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South Africa House

South Africa House, London

ON the 22nd June, 1933, Their Majesties The King and Queen, attended by Lieut.-General the Right Honourable J. C. Smuts and other notable personages, were received at the entrance to South Africa House by Mr. Charles te Water, High Commissioner for the Union of South Africa. The occasion was the official opening, by the King, of this imposing building. Sir Herbert Baker, K.C.I.E., R.A., F.R.I.B.A., the architect of the building, handed to the King a gold key which, after unlocking the door, was delivered to the High Commissioner, His Majesty thereafter declaring the Building open.

The view of South Africa House which is reproduced above is as seen from the top of Whitehall. The exterior design blends with the architecture of the neighbouring buildings of Trafalgar Square, inasmuch as its main features, the two colonnades and the great cornice, are practically identical with those of the National Gallery, and similar to those of the Church of St. Martin in the Fields, seen on the left.

The romance and history, fauna and flora, and the dominant national features of South Africa, are expressed in the decorations both outside and inside through the skill of artists and craftsmen, in the medium of stone, marble, metal, wood and plaster. The beautiful rooms, for instance, owe much of their magnificient appearance to the coloured marbles cut in the quarries of the Transvaal and South West Africa,

whilst the ceilings, walls, friezes and floors depict the earlier phases of South African history, her decorative flowers, the Springbok her national symbol, and many other characteristics in symbolic form.

Round the second dome of the Central Hall is inscribed the Union motto :—

" Eendragt maakt Magt "—" Unity is Strength ",
and round the first dome is inscribed :—

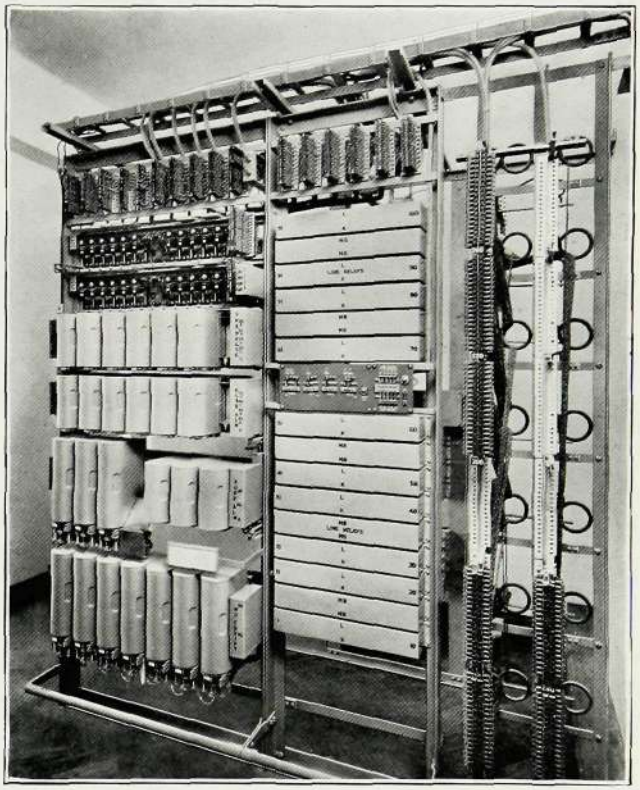
" Florenti fama atque opibus Africæ meridionalis civitati vel maius incrementum det Deus "—

" To this State of South Africa, flourishing in reputation and its resources, may God give even greater increase."

This stately building is a symbol of the Union's endeavour to attain the ideals portrayed by these two inscriptions. Hence the beauty of the surrounding art must be intermingled with modern commercial appliances, prominent amongst which is an efficient telephone system. The Ericsson Company was honoured with the contract for this work.

The Private Automatic Branch Exchange (P.A.B.X.) installed is initially equipped to serve 100 extension lines and 12 exchange lines, and employs a three digit numbering scheme, viz. 200-299. The extensions can obtain direct access to the Whitehall Automatic Public Exchange by dialling "9" or, on the other hand, can call the P.A.B.X. manual operator by dialling " O." Thus, outward calls to subscribers on the public exchange service can be made with or without the intervention of the local operator. All incoming calls are handled by the operator, who extends the call to the required extension via the multiple jacks on the manual board.

A view of the front of the automatic equipment, together with a small main frame adjacent, is shown. This unit consists of a single sided type rack 5′ 5″ wide and 8′ 0″ high, utilising channel type shelves for mounting the necessary switching apparatus. Fifty-point single-motion type switches are employed as line finders, necessitating the division of the equipment into two groups of fifty lines, six switches being fitted per group. Directly connected

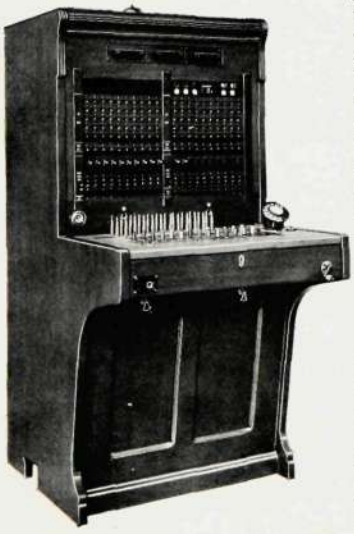


South Africa House—Automatic Equipment and Main Frame

to each finder is a group selector, consisting of a single-motion switch and a relay set. The group selectors have access to ten final selectors which are of the two-motion 100-line type. Summing up therefore, the switching equipment comprises twelve line finders, twelve group selectors and ten final selectors.

The whole of this equipment, excepting single-motion switches, is "jacked-in", thus facilitating the addition of extra equipment or the localization of faults, etc. All relay groups are provided with individual covers as a protection against dust, and twin contacts are fitted on all relays to minimize still further any trouble which might arise from this source. A cross-connecting field for jumpering between the line relays and the final selector multiple is incorporated at the top of the rack to provide a means of equalizing the traffic load over the two groups mentioned above.

The one position manual board, as may be seen from the illustration, is of the floor pattern employing lamps as the calling signals and Ericsson "flap" indicators for supervision. Each of the 100 extension lines is represented on the front panel by a jack and a lamp, and the other terminations are twenty manual extension lines, three private lines and twelve bothway exchange lines. The board has twelve cord circuits arranged for negative supervision and "through" clearing. Night extension keys are incorporated in the cord circuits enabling them to be easily converted into "straight through" cords. At night time, when the manual board is not staffed, the jacks of certain extensions are plugged through to exchange lines, thus enabling these extensions to receive incoming calls from the public exchange. Such extensions are provided with duplicate lines to the P.A.B.X., so that when one is connected to an exchange line the other may be used for local calls.



South Africa House—Manual Switchboard

All exchange lines are provided with visual engaged signals so that the operator can see at a glance those that are being used by extensions for direct outgoing calls, *i.e.* level "9" calls. A hand-generator is fitted on the board as a precautionary measure against the ringing machine failing.

Briefly the switching operations for the various types of calls which can be made are as follows :—

Local Call.

Immediately a micro-telephone is lifted, a line finder searches for the calling line. When the latter is found, dial tone is transmitted to the calling party from the group selector associated with the line finder in use, and the manual board jack is rendered busy.

When the calling party dials the first train of impulses, the group selector is stepped to the desired set of outlets, and, at the end of the impulse train, searches for and seizes a free final selector in that group ; (if all final selectors in the group are engaged, busy tone is connected to the calling party). The final selector, when seized, steps vertically on receipt of the second impulse train, and is rotated to the desired line under the influence of the third impulse train.

The required party's bell is then rung and ringing tone transmitted back to the caller unless the line is already engaged, in which case the caller receives busy tone.

The first party to replace a receiver releases the connection.

Call to Manual Operator.

The calling party is connected to a group selector and receives dialling tone as described for a local call. The digit 'O' is now dialled and this causes the selector to send back a signal to the line equipment, which responds, releases the automatic equipment, and lights the calling lamp on the manual board. The calling party receives ringing tone until the operator answers.

Calls to Public Exchange.

The calling party, on receiving dial tone, dials the digit "9," thus stepping the group selector seized to a group of outlets to the public exchange. At the end of the impulse train the selector searches for a free line in the group. When all lines to the public exchange are engaged, busy tone is connected to the calling party, but if a free line is available it is seized and the associated jack on the manual board is rendered busy.

The calling party now listens for dial tone from the main public exchange and when this is received dials the required number. Release of the connection is dependent upon the calling party.

Alternatively, the calling party can dial "O" and obtain the operator, who, on receiving a demand for a subscriber on the public exchange system, completes the connection via one of the outgoing exchange jacks.

Incoming Call from Public Exchange.

When the final selector at the public exchange seizes a free line, the calling lamp glows on the P.A.B.X. manual board and the circuit is rendered busy for outgoing calls.

The operator answers the call and makes the connection in the usual manual way. A trunk call can be offered without breaking down a local connection.

To prevent the switching equipment being held unnecessarily by permanent loops, due to receivers being left off, etc., the group selector seized releases after a period of between 30-60 seconds if no dial impulses have been received, and the calling signal on the manual board is operated. When the operator answers the call and does not receive a demand, she knows that the line is faulty and can take the necessary steps to have the receiver replaced or the fault cleared.

Visual and audible alarms are provided to indicate blown fuses or the failure of switches to release after the termination of a call. These alarms can be extended to the manual board as desired.

The Ericsson Company has made a special study of Private Automatic Branch Exchanges and is in a position to manufacture and install equipments incorporating all the latest refinements. It has already provided installations for many prominent modern buildings as well as for most of the large railway companies.

Enquiries are welcomed, customers' requirements are carefully studied and complete particulars submitted.

Transmission Testing

IN view of the advance in the efficiency of subscribers' instruments during recent years, particularly as regards microphones, it has become necessary to provide more elaborate methods for the maintenance of standards of transmission and for the testing of microphones, receivers and instruments in general. It may be of interest to outline the methods applied at the Beeston Works, both for the maintenance of standards and for the precise and routine testing of components and apparatus.

The system of maintenance of standards adopted and at present in force ensures adequate maintenance.

The standard against which all apparatus is compared is that fixed by the British Post Office who supply the manufacturers reference standards against which working standards are prepared for the various test departments.

For the purpose of making continual checks of the reference standards, and for checking the standard transmission circuit, a working standard system has been set up at Beeston on the lines of the "Setem" system, (C.C.I. Yellow Book, June 1930 pp. 109-118), the apparatus having been calibrated in Paris against the International Standard Reference system (S.F.E.R.T.)

This apparatus is shown in the accompanying photographs. Fig.1 shows the speaking position with the standard electro-magnetic transmitter, speech volume indicator and secret attenuation shown to the right of the pedestal. Fig. 2 shows the receiving end, which is in three main parts. The upper case shown in the photograph contains the valve

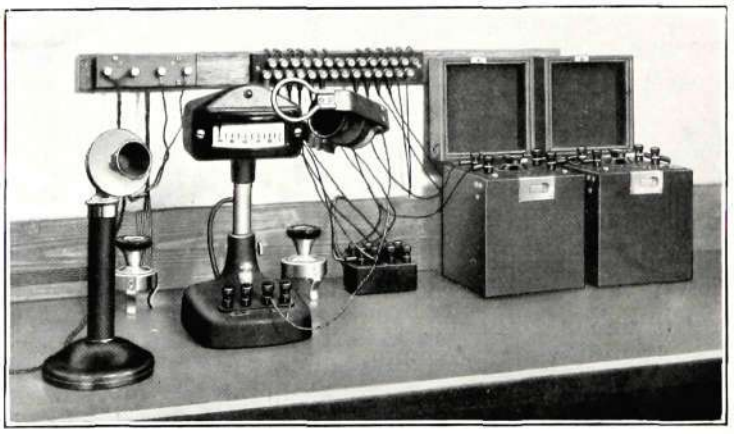


Fig. 1—"Setem" System Transmitter

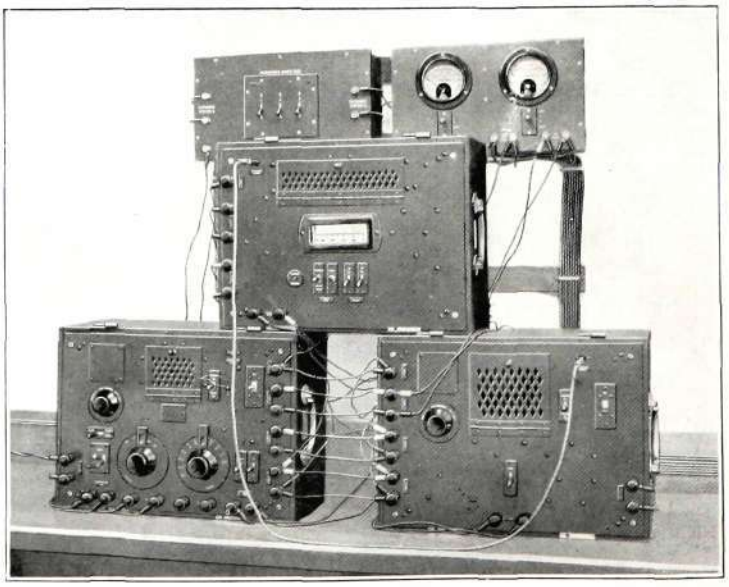


Fig. 2—"Setem" System Receiver

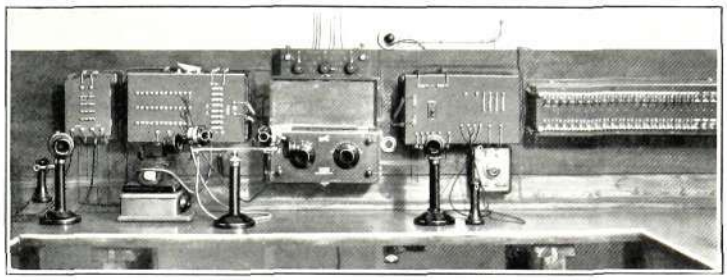


Fig. 3—Standard Transmission Testing Apparatus

maintained tuning fork and peak voltmeter used for the preliminary setting of the apparatus. The peak voltmeter is arranged during test to act as volume control and is in parallel with the indicator at the speaking position, so that the person receiving as well as the person speaking can observe if the level of speech volume is being maintained reasonably constant. The right hand lower case is the transmitter system, which is a two stage amplifier having a mixed coupling, *i.e.* a combination of resistance-capacity and transformer coupling, and a distortionless output filter. The case on the left is the receiver system which comprises the fixed line, a balancing and compensating line, an amplifier and electromagnetic receiver with switching arrangements and lamp signalling to the speaking position. Barreters are provided in series with each valve and are so arranged that the operation of the system is not effected by normal battery variations. Voltmeters are provided, however, as shown in the photograph, so that a continuous observation of operating potentials is possible. Although this apparatus is maintained solely for the checking of standards, it can be used for the comparison of instruments, complete systems, transmitters or receivers, as required.

The provision, checking and maintenance of working sub-standard components and instruments are carried out by the "voice-ear" methods, and the circuit and apparatus used for this purpose are those specified by the British Post Office as standard for transmission testing. The arrangement of this apparatus is shown in Fig. 3. Check and re-check are carried out over an extended period using a testing crew of from three to six persons, and no instrument is issued as standard until a condition of satisfactory stability has been reached. All sub-standards are checked periodically depending upon the amount of use they receive.

The testing of transmitters and receivers actually commences on receipt of the raw material. The suitability of materials and accuracy of machining play an extremely important part in the final efficiency of the component. Very careful metallurgical and mechanical tests are made on materials before they are passed on to the machine shops, and the machined work is tested after each operation with, in general, 100% inspection, as it is only by such rigid inspection that consistent efficiency can be attained.

From each batch of assembled transmitters, a number is selected at random for precise voice-ear test in the laboratory for "frying," pitch, articulation, and volume efficiency. The "frying" test is carried out on apparatus built to the recommendations of the British Post Office, and consists of a sensitive valve voltmeter arranged to measure the voltage across a non-inductive resistance, which replaces the receiver in the standard transmission circuit. The transmitter under test is mounted on a thick sponge rubber base, and a large bell jar is placed over the whole.

In order to obtain conditions as free from noise and vibration as possible, the whole apparatus, *i.e.* valve voltmeter and transmitter in case, is placed in a sound and vibration-proof room, and the fluctuations of the indicator are observed through a small window.

Fig. 4 shows the complete valve voltmeter assembly, which also contains the standard transmission and instrument circuits, and on the right is the transmitter under test on the thick rubber base and covered by the bell jar.

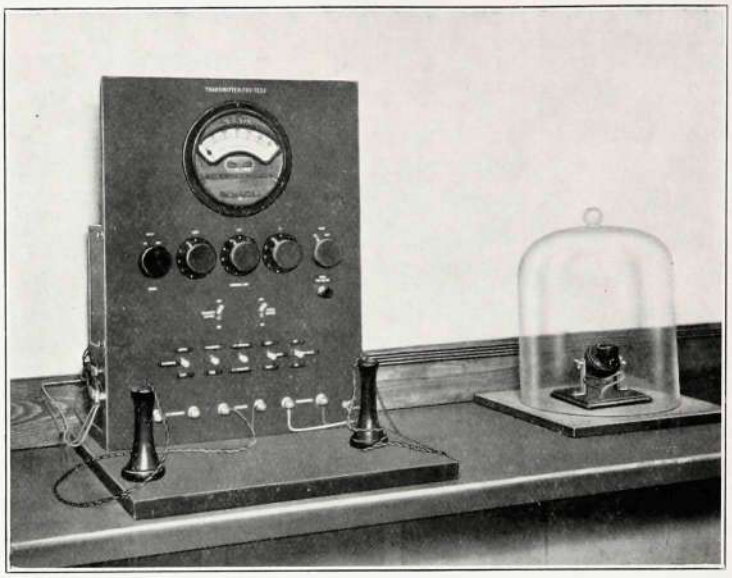


Fig. 4—Transmitter "Fry" Test Apparatus

For the calibration of the "fry test" apparatus, a special calibrating means has been devised. Actual frying has been closely simulated by causing steel wires to scrape over the surface of a rough file, Fig. 5, and a potential is applied and passed through the wires, file surface and the primary of a small transformer. In series with the secondary of the transformer is a control resistance, a thermo-milliammeter and an accurate, fixed resistance of 0.05 ohms. The potential across the resistance is arranged to correspond to a power of 0.00015 microwatt,—the maximum permissible amount of frying,—this potential is applied to the va've voltmeter and gives the position for registration of the allowed maximum amount of frying.

Articulation and intelligibility are tested by voice-ear methods utilising a crew of three. A number of consonant-vowel-consonant logatomes are transmitted, and the percentage of these received correctly is reckoned as the percentage efficiency of articulation.

The compiling of the tables of logatomes has to be very carefully carried out and quite a number of these tables are necessary in order to prevent the possibility of the testing crew learning off the columns of words by heart and thus defeating the object of the test. Words from the German language and Esperanto are chosen, as the phonetic pronounciation is an advantage,

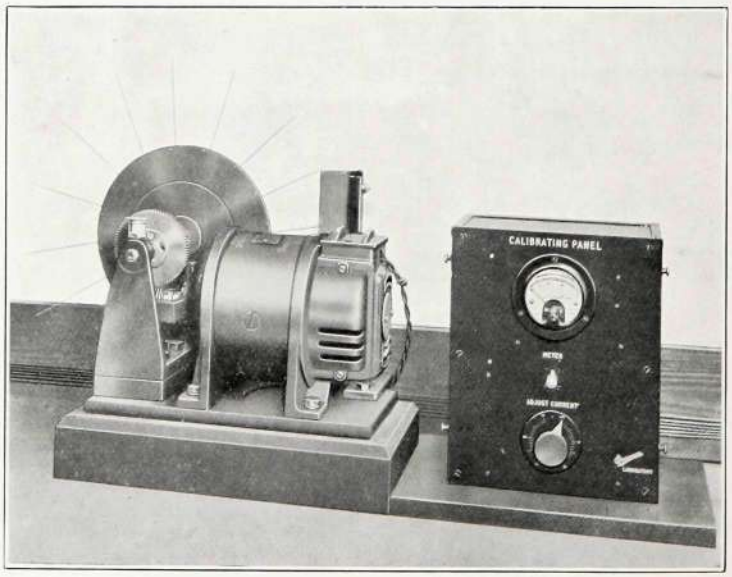


Fig. 5—Arrangement for Calibrating Transmitter "Fry" Test Apparatus

and the possibility of guessing is avoided by not using the English language.

'Voice-ear' tests for volume efficiency are carried out by a crew, the final result being the average of a number of independent tests. The personal element in testing has to be very carefully selected, the vocal characteristics of some persons being entirely unsuitable for transmitter testing owing to the predominance of certain frequencies, and if such predominant frequencies are near to the natural frequency of the transmitter under test, the transmitter may pass satisfactory, whereas with a person having well balanced frequencies it may be rejected. Similarly with hearing, quite a large number of persons have a considerable falling off in hearing powers at frequencies of 2,500 and over, and this may seriously affect the accuracy of their judgment.

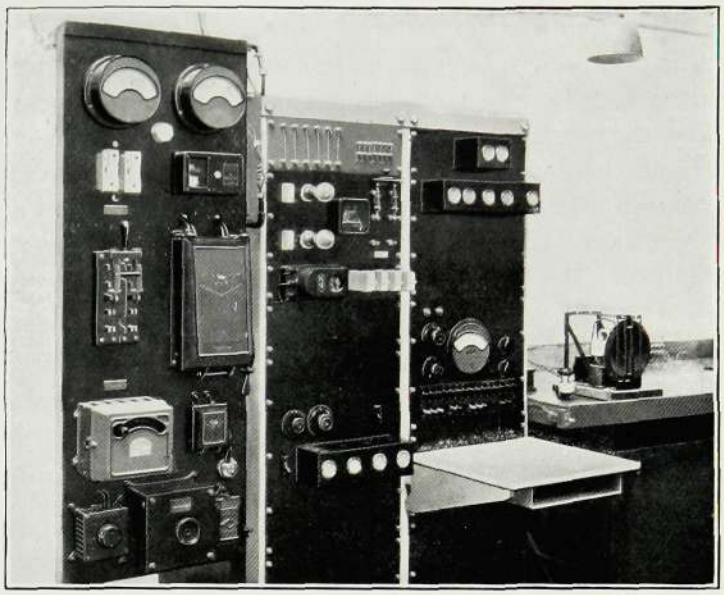


Fig. 6—Transmission Instrument Efficiency Tester

The bulk testing of transmitters and receivers is carried out on the "Transmission Instrument Efficiency Tester" made to details supplied and thereafter calibrated by the British Post Office, Fig. 6 shows a view of this apparatus. It consists of a rhythmic oscillator composed of an oscillator arranged by means of a rotary condenser to deliver oscillations between 600 and 1,600 periods per second, and a second oscillator arranged to give a fixed frequency of 180 p.p.s. The output of the first oscillator is modulated by the output from the second oscillator, a filter removing the 180 p.p.s. component. The resultant is fed into a single stage amplifier and then passed on to the supplementary amplifier, the output feeding a loud speaker from which energy is picked up by the transmitter under test, the latter being held in a predetermined position in front of the loud speaker. The transmitter is connected in a standard instrument circuit and a standard exchange system. The output from the secondary of the repeating coil is shunted by a known resistance, the potential across a portion of which is rectified and amplified, and then passed to one valve of a pair of balanced rectifiers, the other valve of the pair being fed by part of the output from the supplementary amplifier. Connecting the anodes of the pair of balanced rectifier valves is a voltmeter, and the arrangement is adjusted so that a centre-zero scale reading is given when the volume efficiency of the transmitter under test is equal to that of the standard specified by the Post Office. The voltmeter has a special scale calibrated in decibels on each side of the centre zero and consequently the efficiency of the component under test is read directly on the scale; thus for volume testing the personal equation and possibility of error is considerably reduced and the speed of testing materially increased. The voltmeter indicator of the measuring panel is

arranged so that, in addition to the volume efficiency being measured, the resistance is also directly indicated on a special scale, and the simple action of depressing a key allows this to be done immediately after the volume indication has been observed. Operation of other keys allows the H.T., filament and grid bias voltages of the oscillator and amplifiers to be read, so that a constant check can be made whilst the apparatus is in use. Slight variations in gain, &c. are experienced from day to day, and the calibration is checked daily, or more often as required, utilising six special standards supplied by the Post Office research station.

There is no doubt that this apparatus or some modification thereof will be used exclusively for routine testing of apparatus, but for the precise testing of intelligibility and articulation there seems little or no possibility of devising means other than that of ' voice-ear ' testing in the laboratory.

The frequency response of microphones is an important detail and one which requires careful attention. The theoretical ideal is of course, a level response over the whole range of audible frequencies, but from a practical point of view such a response is not desirable. A high response will cause the accentuation of the sibilants which would be extremely objectionable in commercial use. Circuits have been arranged with band filters passing frequencies between 800 and 1,500 p.p.s. and weak but quite intelligible speech is received under these conditions. The structure of the ear is such that it is able to supply, quite unconsciously on the part of the hearer, sufficient of the missing frequencies to render the intelligibility normal. Extended practical tests prove that the frequencies from 500 to 1,800 p.p.s. are the ones necessary for good articulation, and an extension of the upper limit to 2,500 p.p.s. adds to the naturalness of the speech.

There are several methods of taking the frequency response curves, and extreme care is required in the setting up of the apparatus and in the calibration of the components, so as to ensure that the response of the transmitter is not masked by deficiencies of the arrangement used.

Curves have been made of a number of microphones of various types belonging to the principal manufacturers and chief administrations in Europe, and although space does not permit the reproduction of these individually, they have all been superposed on one base to produce a composite curve (Fig. 7).

The arrangement which was used to produce the curves is shown in Fig. 8. It will be noticed on examination that the loud speaker controls its own volume, and by means of the apparatus controlled by the condenser microphone placed adjacent to the microphone under test, the level of

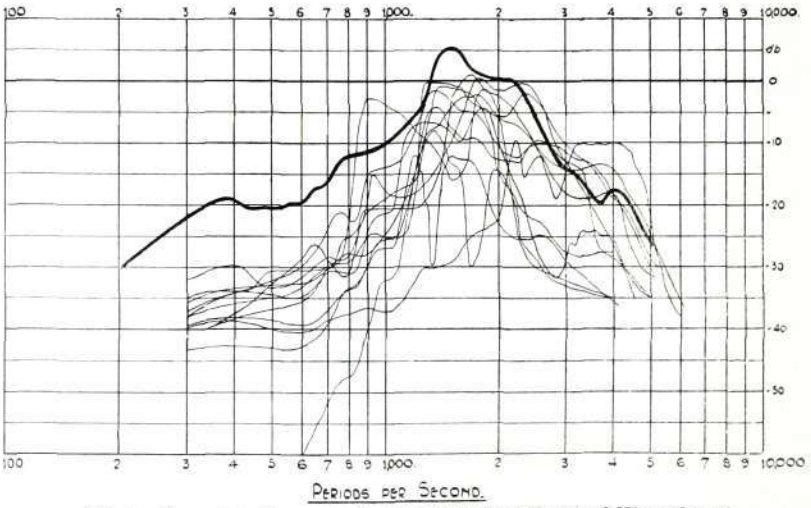


Fig. 7—Frequency Response Curves of Various Types of Microphones

volume is registered on a recording meter which, of course, produces the characteristic curve. Each microphone tested was connected in the instrument circuit for which it was designed, and which in turn was connected to the correct exchange system, thus ensuring no false record due to being used under the wrong conditions.

Referring again to Fig. 7. the curve shown thickened represents the average characteristic of the Ericsson N7742A microphone, and illustrates the advance made towards the realisation of the elusive straight line frequency response for commercial carbon granule microphones.

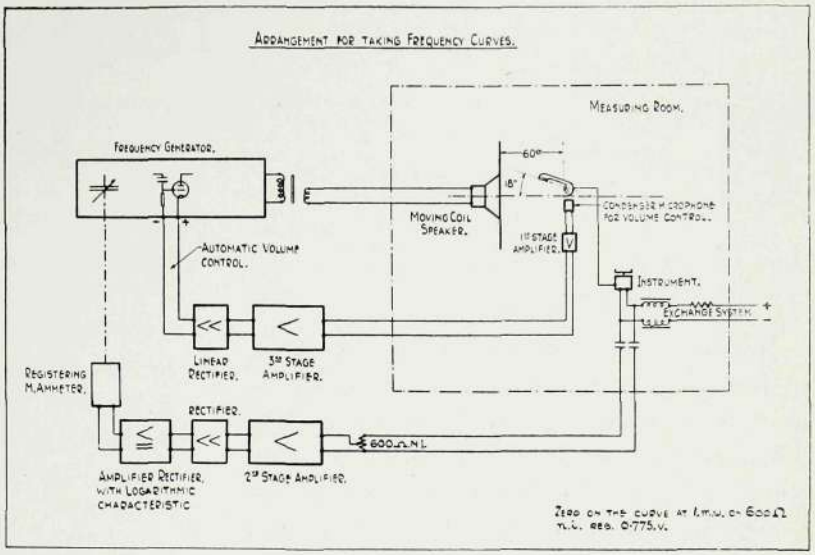


Fig. 8—Diagram of the Arrangement for taking Frequency Response Curves

The testing and measurement of side tone is also receiving prominence on account of the increased efficiency of subscribers instruments. There are three points of view when considering the subject of side tone. Firstly, room noises &c. will be transmitted as well as speech, and these may reach such an extent that reliable conversation will become very difficult. The second point is that excessive side tone can be very annoying to a speaker, and thirdly, hearing his own voice so loud in his receiver the speaker will lower it to a point where the side tone is not inconvenient, thus producing a reduction of sending efficiency. On the other hand, if the side tone is reduced too much the speaker will imagine his telephone to be "dead," and will shout into the transmitter, usually to the discomfort of the person at the other end of the line, and in any case degrading the quality of speech.

Preliminary experiments in the measurement of side tone have been carried out by comparing the side tone of an instrument against received speech from that instrument when connected to a standard transmission circuit, the receiver from the sending instrument being carried through to the receiving cabinet and comparison made by altering the value of attenuation until balance is obtained. Using this method of rough approximation, a value of about 30 decibels was arrived at for the microtelephone instrument with separate anti-side-tone transformer and with the multiple winding induction coil the value is about 20-25 decibels or just below the level of quiet speech, which is the amount agreed on as being normal.

A method of side tone measurement developed by the Post Office Research Department is outlined in the I.E.E. Journal in an article entitled "Some Acoustic and Telephone Measurements," by H. R. Harbottle. It is intended to adopt a method utilising the principles outlined therein.

Bakelite Telephones

RECENT years have witnessed a notable change in the design and construction of telephone instruments, due largely to the application of mouldings of the synthetic resin type to their manufacture.

By the application of modern moulding methods, an instrument of the type shown in Fig. 1 was developed early in 1930. This instrument is of the one-piece, self-contained type, *i.e.* the components which sometimes form a separate unit—a bell set—are incorporated in the instrument.

For many years an instrument with separate transmitter and receiver was largely in vogue with telephone authorities, but with the introduction of moulded bakelite

Fig. 1—Bakelite Table Set, Type N1010A

telephones as illustrated, a general return is taking place to an earlier practice in favour of the hand micro-telephone, a unit originally designed by the Ericsson Company.

The number of parts is kept down to a minimum, and in consequence the quantity of spares which it is necessary to carry for repair and maintenance is reduced, thus effecting an economy in maintenance costs.

Easy access to the internal apparatus is effected by simply unscrewing the four screws fixing the base plate ; the screws are of the captive type and are retained in the plate. On the base plate are mounted the ringer, condenser and connecting terminal block (the equivalent of the bell set which it is customary to use with the pedestal type of telephone). Connections are made to the cradle switch springs, anti-side tone induction coil, and automatic dial fitted in the body of the instrument, by means of a three way flexible cord of sufficient length to enable the body portion to be lifted clear of the base, thus giving ready access to all the components, Fig. 2.

The moulded body, on which the micro-telephone cradle and plunger operating the switch springs are fitted, has an aperture

Fig. 2—View of the Interior

for accommodating an automatic dial of the standard British Post Office type. This aperture is fitted with a suitable cover plate when the instrument is required for manual C.B. operation.

The instrument is also readily adapted for wall fixing by the use of a specially designed bracket, Fig. 3. When used in this manner it is customary to dispense with the three-way flexible cord and moulded connecting block, normally used when the telephone is for desk use, the external

wiring being connected direct to the instrument terminals

The hand micro-telephone Fig. 4.is of the moulded type and is fitted with a three-way flexible cord of suitable length. The connectors between the receiver and transmitter housings are embedded in the moulding. The receiver, utilizing a cobaltchrome steel magnet, is of the inset type, and its electrical connections are automatically completed by means of the fixing screws. The capsule type transmitter has been specially designed and incorporates highly polished immersed electrodes. It is readily repairable, the diaphragms being clamped in position by means of screwed rings. The connections to the transmitter are also automatically completed, when the inset is placed in position, by means of a spring pin

Fig. 3—The Set for Wall Fixing

in the transmitter housing of the moulded handle engaging with a socket connected to the bottom electrode of the inset, and a fixed flat type spring making contact on the case. This may be readily seen by referring to Fig. 4.

In the event of the instrument being required for use under adverse climatic conditions, special finishes are given to all metal components in order to prevent corrosion, all coil windings are suitably impregnated, and cords specifically designed for use under tropical conditions are fitted.

Increased transmission efficiency is ensured by the use of a specially designed induction coil embodying the anti-side tone feature, shown in the circuit diagram, Fig. 5 (A reproduction of this diagram is affixed to the top of the condenser case in each instrument, for purposes of reference, making connections and tracing faults). The combination of the anti-side-tone circuit and the improved capsule transmitter provides a high standard of

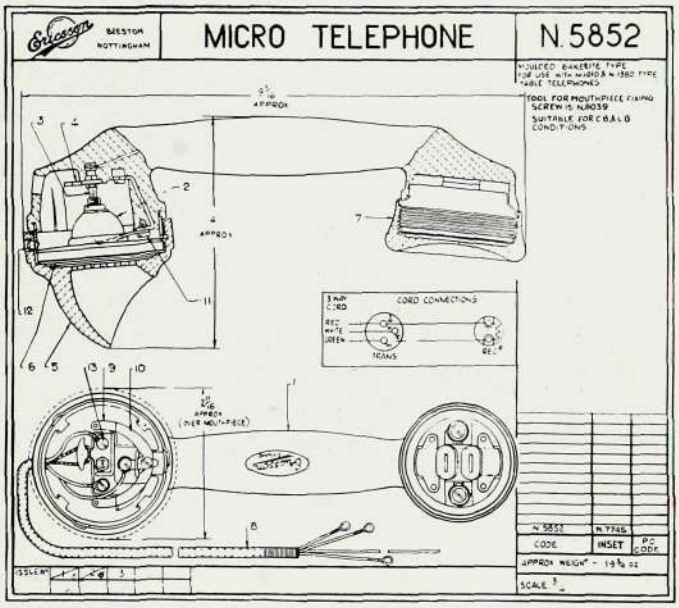


Fig. 4—Drawing of the Micro-Telephone

transmission. The average efficiency of transmission is 5 decibels better than that of the C.B. solid back transmitter as specified by the British Post Office, and the average efficiency of reception is 0.5 decibel below that of the bell receiver standard, also specified by the British Post Office.

The general design of the instrument follows closely that of the latest British

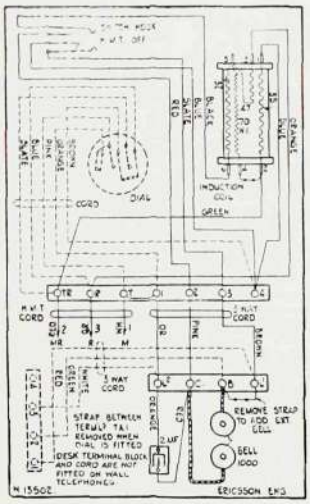


Fig. 5—The Circuit

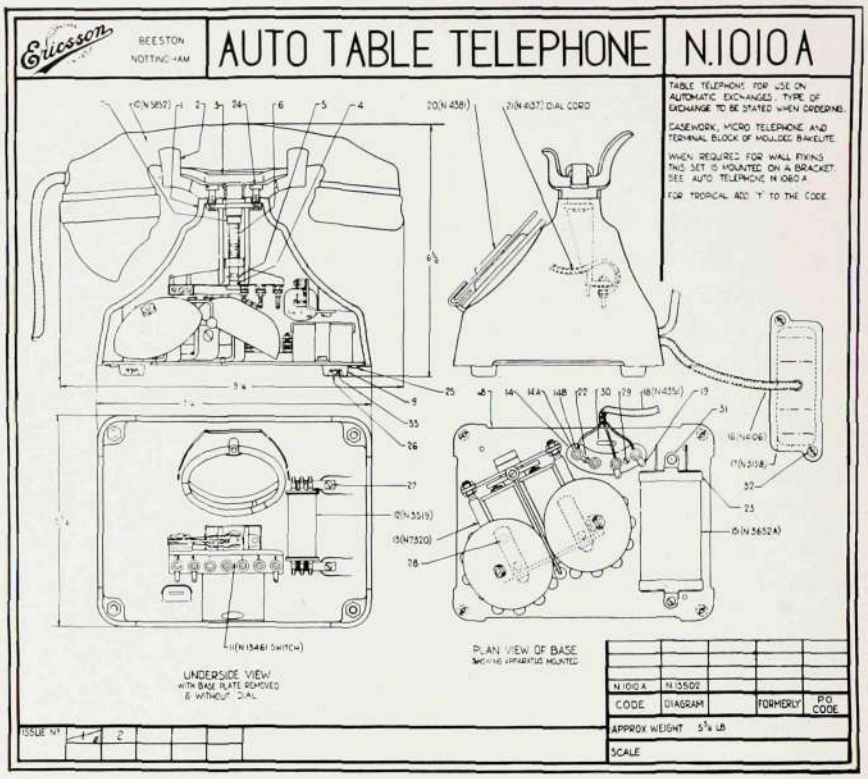


Fig. 6—Assembly Drawing of the Complete Telephone

Post Office standard, and as far as practicable, many of the components are interchangeable with those of the Post Office Instrument (Type No. 162).

One of the interesting features is a ringer having the usual standard size gongs inclined for mounting in a restricted space, as may be seen from Figs. 2 and 6. It utilizes many components of the British Post Office standard bell No. 1A and is so designed that with minor modifications, this bell can be readily converted for use in the instrument. This adaptability should make a special appeal to telephone administrations, who have stocks of these bells, and who desire to provide their subscribers with the ideal one-piece instrument and its accompanying increased efficiency and ultimate economy. For this purpose the Ericsson bakelite telephone can be supplied, with the base plate unequipped, so that it may readily replace the pedestal type and be temporarily connected to the existing separate bell set. the anti-side-tone features of the combination induction coil being at the same time utilized.

It will therefore be seen that a change over to the self-contained instrument may be made gradually by slight modifications to the method of mounting the gongs of the bell set ringer, thereby enabling the latter to be fitted on the originally unequipped base, the condenser from the bell set, when of suitable size and capacity, may also be readily fitted to the base.

From the foregoing brief description of the Ericsson bakelite instrument, N1010A type, it will be seen that the telephone is suitable for service under the most exacting conditions, its high transmission qualities and low cost of maintenance rendering it suitable for use by telephone administrations in all territories.

The Importance of Life-Testing in Telephone Engineering

DURING the last 10 years, capital to the value of millions of pounds has been expended on Automatic Telephone Equipment. From an economic point of view, therefore, it is of great importance to know the length of time that such equipment can be expected to give good service. Moreover it is necessary to have this knowledge before manufacturing is commenced.

In order to provide this information, advance samples of all apparatus proposed for service are subjected to rigorous performance tests, data from which enables prediction to be made of the useful life to be expected from the equipment when in service. Tests of this nature are known as life tests, and this article deals with life testing in a general way, with particular reference to automatic switchgear such as uniselectors, two-motion selectors, relays, etc. Tests in connection with telephone instruments, durability of finishes, and equipment for use under tropical conditions, all demand their own special consideration.

In addition to ascertaining the approximate period of years over which an approved design will last, it is also necessary to ensure that the mass produced article is consistently equal to the approved performance of its prototype. The tests which are imposed to this end are referred to as comparative checks, and while being similar to the actual life determining tests, have the advantage that the rate of testing may be increased considerably.

The great advantage gained by life testing is that, simultaneously, it determines the suitability or otherwise of all the important factors that go to produce good sound apparatus, for example, materials, workmanship, design, efficiency, etc.; also, in the case of comparative checks, it provides a conclusive double check on the already exhaustive component and material tests that are imposed prior to manufacture.

When formulating a life test the first consideration is to ascertain the most exacting conditions to which apparatus represented by the sample will be subjected. In some cases it is desirable to go further and to anticipate and apply even more severe conditions than those to be fulfilled normally. This policy is particularly necessary with automatic switchgear, because this type of apparatus is called upon to fulfil an almost endless variety of functions, some of which are quite simple, from the point of view of life, while others are extremely severe. When the most stringent conditions likely to be imposed in practice have been fixed, a test is arranged which will adequately simulate them and produce the same conditions of wear, but which is condensed into a usefully short testing time. It is this shortening of the time factor that complicates the judgment of the test results, because important differences between the actual and the test conditions are thereby unavoidably introduced, chief among them being, (*a*) operating temperatures differ, (*b*) atmospheric effects on lubricants and surface of materials are not representative, (*c*) ratio of stress period to recuperative period is altered. To allow for these differences it is necessary to know something of both their collective and individual effect upon the general operation of the apparatus. The

more important considerations associated with these variants may be summarized as follows :—

(*a*) *Heating Effects*, the principal results of which are :—

1. Change of Adjustment due to expansion, and tightening of parts.
2. Increased friction generally, and thinning of lubricants.
3. Change in wear resisting properties of materials.
4. Change of magnet pull due to various causes, such as, increased coil resistance and changed air gap dimensions.

Of these, the effects of (1) are the most important, as uniselectors and kindred mechanisms can be thrown entirely out of adjustment due to this cause alone. Reduced magnet pull (4) causes a lessened armature velocity and a slowing of overall speed, both of which may give a false increase in the anticipated life. In the case of (3) the temperature rise is usually insufficient to affect the durability of the materials.

(*b*) *Lubrication.* Representative lubrication, *i.e.* lubrication which when under testing conditions has the same effect on wearing qualities as when in practice, is extremely difficult to determine. In the latter case, prolonged exposure to the atmosphere between the lubricating periods, often with the apparatus in a stationary condition, causes congealing and fouling of the oil, thus making simulation under test conditions extremely difficult. Lubrication while testing is therefore carried out on the assumption that in practice all apparatus receives regular and adequate attention, hence only the absolute minimum of lubricant necessary to obtain smooth running is applied during the test period. One of the chief dangers of an excess of lubricant is the fact that oil 'slinging' may occur and thus cause particles of oil to fall on wipers and other parts intended, for circuit reasons, to run in a dry condition.

(*c*) *Effect of Testing Rate on Wear.* When dealing with comparatively high speed apparatus such as selectors of all types, it is an accepted fact that, within limits, the greater the testing rate the greater is the rate of wear, other things—heating and velocity of friction surfaces for example—remaining constant. The explanation of this lies in two main directions, (1) molecular changes in the metal due to fatigue, and depending upon the ratio of stress periods to recuperative period, and (2) effects of atmospheric oxygen on the friction surfaces, particularly in the case of wiping contacts. The nett result of these two effects produces a progressive and appreciable reduction in the total number of operations obtainable as the testing rate increases. For this reason therefore, efforts are made to obtain as long a recuperative period as possible commensurate with a reasonable period of time between the commencement and finish of the test. The stress period referred to is the uninterrupted time over which a mechanism is allowed to operate, while the recuperative period is a short interval of rest interposed between the stress periods.

The chief functions of the testing circuit are, to operate the test sample suitably and reliably, in accordance with the above-mentioned conditions, and to count or meter the number of operations imposed ; also in the event of any failure occurring, to stop the whole test automatically and give suitable alarms. To improve the reliability of the test circuit operation, twin contacts are used on the apparatus

employed, and the counting element is provided in duplicate.

The chief causes of breakdown of electromagnetic apparatus can be divided into two groups, (*a*) electrical failure, and (*b*) mechanical failure. A list of the main sources of trouble occurring under each heading is given below.

(*a*) *Electrical failure*

1. Contact destruction
2. Coil disconnection
3. Insulation breakdown

(*b*) *Mechanical failure*

1. Breakages
2. Excessive wear
3. Distortion
4. Loss of spring tension
5. Loosening of parts
6. Jamming due to fouling

During the life test strict supervision of the general progress is necessary. This takes the form of periodical examinations made at suitable intervals spread over the whole test period. The frequency of examination varies according to circumstances, but it is usually greatest during the early stages, in order to check for faulty operation, premature loosening or failure of parts, etc. In all possible cases the amount of wear is gauged by the dimensional change of the parts concerned, ' feeler ' gauges being used for this purpose. Also while making these examinations great care is taken not to disturb the mechanism adjustment, or to cause false distribution of the surplus lubricant usually found on ratchets or exuding from bearings.

In addition to checking the physical conditions of the equipment, the actual standard of performance is also observed. Two-motion switches are tested for their response to impulsing, and any deterioration noted. Relays are also checked for performence change, etc., and so on. In this manner the degree of performance of automatic equipment can be gauged for any period throughout its useful life.

Complete records of each test, constituting very valuable information, are filed for reference. From these records, accumulated from tests covering many years, it is possible to classify materials upon their suitability for ' heavy ' or ' light ' duty, and thus to design apparatus with a life which is most suitable for the duty it has to perform.

In the case of precious metal contacts the need for careful classification is particularly instanced, and is well illustrated by the comparison between the relative duties of a relay contact used on an infrequently operated alarm circuit, and a contact used on a tone generating relay. In the former case, one hundred operations per annum is a reasonable number, but in the latter, one thousand million operations are to be expected over the same period. It is clearly an unnecessary expense not to discriminate between two such requirements as these when designing telephone apparatus.

It is when developing ' heavy ' duty equipment that the value of life testing is most emphasised, for under test the weakest component is always being revealed to the designer. By giving attention to each weakness as it is revealed the life of the equipment is increased step by step until the required service is obtained.

As previously stated, however, life testing not only assists development but also provides a means of checking production standards. By comparison between early and current life test record sheets, the general trend of performance and effect of manufacturing methods can be closely observed. Thus high standards of performance are continually maintained.

Mercury Contact Relays

FROM many viewpoints the mercury contact relay is unrivalled for the remote control of power circuits, especially in cases where the mains voltage is in the region of 250 volts, and currents up to 20 amperes require to be catered for.

Among the advantages normally incidental to the use of a " tube contact " for switching purposes are the facts that the possibility of igniting inflammable atmospheres when the circuit is made or broken is removed, and that dusty atmospheres cannot affect the reliability of the contact. In addition to these, the Ericsson Mercury Contact Relays have certain special features, including extreme sensitivity, and universal operation on A.C. and D.C. over the same voltage range, while a combination of both of these facilities is frequently required.

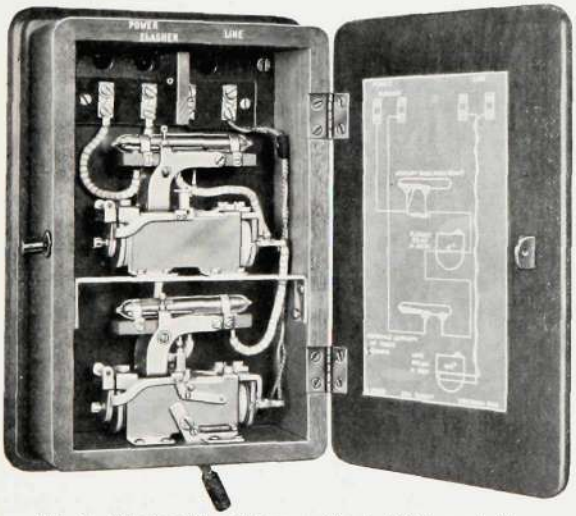


Fig. 1—Flasher Type Mercury Contact Relays in Case

Figure 1 shows a self-contained " flasher " unit which consists of two mercury contact relays. The lower relay, called the " line " relay is in the control circuit and will operate over a long junction line on a very low voltage. Specifications met have necessitated operation from a 4-volt dry battery over a 200-ohm line, or from a telephone ringing supply, the relay being connected in place of, or in parallel with, a standard telephone bell. The upper or " flasher " relay is of very low resistance and is connected to the power circuit in series with the line relay's mercury contact and its own mercury contact. Thus when the line relay is operated the flasher relay will make and break the power circuit at a rate of about 40 flashes per minute. The power circuit usually consists of metal filament alarm or signal lamps and the flasher relay is designed to work from both A.C. and D.C. supplies. In order to maintain a smooth action, even when flashing at the above-mentioned speed, the platform carrying the mercury contact is loosely coupled to the relay armature by means of a flexible ' U ' shaped link, which results in a non-violent movement of the tube while at the same time taking advantage of the full travel of the armature. The armature of the line relay may be fitted with a locking detail under the control of a restoring key, as shown at the bottom of the case in the illustration. This facility, which is used in certain police and alarm systems, enables the flashing signal to be maintained until acknowledged at the distant end.

Figure 2 shows a super-sensitive type of A.C. relay which has been designed for use on party line systems where many such relays may be required to operate in parallel over a junction line. By the use of this relay great economy in power can be effected enabling as many as a score of calling signals to be given simultaneously from a small ringing vibrator, even when each station is separated from the main station by a

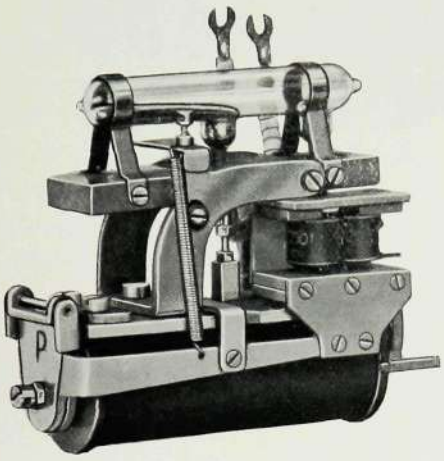


Fig. 2—A.C. Mercury Contact Relay

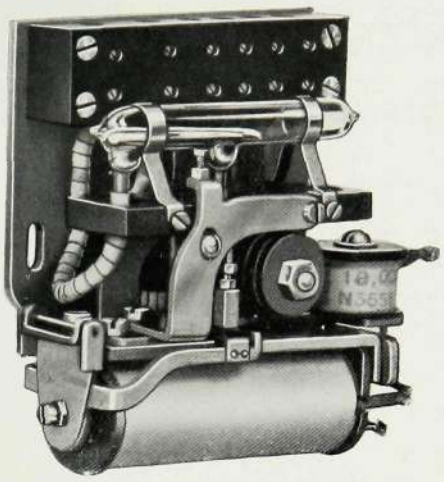


Fig. 3—A.C. or D.C. Relay for Control Circuits

distance represented by a 600Ω loop. A typical use for this relay is to be found in the Police System which was described in Bulletins 1 and 2.

Another type of relay which is often used to effect a saving in lines between one point and another is the " polarised " mercury relay. This relay has a permanent magnet associated with the magnetic system so that current may flow through the circuit in one direction and perform specific functions without operating the relay. If the current direction is reversed, however, the relay operates and gives the necessary signal.

Figure 3 shows an Ericsson Mercury Contact Relay which has been designed to carry out a function where absolute reliability is essential, namely, the control of emergency lighting systems. When one considers the case of the operating theatre where the failure of the mains supply or the blowing of a lamp filament may have serious consequences, the importance of the function will be readily appreciated. This relay is held operated in series with a lamp normally drawing current from the mains ; it is consequently essential that its power consumption be a minimum in order to prevent a serious voltage drop across the filament. The mercury tube is connected in series with emergency lamps which draw current from an emergency accumulator battery when the mercury completes the battery circuit. Thus in the event of any failure in the mains circuit or lamp filament the emergency lamps are immediately switched in and illumination is maintained.

The following facilities are provided on the relay mentioned above :—

(1) Universal for A.C. and D.C. supplies.
(2) Universal for voltages from 100-250.
(3) Silent in service on both A.C. & D.C.
(4) Self-contained unit providing screw type connection for power mains.
(5) Reversible tube for providing either a " make " or " break " contact.

These facilities are also given on a similar relay which is designed for use in cases where it is only necessary to switch in the emergency lamps when the mains fail. This involves a high resistance relay permanently connected across the mains.

Another useful application of the mercury contact relay is in connection with battery charging circuits. For use in this connection the Company has developed a relay which will protect the battery against discharging through the mains in the event of failure, and will also release and cut off the charge when the battery voltage has reached a predetermined value.

Combined Magneto Generator and Bell for Portable Testing Sets

PERSISTENT demands have been received from various administrations for a magneto generator, for use in conjunction with portable test sets, which will give a higher power output than the type hitherto used for this purpose.

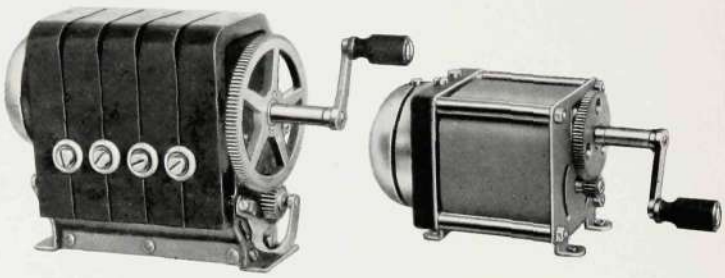


Fig. 1—The Old and New Generator

In addition to instruments embodying 3 and 4-magnet types for which many orders have been executed, requests have been received for a new design of generator to be produced, which would have an output equivalent to that of the well-known 5-magnet class, but smaller in size and appreciably lighter in weight. A typical 5-magnet generator weighs 6 lbs. and has dimensions of 8″ x 4-5/8″ x 2-7/8″, which can hardly be classified as suitable for use as a portable type.

To meet the above specification, namely, equal output, smaller size, and lighter in weight than the usual 5-magnet type, a distinct departure from standard telephone practice was clearly indicated. The requirements of weight reduction coupled with high efficiency indicated magnetic circuit design as the most fruitful field for attention.

A new design of generator has therefore been produced using a cast magnet of cobalt-chrome steel which incorporates the necessary polepieces. The appearance is neat, the construction bold and the efficiency equal to that of the 5-magnet generator. The new design is approximately 40% less in weight and it can be housed in a much smaller space than the 5-magnet type, as will be appreciated by reference to Fig. 1. The cobalt-chrome steel magnet is well proportioned and during development the fullest advantage has been taken of the exceptional magnetic features of this material. The characteristics of this steel are well known, but for convenience they are summarized in Fig. 2.

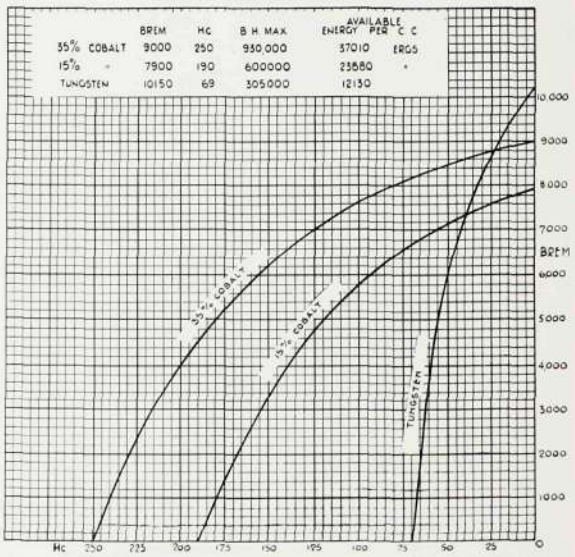


Fig. 2—Characteristics of Magnet Steels

Cobalt-chrome steel is much more expensive than tungsten steel, but every effort has been made in the planning of the

unit to avoid any substantial increase in cost. Wasteful magnetic leakage has been reduced to a minimum, and actually the extra cost will be small in comparison to the many advantages which have been procured, largely by the introduction of a one-piece magnetizing element of cobalt-chrome steel.

While 35% cobalt steel has the highest magnetic energy of any commercial steel for a given volume, it was found that a cobalt-chrome steel having a cobalt content of 15% would be the most economical for the aim in view, taking all factors into consideration.

The ringer is fitted in such a manner that it protects the generator spring assembly and also adds to the general appearance of the unit. By means of a novel and ingenious layout of the magnetic circuit, it has been possible to dispense with the use of individual magnets on the ringer, which is conveniently polarized direct from the generator magnet, thus effecting a further saving in weight. In addition, an improved design of armature movement has been provided, whereby the ringer may be readily adjusted by means of a screwdriver without removing the metal gong ; reference to Fig. 3, which is an exploded view of the complete generator and ringer set, discloses this facility.

It will also be noted that apart from the driving mechanism for the generator, all working parts are almost totally enclosed and therefore efficiently protected against damage by accident or rough usage.

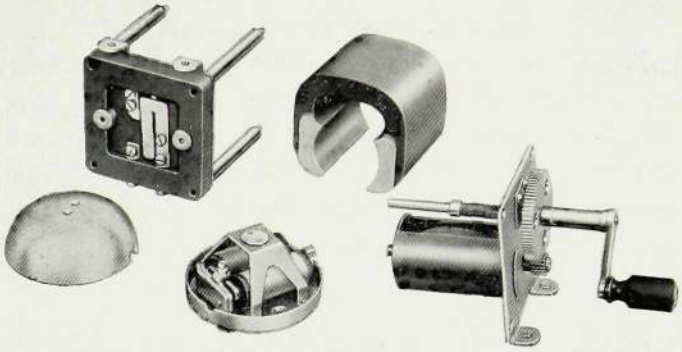


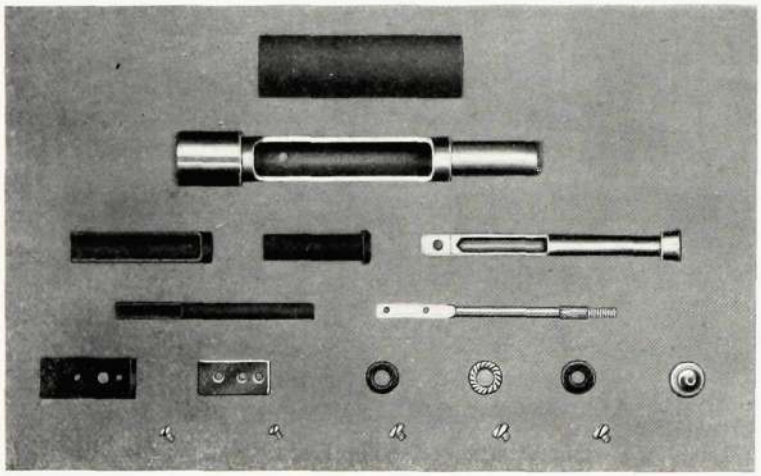
Fig. 3—The New Ericsson Generator and Ringer, Dissected

Although primarily designed for use in portable telephones it will be readily appreciated that this recent Ericsson production, which can be supplied without the bell, may be used with advantage in switchboards and ordinary magneto telephones, especially for long distance working. The combination of generator and bell, fitted in a suitable carrying case is useful for many simple testing purposes, but its crowning success is that it enables the Ericsson Company to supply customers with a powerful yet light portable testing telephone for the use of linesmen. This unit could also be usefully adopted in many other directions such as for insulation test sets, etc.

Moulded Switchboard Plugs

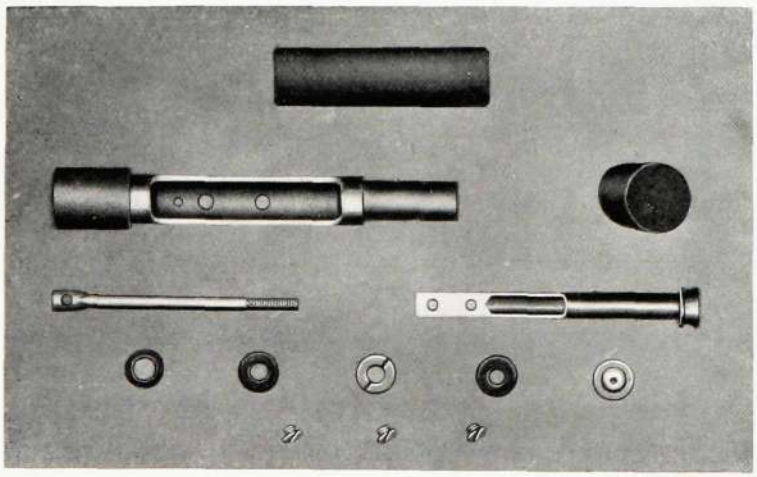
SWITCHBOARD plugs, like most manufactured products, have advanced from a primitive form; the early type of plug being a knife or blade fitted into a handle of insulating material.

This knife plug was superseded by the more familiar peg type about the year 1884, ultimately developing into the now well-known built-up plug consisting of two or three conductors insulated from each other by ebonite tubes, collets and washers, the whole of which fit loosely together and are held in position by small screws and a brass plate. This design is not always reliable owing to its lack of stability, and it has proved a source of trouble to telephone engineers whose aim is to provide an uninterrupted service for their subscribers. The purport of this article is, to point out the steps that have been taken to deal with the faults that arise from this source, and to show as simply and clearly as possible the advantages of the plug produced by the most modern methods.



The Components for a 3-Way Built-up Plug

During the year 1923 the Ericsson Company acquired manufacturing rights of a plug having a solid one-unit insulation and since that time both the built-up and the moulded types have been produced at the Beeston works.



The Components for a 3-Way Moulded Plug

The superiority of the moulded over the built-up plug will be readily appreciated by an examination of the accompanying photographs which give a comparison of the component parts of a three-way plug; the first being the built-up type and the second the moulded type. The number of component parts has been reduced from eighteen in the built-up plug to thirteen in the moulded type, and it is interesting to notice that the most delicate

components are eliminated in the plug with the one-unit insulation.

A great feature also of the one-unit insulation is that it ensures far longer reliable life than is given by the old type of built-up switchboard plug, without additional cost.

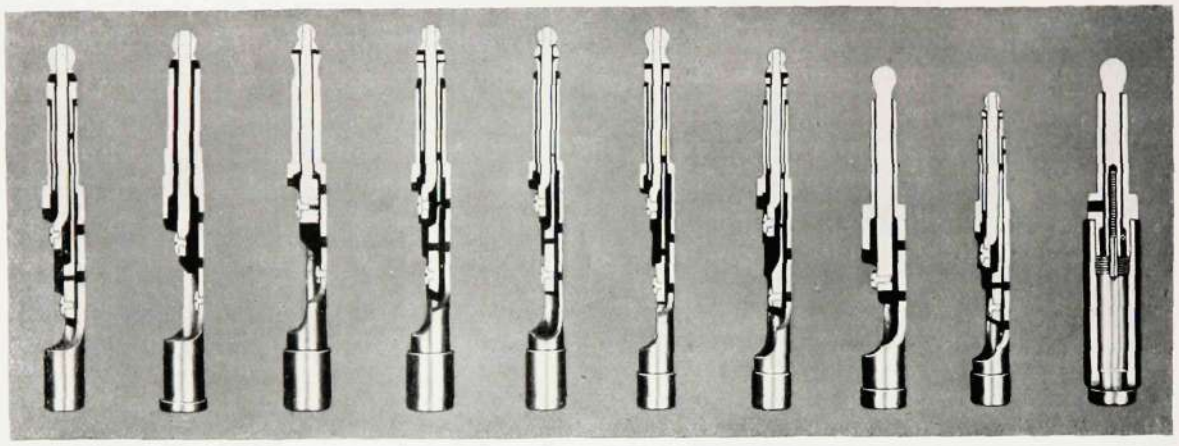
Under the moulded process the conductors are correctly spaced and securely clamped in position ; they are then placed in a mould and the insulation material, which becomes plastic by the application of great heat, is forced in under considerable pressure ensuring that even the most minute cavities are filled, and that the whole assembly is bound together into one homogeneous mass.

After they are taken from the mould and cooled down to the temperature of the room, an alternating current at about 700 volts peak value is applied across the various conductors. They are then tested for insulation resistance by means of a 500-volt megger, the reading of which must register infinity. Plugs which fail to pass either of these tests are rejected, while those that pass are machined by turning and profiling operations carried out under a carefully thought-out system of gauging. Finally, they are code marked and despatched to the final inspection and testing department where they are subjected again to electrical tests to ensure that no damage has been caused during machining. They are also carefully examined for damaged insulation, checked for correct diameter, profile, and smooth finish. The plugs that pass this final test are fitted with covers and sent to the despatch department for shipment. The thoroughness during manufacturing and inspection is reflected in the satisfaction which has been expressed by those who have had experience in the use of this moulded type of plug.

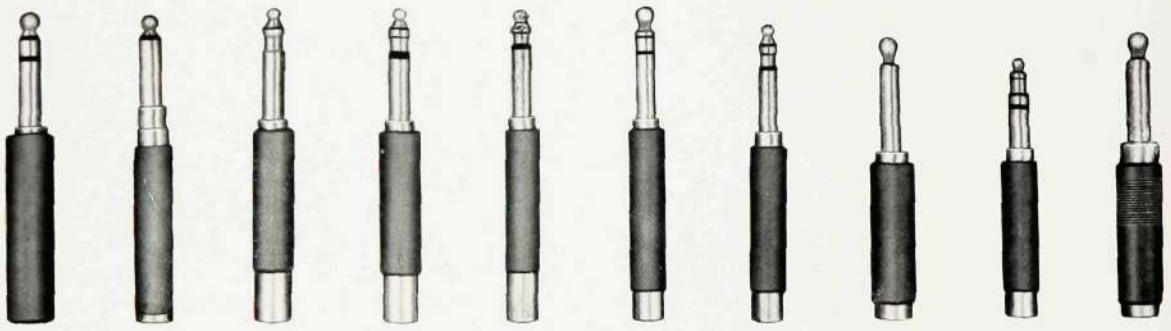
Constant plugging in and out is obviously hard on the life of the switchboard plug, and the Ericsson Company has been untiring in its efforts to provide its customers with the best possible products, particularly in respect of their capability to withstand hard usage.

During the past year further study has been given to various aspects of plug design. Experiments were carried out in the Company's laboratory, embracing the physical and electrical sides of the requirements that have to be met under the most rigorous service conditions a plug could possibly be called upon to face. Certain components were re-designed and strengthened where it was judged expedient. The shape of the profile was modified to obviate possible interference of the conductors with the jack springs on the insertion or withdrawal of the plug. The tip of the plug was reinforced to minimise such damage as that occasioned by a sudden jerk on the cord when extracting the plug from the socket on the completion of a call. This method of extraction is, of course, strongly deprecated but it does happen and causes an undue strain on the tip tending to bend or fracture the central conductor stem, which is of stainless steel on all plugs.

As a result of research conducted by a highly skilled technical staff, the Company now claims to offer the most efficient switchboard plug on the market, and it is also claimed that this has only been made possible by the one-unit insulation which to so large an extent eliminates the faults inherent in the built-up type of plug.



A few Ericsson Moulded Plugs in Section



The same Plugs complete with Covers

The photograph reproduced on this page of sectioned plugs demonstrates that one half may be cut away without the remaining portion falling apart. The conductors and insulating material have become one compact mass thus producing a plug of maximum stability.

The Ericsson Company has produced more switchboard plugs than any other European manufacturer, and the very extensive experience thus gained is placed at the service of its customers.

Consideration has naturally been given to tropical requirements, and the most suitable materials have been selected to meet those conditions. Moulded covers in various colours are supplied for tropical use.

The standard British Post Office types have the usual fibre covers in either black, red or grey.

Inquiries are invited from those interested in the standard or special type of plug of this improved construction. The one-unit insulation will help to reduce operating costs while contributing to the general efficiency of a telephone service.