanhope House, Kean Street, London, W.C.2, have just released information of their Electronic Relay type E.A.2. This relay needs only a few microwatts to operate it, and will control a load of 2 kW at 200/250 volts A.C. Primarily

developed for use with light contacts (*e.g.*, toluene regulators), it can be adapted to operate with a photo-electric cell, and thus has a wide range of usefulness. The overall dimensions of the E.A.2 are 6½ in. by 6½ in. by 3½ in. and the approximate weight is 7½ lb. Further details can be obtained direct from Sunvic Controls, Ltd., who will also be pleased to supply lists of their Dimetal Relays and Hotwire Vacuum Switches.

"Trade"

A monthly review of international commerce entitled "Trade" is published privately by General Trade Clearings, Ltd. Circulated to over 5,000 importers every month throughout the world, it is a means whereby British goods of every description can be brought before a world-wide market. A brochure which gives comprehensive details can be obtained from the publishers at 65 Portland Place, London, W.1.

The Art of the Film

A course of lectures, "The Art of the Film," will be given at the Harrow Technical School on Monday evenings at 7.30 p.m. from January 14 to April 1, 1946. The chairman and organiser is Stanley Schofield, F.R.P.S., and the fee for the whole course is 20s. Applications should be made to The Principal, Harrow Technical School, Station Road, Harrow.

Tin and its Uses

Tin and its Uses, No. 16, just published by the Tin Research Institute, describes a study of the use of very thin coatings of tin on steel as a pre-treatment before painting. Tests carried out in collaboration with the Paint Research Station demonstrate that tin under paint gives a high degree of protection from rusting. A copy of the booklet "Tin and its Uses" may be obtained free of charge from the Tin Research Institute, Fraser Road, Greenford, Middlesex.

Correction

New "Clix" Components

Our attention has been drawn to an error in the editorial notice which appeared on page 782 in the November issue.

The Valveholder illustrated at the head of the column is the "Clix" B9G Valveholder, and not the Cathode-Ray Tube Holder. The information given applies to the "Clix" Cathode-Ray Tube Holder of the Shrouded and Unshrouded types, and is quite correct. The second illustration is a Screened Cathode-Ray Tube Holder.

The "Clix" B9G Valveholder is available with Ceramic body (VH. 369/9) or with Silica loaded Polystyrene body (VH. 359/9). The design of this Valveholder incorporates a new feature, the sockets being fixed rigidly in the base of their cavities, and the pin contacts being of different pitch circle diameter to that of the pins in the valve, so that when a valve is inserted in the holder the contacts adjust themselves, taking up any variation in the valve pitch circle diameter, and such displacement of the contact on insertion of the valves is independent of the soldering tag. It will be seen, therefore, that with this Valveholder it is not necessary to use a dummy valve or gauge when making connexions to tags, and that the contacts have full freedom of movement when one or more are soldered to a rigid member.

The rigid fixing of the pin contacts also avoids any possibility of contacts riding up in their cavities, and flashing over to sole plate of valve.

BOOK REVIEWS

Radio Receiver Design—Part II

K. R. Sturley. (Chapman & Hall, 1945, 28s.) 468 + 11 pp. Index.

The book under review is the second part of Dr. Sturley's text book on the Fundamentals of Radio Receiver Design, the first volume of which was published in 1943 and reviewed in the May, 1943, issue of this Journal.

This book is divided into eight chapters numbered from nine onwards as it is only due to war conditions that the whole subject has had to be divided into two volumes.

The first chapter deals with audio-frequency amplification and covers resistance capacity coupled amplifiers, transformer coupled amplifiers and tone control circuits. The effect on performance of circuit constants is extensively treated, but though equations are derived for calculating the effect of a given value of leakage inductance on the higher audio-frequency response of a transformer, no relations are included for estimating the leakage inductance of alternative designs.

While in a book of this type it is essential to derive the complete mathematical equations in order to be able to ascertain the performance for a given set of conditions, for the benefit of the less initiated reader it is desirable in addition to illustrate graphically the effect of varying the principal parameters. Generalised performance curves are given for the majority of the circuits discussed. The complicated analysis of intervalve-transformer performance would, however, be improved by the addition of some frequency response curves of a typical transformer showing the effect of altering the capacitative and resistive loading of the secondary and the effect of the source resistance on the high-frequency response of the transformer as well as the low-frequency response of an R.C. coupled transformer.

Chapter 10, which covers the design of the power output stage, is very well done. The calculation of distortion and power output for straight and push-pull stages, the design of the output transformer and the inclusion of negative feedback are all treated. The shift of the dynamic load line is, however, not mentioned. Also, the fact that the second harmonic reverses phase with increase of anode load resistance in the case of a pentode is apparently contradicted by the second harmonic curve on Fig. 10.10B not going down to zero. It is a pleasure to find that the subject of intermodulation products is included, and this would have added interest by the inclusion of a companion curve to Fig. 10.10B showing the percentages of the different order sidebands.

The principles underlying the design of power supplies are treated in Chapter 11. When dealing with the design of a mains transformer, the author erroneously employs the r.m.s. value of the fundamental component of rectifier anode current for the calculation of the copper losses and current density in the secondary. For this purpose the r.m.s. value of the rectifier anode current should be employed which is nearly twice as large.

The usefulness of this section to a designs engineer would be greatly increased by the provision of a series of curves relating the r.m.s., Peak and Mean rectifier anode current components with the voltage rectification efficiency. Such families of curves, as for example those published by Shade and by Roberts, do tremendously simplify the design of power supplies. Choke-input rectifier circuits and the design of inductances for filters are also dealt with in this chapter.

Chapter 12 covers comprehensively the different types of automatic gain control including both simple and amplified types with and without inter-channel noise suppression. Noise limiters are also briefly discussed.

Miscellaneous subjects such as push-button tuning, remote control and automatic frequency correction are discussed in Chapter 13—the last-mentioned subject in considerable detail. The measurement of receiver overall performance is dealt with in the following chapter.

Frequency modulated reception is treated at some length in Chapter 15 (64 pages) with a rather wider scope than the author's well-known monograph.

The remaining chapter of 105 pages deals with television reception and is not up to the generally high standard set by the rest of the work. After reading this chapter the reviewer was left with the impression that the author's practical experience of the subject was rather limited. A number of errors and erroneous statements are present, as for example, Fig. 16.18 and the discussion on a.g.c. on page 418.

It is a pity that the author expresses performance in terms of phase angles and only occasionally converts this into an equivalent time delay; it is preferable and no more difficult for engineers to think of this type of distortion in terms of a non-constant time delay.

The method of numbering the diagrams and sections is excellent, and a good index and glossary of symbols employed is included.

The reviewer is sure that this volume will find its way on the reference book shelf of the majority of radio engineers, and the remarks above are only intended as suggestions for still further increasing the usefulness of the book when the second edition is contemplated. The section on television, however, should be re-written for the next edition with more space devoted to the introduction covering the basic principles of the subject and less stress laid on single side-band operation.

C. L. HIRSHMAN.

Modern Plastics

Harry Barron. (Chapman & Hall, Ltd., 42s. net.) 680 pp.

This book aims at providing an adequate technical background and a general view of the plastics industry for readers with a modest knowledge of science or engineering.

It is divided into six parts. The first is preliminary and gives a very good survey of plastics, their raw materials and general scope. The fact that the industry is based on chemical synthesis either from simple products such as ethylene or by the physical and chemical treatment of natural and chemurgic products, is thoroughly driven home and starts the book well.

The building up of the polymer from the monomer derived from this chemical treatment is also well described in a rather non-technical way; the actual mechanism of polymerisation is dismissed, however, in a simple casual sentence. A work of this magnitude and price should at least attempt to give some indication of the wealth of knowledge now available regarding polymerisation initiation, propagation and termination. The references do not even mention the chapters in Meyer's "Natural and Synthetic High Polymers" and the long and detailed account in "The Chemistry of Large Molecules" by Mark. The section on copolymerisation is also rather unsatisfactory, particularly in respect of its insistence on work done on mixtures of polymers as a preliminary to the discovery of copolymerisation.

The second section deals with thermosetting resins. The distinction between one-stage and two-stage resins, resols, etc., is firmly tackled and the reader gets a very fair picture of the theoretical and practical background of these resins. This section concludes with a very useful account of laminated materials.

Parts 3 and 4 deal with cellulose and vinyl plastics respectively. The preliminary section on cellulose plastics contains a great deal of very useful information and gives a good picture of the chemical background, though reference might have been made to the difference between the primary and secondary hydroxy-groups. The account of the cellulose ester plastics is also very informative and on the whole accurate, though marred by odd statements, as that the celluloid industry is "part of the manufacture of raw material for guncotton," that celluloid containing below 10.5 per cent. nitrogen is suitable for lacquers, and by queer recipes for cements, and, particularly, by the statement that extrusion is one of the largest outlets for acetate plastics. The edgings and beadings referred to should never be made of cellulose acetate, which lacks the necessary dimensional stability.

Here the author interposes a chapter on injection moulding, which is characteristic in the way in which he associates manipulation with particular materials, instead of treating it in a systematic way. It leads him, incidentally, to describe film manufacture twice over, once for nitrocellulose and again for acetate. His treatment of ethyl cellulose is adequate but he does not distinguish between the plastic properties of ethyl cellulose of different ethoxy content.

To some extent the lack of information about polymerisation already noted is remedied in the section dealing with vinyl resins, but too much stress is laid on emulsion methods.

The chapters that follow on the vinyls are the best in the book. A chapter on plasticisers is inserted in the middle of the section, followed by one on extrusion. It seems a pity that a book so full of information should be so curiously arranged.

The fifth part deals with polyamides, alkyds and protein plastics and thus concludes a survey of all the industrial plastics in general use.

A very considerable amount of information about analytical and physical testing is rather crammed into the final part. Nearly half as much space is devoted to high-frequency heating as to physical testing, so that there is no room for any critical examination of the tests or any account of high elastic and creep phenomena.

The general effect is that of a very considerable volume of information, not always very well arranged. The documentation is fair but there are far too many tables of properties without authority. The book abounds in misprints. Attention should be drawn particularly to the formulæ of the cyanides and to the frequent reference to Rath instead of Raff. The index is thorough, but could be improved by the use of heavy type to indicate main references.

E. G. COUZENS.

ABSTRACTS OF ELECTRONIC LITERATURE

C.R. TUBES

Deflection Sensitivity of Parallel-Wire Lines in Cathode-Ray Oscillographs
(H. G. Rudenberg)

The deflection angle θ of a cathode-ray beam accelerated by a potential V is shown to be proportional to the linear charge density ρ transverse to the beam on the interior of the electrostatic deflection system, $\theta = \rho/2V\epsilon_0$. The voltage deflection sensitivity depends on the plate-to-plate capacitance c per unit width, $\theta/E = c/2V\epsilon_0$. This includes edge effects and permits a determination of the sensitivity from capacitance measurements or a simple graphical evaluation from the dimensions of the deflection system. The use of parallel-wire lines as a deflection system is suggested, and its deflection sensitivity evaluated. Such lines have low transit time error and are either easily tuned or can be operated non-resonant with resistive termination.

—*Jour. App. Phys.*, May, 1945, p. 279.

MEASUREMENT

A Review of A.C. Network Analysers
(P. F. Soper)

This paper discusses the various types of A.C. network analysers and the reasons for their development. The essential features of these analysers are described in sufficient detail to enable a critical estimate to be made of the relative merits of each kind. Their present application to engineering problems is discussed as well as some possible future uses. Finally, there is a fairly complete bibliography of the subject.

—*B.E.A.M.A. Jour.*, Sept., 1945, p. 303.*

A Device for Indicating Small Changes in Electrolytic Resistance
(G. G. Blake)

Variations in the Q of an oscillator occur when a resistance capacitively coupled in parallel to it is varied. Making use of this effect, differences in the electrolytic resistance of solution concentrations are determined by a zero-shunted micro-ammeter in the plate-current feed. Curves are given for a liquid column of fixed dimensions for two solutes showing solution concentrations plotted against corresponding plate-current variations; there is a critical resistance value beyond which energy losses diminish. By suitable spacing between electrodes on the outside of a glass tube filled with the solution under test, the same value of the plate-current is obtainable for any solution. An application is described for indicating changes in the electrolytic resistance of a solution flowing through a pipe system. When sufficient change takes place in the concentration a relay operates, the liquid flow is stopped and a call bell rings. A new type of relay and flow control valve are described.

—*Jour. Sci. Inst.*, Sept., 1945, p. 174.

A Simple High Voltage Electrostatic Voltmeter
(L. Marton)

A very simple and inexpensive electrostatic voltmeter consists of a cylindrical steel container as one electrode and a disk-shaped electrode made of any other metal in its centre. This latter is mounted on a bushing passing through a tightly closed cover of the steel container. The container is provided with a cylindrical well at the bottom centre, which is filled with mercury. A thin circular steel disk floats on top of the mercury. The well communicates with an inclined glass capillary through which the position of the mercury meniscus can be observed. The upper end of the glass capillary is connected to the top part of the steel container. All the space above the mercury is filled with an insulating liquid. When a field is applied, the mercury-pool level is raised and a corresponding retraction of the meniscus is produced. The range of the instrument can be conveniently changed by altering the distance between the disk-shaped electrode and the mercury pool. A variation of the same principle consists of building in a flexible metallic bellows in the well instead of filling it with mercury, and using two non-miscible liquids in the capillary.

— *Bull. Am. Physical Soc.*, 15/6/1945.

INDUSTRY

Magnetic Dust Cores
(E. R. Friedlaender)

The historical development is outlined and the need for planned research on metal dust and core problems is stressed. Permeability and loss analysis are discussed, and the need for standard test specifications stated. The relative value of the mathematical loss calculation and the graphical loss analysis methods based on the calculations are reviewed and their accuracy examined.

The application of different radio types is set out and a table of preferred applications is given and discussed. The influence of magnetic dust core developments in connexion with I.F. filter design and push-button tuning is described together with practical implications of permeability tuning. The technological aspect is considered and plant used for the production of dust cores mentioned. The mechanical and electrical tolerances are stated after a survey of suitable metal dusts indicating their useful application.

—*Jour. Brit. I.R.E.*, Vol. 5, No. 3 (1945), p. 106.

The Betatron
(T. J. Wang)

After reviewing the fundamental principles of the betatron the author discusses the basic design equations and gives an analysis of pole-face shapes. In dealing with the geometry of a practical betatron, the use of saturation, a means of making the electron beam clear the injector and the use of large capacitor bank for power factor correction are discussed. Reference is made to betatrons designed by Kerst and Steenbeck and diagrams are given to illustrate their modes of operation.

—*Electronics*, June, 1945, p. 128.*

Automatic Liquid Level Controls
(T. A. Cohen)

An industrial electronic liquid level control system in which capacitance changes produced in an immersion or manometric capacitor cause the plate current of an oscillator to change and operate a relay. A pyrometric control system utilising inductance changes produced by a meter flag between split coils is also described.

—*Electronics*, April, 1945, p. 120

* Abstracts supplied by the courtesy of Metropolitan Vickers Electrical Co. Ltd., Trafford Park, Manchester

JANUARY MEETINGS

*NOTE.—In general, visitors are admitted to the meetings of scientific bodies on the invitation of a member, or on application in writing to the Organising Secretary at the address given. In certain cases (marked *) tickets may also be obtained on application to the Editorial offices of this Journal.*

Institution of Electrical Engineers

Radio Section

Date: January 16. Time: 5.30 p.m.

Lecture:

"A Standard of Frequency and its Applications."

By:

C. F. Booth and F. J. M. Laver.

The Secretary:

The Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2.

Cambridge Radio Group

All meetings of the Cambridge Radio Group will be held in the Cambridgeshire Technical College.

Date: January 7. Time: 6 p.m.

Lecture:

"The Servicing of Radio and Television Receivers."

By:

R. C. G. Williams, Ph.D., B.Sc. (Eng.).

Date: January 29. Time: 6 p.m.

Lecture:

"Colour Television."

By:

L. C. Jesty, B.Sc

Group Secretary:

D. H. Hughes, c/o Pye Ltd., Radio Works, Cambridge.

Institute of Physics

Electronics Group

Date: January 4. Time: 5.30 p.m.

Held at:

Royal Society, Burlington House, Piccadilly, London, W.1.

Lecture:

"Artificial Radioactivity."

By:

Professor N. Feather.

Group Secretary:

A. J. Maddock, M.Sc., F.Inst.P., Messrs. Standard Telephones and Cables, Ltd., Oakleigh Road, London, N.11.

Brit.I.R.E.

North-Eastern Section

Date: January 16. Time: 6 p.m.

Held at:

The Mining Institute, Neville Hall, Westgate Road, Newcastle.

Lecture:

"Deaf Aid Systems."

By:

Dr. R. T. Craig.

Section Secretary:

H. Armstrong, 69 Osborne Road, Jesmond, Newcastle-on-Tyne.

R.S.G.B.

All meetings are held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Date: January 18. Time: 6.30 p.m.

Lecture:

"The Birmingham Police Radio System."

By:

Superintendent G. Brown.

The General Secretary, R.S.G.B., New Ruskin House, Little Russell Street, London, W.C.1.

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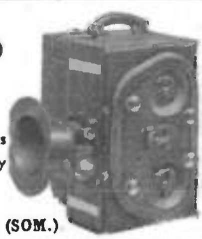

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Vacancies advertised in these columns do not relate to men between the ages of 18 and 50 inclusive, or women between the ages of 18 and 40 inclusive, unless they are exempted from the provisions of the Control of Engagements Order, 1945, or the vacancies are for employment excepted from the provisions of that order.

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