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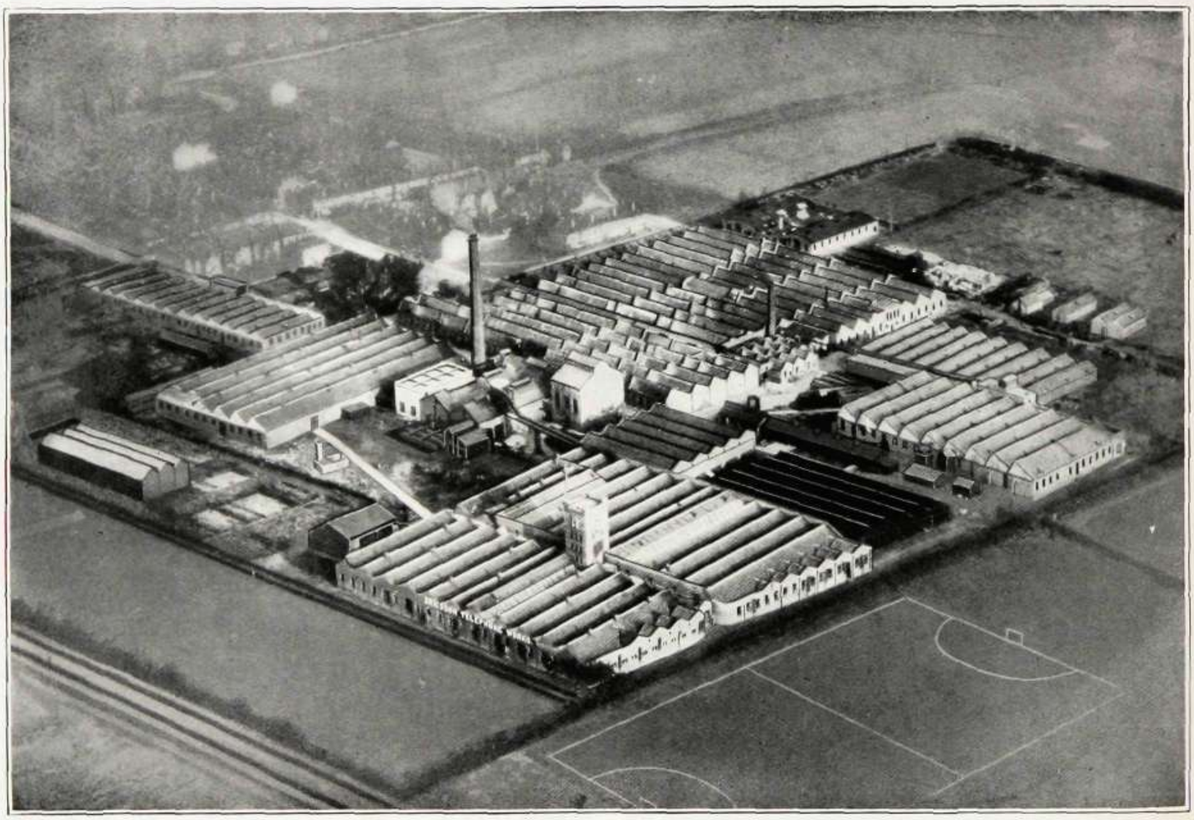


Aerial View of the Works, Beeston, Nottingham

Police Telephone System Further Developments

MODERN methods of communication and transport have occasioned considerable change in police organisation and control.

Hitherto, with the method of control generally used, the police officers reported on duty at a police station, and after the routine and other orders were conveyed to them they proceeded to their beats. Supervision was maintained by periodic visits to the beats by sergeants and inspectors. Close contact with headquarters was not possible once an officer was on his beat. This form of control is being largely superseded by one in which use is made of police boxes and pillars erected in the streets and telephonically connected to headquarters. Each police box becomes, virtually, a police sub-station and personal appearance at headquarters by the beat officers is rarely necessary, contact being maintained via the telephone system. All officers report "on" and "off" from assigned boxes or pillars, and thereafter, during their period of duty, report, in a scheduled order at definite times, from other boxes or pillars on their beats. Notices and routine reports are posted in the boxes; distribution being made by motor vehicle.

The general desire by the police authorities for a modern telephone communication system has been met by the Ericsson Police Telephone System; adopted as standard by the British Post Office and described in Bulletin No. 2 January 1933, and No. 3 July 1933. This system provides a communication network interconnecting boxes and pillars in the streets, police sub-stations, police headquarters and the Post Office telephone exchanges. Line costs are reduced to a minimum by connecting more than one street point, i.e. box or pillar, to each line. The public are permitted restricted use of the system;

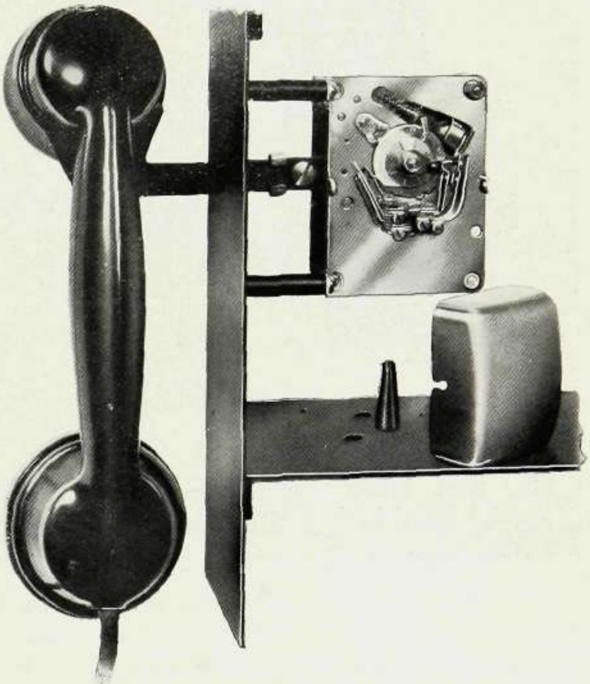


Fig. 1—Automatic Dial Mechanism Operated by Police Handset

public calls being limited to communication between the street points and the police or fire stations. Speech from the police operator to the public is received at the street point by way of a loud-speaker.

The police authorities have not hesitated to take full advantage of the facilities offered by the Police Telephone System to remodel their organisation upon modern lines. The increasing importance of the system in police administration and the tendency of the public to use the services offered, even as far as for other than strictly emergency calls, have necessitated further development of the system. This development is concerned, mainly, with the following facilities :—

(*a*) Inward Signalling
(*b*) Public Call Preference
(*c*) Intrusion
(*d*) Extension of public calls.

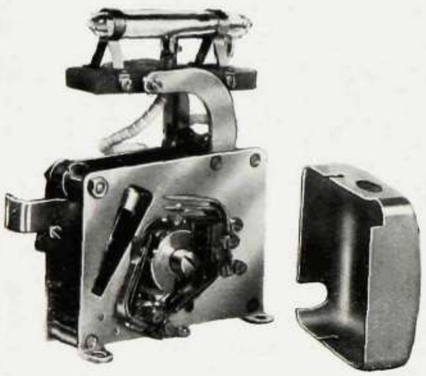


Fig. 2—Automatic Dial Mechanism Operated by the Public Door

The first facility is essential for the successful working of the " box " system of police control, because it indicates, at the switchboard, which of the call points connected to a line is calling and also the class of caller, i.e. police or public.

A signalling device, based upon an automatic telephone dial mechanism, is operated automatically when the police handset is lifted, or the public door is opened, and transmits to the line a train of pulses. The mechanisms are shown in Fig. 1 and Fig 2. These pulses operate relays at the switchboard and light a lamp display to give the required indication. In connection with this facility a considerable amount of circuit development has been carried out to prevent lost calls, and to reduce to a minimum the possibility of false calls. If mutilation of the pulse train should occur due to extreme conditions, occurring but rarely in practice, the type of call is always shown correctly. The answering of a public call is thus never delayed because of an incorrect display.

Delay which may arise from other causes is eliminated by facilities *b* and *c*. The former gives preference to a public call display in such a manner that, if a police call is displayed and awaiting attention and a public call should originate on the same line, the display of the police call is cleared and the public call display substituted. A police call following a public call cannot, however, clear down the public call display.

Facility (*c*) permits a public call, that originates on a line already in use by a police call, to be displayed irrespective of the destination of the police call, which may be extended to a police extension line, another switchboard in the police area or to the Post Office exchange. This facility also permits an intruding police call to be displayed ; in which case facility '*b*', giving preference to a public call display, will function should a public call originate.

Previously all public calls were answered by the operator who, by actuating certain keys, was connected to the line via an amplifier. Experience has shown that, generally, the operator is fully occupied with routine police calls, and the question of permitting, if necessary, the answering of public calls at some point remote from the switchboard has received consideration. The circuits have been redesigned so that the answering of public calls is effected by special cord circuits, thus allowing extension in a manner similar to that of a police call.

Extension can be made to selected extension lines only; such lines may include those to the charge room, the superintendent's office, the ambulance and fire-stations. The operator may "listen-in" to an extended call; a facility of great value on fire calls.

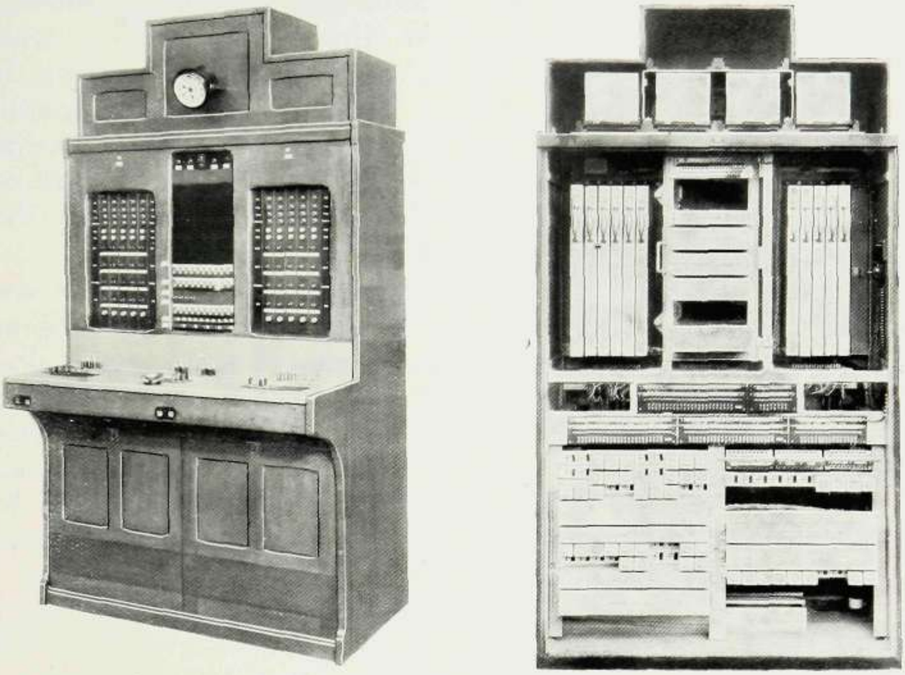


Fig. 3—Front and Rear View of the Switchboard

The switchboards are each equipped with six of these special cord circuits and, since the answering of a public call requires amplified speech, an amplifier is associated with each cord circuit. The amplifiers are accommodated on the top of the switchboard as seen in Fig. 3. The plugs of the public-call cord circuits are situated in the centre of the switchboard and are, therefore, accessible to both operators. Each amplifier employs one valve only, and is fitted with a "suppressor" using metal rectifiers for reducing, to a comfortable level, the strength of that part of the loud speaker's output which is returned to the operator's telephone by way of the street point transmitter. Fig. 4 shows clearly the compact form of the amplifier and suppressor unit.

The public-call cord circuits are arranged so that an attempt to extend a public call to any line other than those assigned will cut-off the amplifier and light the alarm lamp. This also occurs under any other condition of misuse or incorrect operation thereby reducing failure, due to the human element, as far as possible.

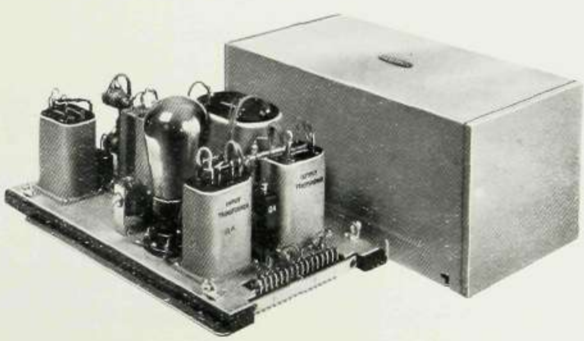


Fig. 4—An Amplifier Unit

"Extreme Accuracy" in Measurement

WHAT is it? No measurement is absolutely correct, and as there is a great variety of circumstances governing the degree of correctness to which measurements are made and worked, "extreme accuracy" therefore cannot be defined in any one unit, but rather in variable degrees according to the class of work to be produced.

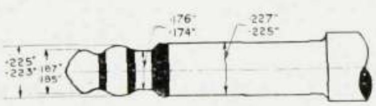


Fig. 1—Part of a Switchboard Plug

For instance, the accuracy worked to by a carpenter fitting a show case lid cannot be classed with the precision of the chronometer maker; or, to go further, to that of lens manufacture where measurements are made by means of light rays using an interferometer. In the case of the carpenter, a few good tools, an accurate eye and long experience, and he can produce a piece of work that could be defined as extremely accurate. The chronometer maker's machines can be adjusted and set to turn out work to a tolerance of one thousandth, half-a-thousandth of an inch, or even smaller, while the lens-maker's degree of accuracy is represented by a few millionths of an inch. From these comparisons it will be appreciated that each class of work has its own "extreme accuracy" in measurement.

The purpose of this article, therefore, is to give some idea of extreme accuracy in measurement as applied to the manufacture of telephone apparatus in the Ericsson Works.

According to the methods adopted, so the degree of accuracy is attained, but the fact must not be overlooked that the higher the degree of accuracy the greater the cost. This is mentioned because an unnecessarily fine tolerance may be called for when a much bigger tolerance would give an equally suitable article at a very much lower cost. This is a very important point and one which should have careful consideration.

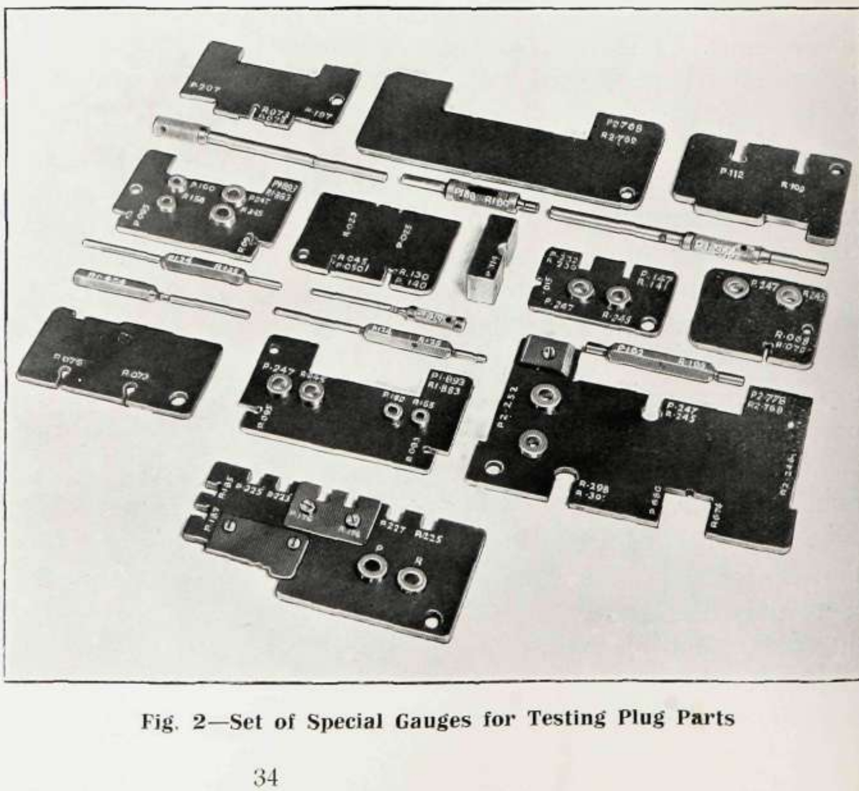


Fig. 2—Set of Special Gauges for Testing Plug Parts

The degree of accuracy generally required for the manufacture of telephone apparatus and parts will be more easily explained and followed from an example. In a previous issue of the Bulletin, a general description of the building-up, finishing and testing of switchboard plugs was given, so that one of these plugs can quite appropriately be taken as the example. The part of a switchboard plug which necessitates special attention is shown in Fig. 1, which also indicates the sections requiring extremely accurate measurements. The components are turned, milled, drilled, etc., as the case may be, to a tolerance of two to three thousandths of an inch, but when assembled and finished they must be within the figures, shown on the drawing, which allow only a deviation of one thousandth of an inch plus or minus.

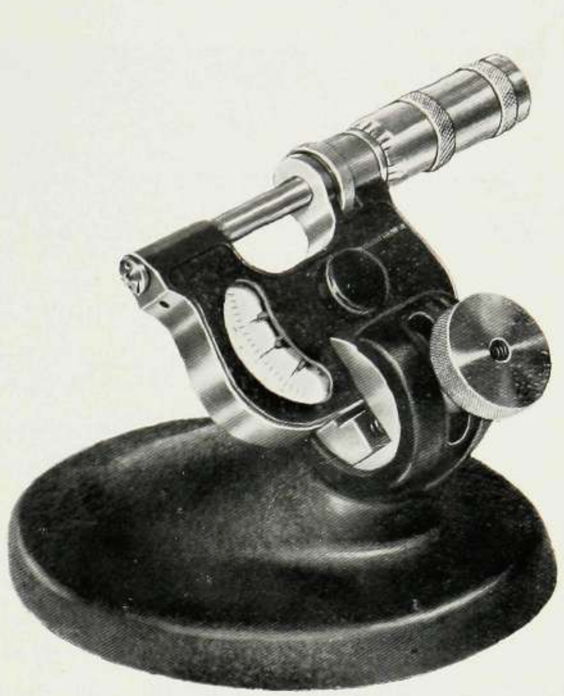


Fig. 3—Indicator Micrometer

Apart from standard gauges, Fig. 2 shows a number of special gauges which have to be made before commencing manufacture of the component parts, and also at the bottom of the illustration, the master gauge used for checking the finished plug; on this gauge can be seen the profile check at the left-hand bottom edge. All gauges

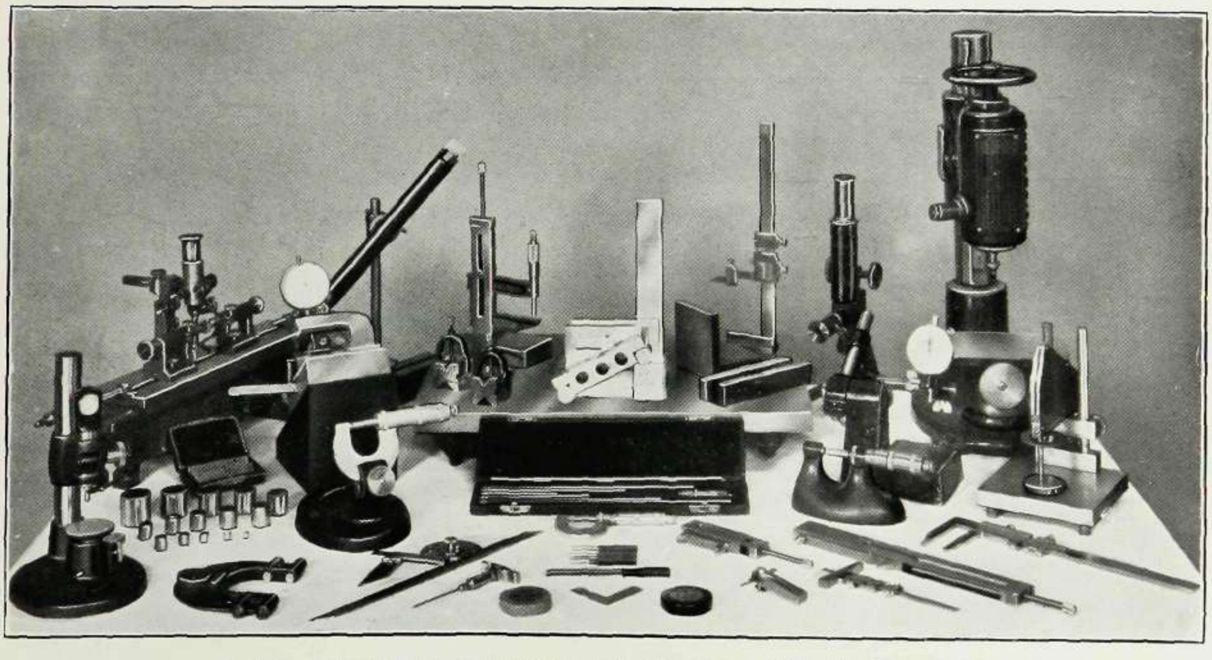


Fig. 4—A few of the Necessary Instruments used for Tool Inspection

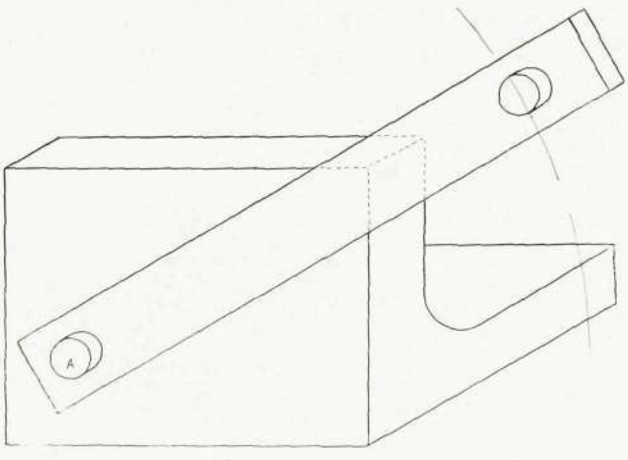


Fig. 5—A Sine Bar

are of the " two-dimensions " type, one for pass and one for reject and are marked " P " and " R " respectively with, in most cases, the dimensions referring, as may be clearly seen on the illustration of the set of gauges Fig. 2. It naturally follows that these gauges are made to a much greater degree of accuracy than the parts they test, the tolerances being of the order of one tenthousandth of an inch, and this degree of accuracy is found to meet the requirements of the telephone industry.

Gauges and tools are all closely and carefully tested in the tool inspection department, and a large number of measurements are made in each case in order to prove that the degree of accuracy aimed at has been attained. Various kinds of fine measuring instruments are in use for making these tests ; that shown in Fig. 3 is an indicator-micrometer which gives direct readings, accurate to one tenthousandth of an inch,and is invaluable for making rapid measurements.

Tools for production purposes vary in hardness according to the purpose for which they are required, the hardness being tested by means of a Hardometer or Brinnel hardness testing machine which forces a diamond or hardened steel ball respectively into the surface of the tool. The impression thus made is measured by means of a calibrated microscope and in this way a measurement of the hardness is obtained. A few of the measuring instruments used in the tool inspection department are shown in Fig. 4. The hardometer and microscope can be seen in the right-hand background.

Gauges for checking angles require very keen and exacting inspection, and one of the most accurate methods is by means of the sine bar, Fig. 5, which consists, in one form, of a steel bar hardened, seasoned and ground to prevent distortion. At each end and projecting from both sides of the bar is a ground steel button ; that marked ' A ' fitting a hole in the angle plate so that the bar may be moved to any angle.

Slip gauges are often used in conjunction with the sine bar, and the method adopted to check the angle of a gauge may be readily followed from Fig. 6. First, place slip

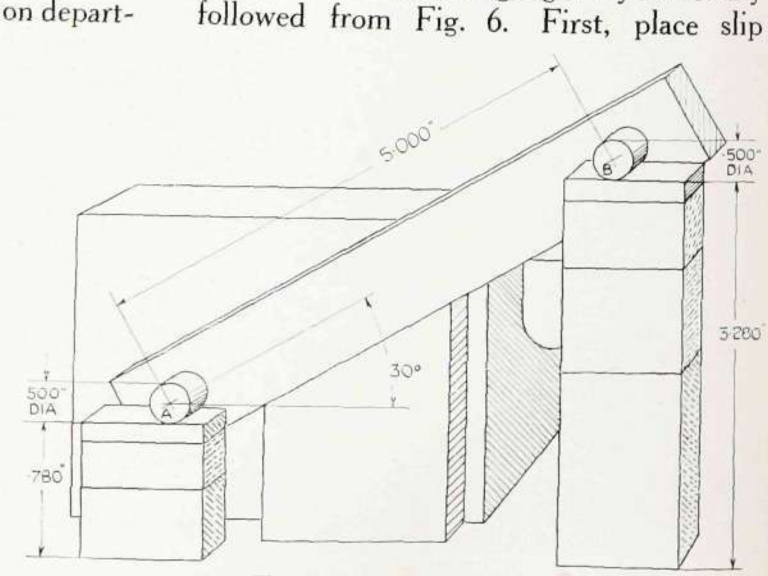


Fig. 6—A Sine Bar in use

Fig. 7—Set of Slip Gauges

gauges between button 'A' and the surface plate to determine this dimension, which in the example is .780″ and is of course a constant "k" for this particular sine bar, and in practice would be a known quantity. The angle gauge is then slid under the sine bar until they fit together exactly, and slip gauges are built up until the top one just touches button "B" giving in the example a dimension 3.280″. By a very simple calculation $\frac{\text{Height B} - \text{k}}{\text{distance AB}}$ gives the sine of the angle and from standard tables the angle is obtained, which in the case under test is 30°.

A set of slip gauges used for testing tools and gauges is shown in Fig. 7, and here again the accuracy must be greater than that of the articles they are used to test;

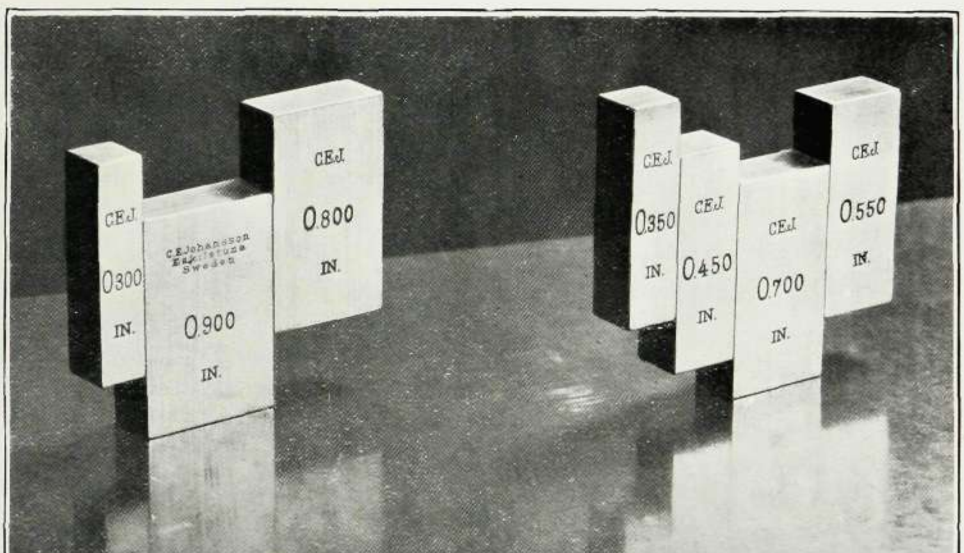


Fig. 8—Slip Gauges Wrung Together

they are, in fact, accurate to one hundred-thousandth of an inch, even when several are wrung together. Not only are they of this accuracy from face to face, but each face is also parallel and flat to the same degree of accuracy. When wrung together all air between the faces is excluded so that they adhere, as illustrated in Fig. 8, and require a pull of several times their own weight to separate them.

To test the slip gauges or similar very accurately lapped surfaces, use is made of an optical flat such as that shown in Fig. 9. By bringing the flat surface to be tested in contact with one side of the optical flat and looking through the other, straight coloured lines or "interference bands" as they are termed, will be observed if the flat under test is accurate, but if worn or damaged the bands will appear irregular and dark patches will be seen. The optical flat is guaranteed to be accurate to one fivemillionth part of an inch.

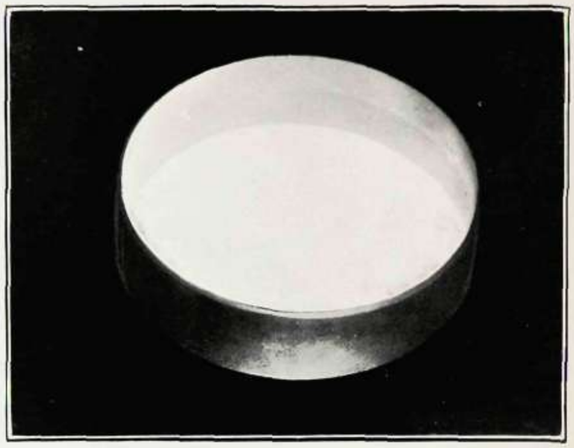


Fig. 9—The Optical Flat

As already mentioned, each degree of accuracy requires another more accurate in order to make a test, so that to test the optical flat use is made of the interferometer, a highly sensitive instrument which enables light rays, from the surface under test, to be reflected in colours on to a screen. As each colour denotes a known dimension, surfaces of the highest degree of accuracy can thus be measured.

Voice Frequency Keysending

FOR dealing with calls between manual exchanges the " order wire " method has become firmly established on account of its simplicity, both in apparatus and operating procedure. A group of junctions connecting two manual exchanges are, at their outgoing end, multiplied over the suite of " A " positions in one exchange and terminated at the other exchange on the plugs of a " B " position. Each " A " position is provided with an order wire button which, when pressed, connects the " A " operator's telephone to the " B " operator's telephone, via one of the junctions allotted for the purpose and known as the " order wire." The " A " operator gives the number of the required subscriber and is then informed by the " B " operator of the number of the junction over which the call is to be extended. The " A " operator connects the calling subscriber to the assigned junction which is, in turn, connected to the wanted subscriber by the " B " operator.

With the advent of automatic exchanges certain difficulties arose in applying such a simple method to the handling of manual to auto calls. The dialling of the wanted subscriber's number by the " B " operator would considerably lengthen the operating time for each call, with the result that, if calls were not to be unduly delayed, a greater number of " B " operators would be required, thereby increasing operating costs. The solution of the difficulty was found in providing the " B " operators with a means that required less time than a dial to actuate the automatic apparatus. The " key sending " system was, therefore, designed and the " B " operator was provided with a strip of 10 keys on which she tapped out the required number. Special equipment—the sender—received the signals from the keys, translated them into " dial " impulses and sent them out to the automatic exchange apparatus. Thus, while the sender was completing a call, the " B " operator was free to attend to other calls.

The next development aimed at the elimination of the order wire and was known as the " straight forward junction " system. In this the " A " operator selects the junction to be used for the call and plugs into it. This action causes the " junction terminating " relay set at the automatic exchange to associate itself with a free " B " operator and a free sender, by means of an " outlet " relay set equipped with searching switches of the rotary type. The " A " operator is advised by a " pip-pip " signal, consisting of two short applications of N.U. tone received over the junction, that the " B " operator is connected to the line. The " B " operator takes the demand, keys-up the number required and is then released from the junction, this being the only part she plays in the setting up of a call. The sender is released and made available for another call immediately it has finished impulsing out. The control and clearing down of the call is in the hands of the " A " operator.

It was recognised that if the digit keys were placed at the " A " position and the " B " operator eliminated, several obvious advantages would accrue. The early attempts to accomplish this made use of order wires to send the key signals from the " A " positions to the senders at the automatic exchange. This arrangement, while giving the advantages expected, proved to be clumsy and lacking in general flexibility.

It was then realized that the use of separate order wires for passing signals might be avoided by using key signals consisting of alternating currents, having frequencies within the voice range, and which could be passed over the junction.

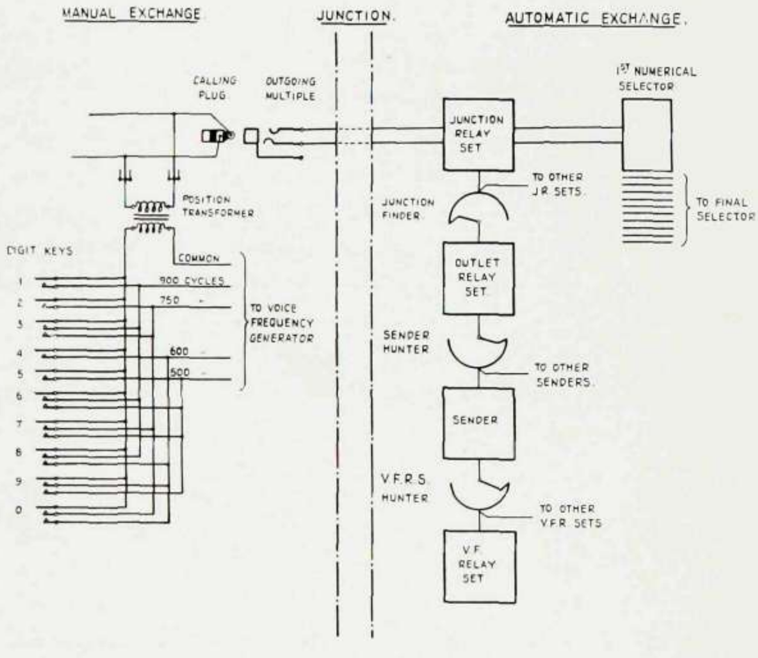
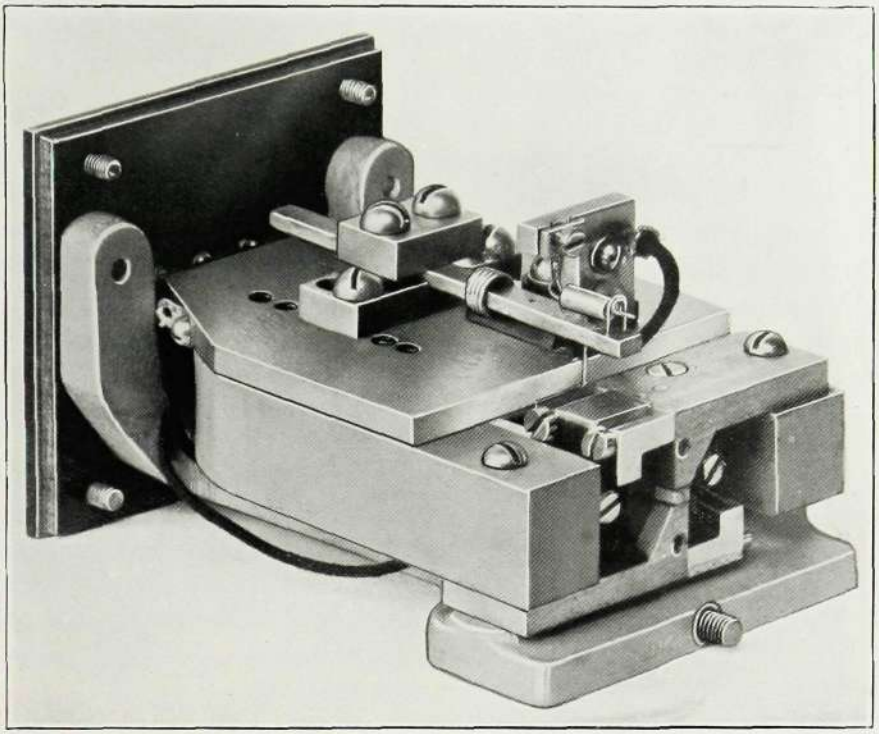


Fig. 1—Schematic Diagram of Voice Frequency Keysending

A system using voice frequencies for calling and supervisory signalling over trunk lines already existed and its principles were applied to the straight forward junction system. The only modification to the "A" positions at the manual exchange consists of the provision of a source of supply for voice frequency currents, its connection to a strip of keys on each "A" position and some slight modification to the cord circuits. At the automatic exchange the "B" operator is replaced by an apparatus unit known as the "Voice Frequency" Relay Set. Four frequencies, 900, 750, 600 and 500 cycles per second, are used and these are arranged to be sent from the keys in coded combinations to give the signals for 10 digits. Each digit is allotted one or two of the frequencies so that the depression of, say, digit key 8 will connect the 900 and 600 frequencies to the junction. False signals due to interference by actual speaking currents are avoided by arranging the circuits so that, before signalling is commenced, a signal of three frequencies is sent to the automatic exchange, this has the effect of restoring the receiving apparatus to normal.

The "A" operator selects and plugs into a junction, thereby causing the junction relay set to connect a sender and, instead of a "B" operator, a voice frequency relay set to the junction. Upon receipt of the "pip-pip" signal, indicating that the voice frequency equipment is connected, the "A" operator keys-up the required number and the voice frequency signals are passed over the selected junction. They are received by four special relays mounted in the voice frequency relay set. These relays are unlike the usual automatic telephone relay for the armature is connected to a metal reed tuned to the frequency to which the relay is required to respond. The contacts of the relays take the form of a light weight supported by wire links, one of which is connected to the reed. The vibration of the reed, when the correct frequency is applied to the coil of the relay, disturbs the links and causes their contact resistance to increase thereby removing a short circuit from an auxiliary relay connected across them.

matic equipment. Manual control of the call is from the "A" operator's position.



Courtesy of Standard Telephones & Cables Ltd., London.

Fig. 2—A Voice Frequency Relay

The four auxiliary relays connect signals to the sender identical to those it would have received if the number had been keyed-up on a "B" position. The sender translates these into "dial" impulses. The junction relay set remains in service during the call but the voice frequency relay set is released, and may be taken into use for another call immediately the last signal is sent to the sender which, in turn, releases after the last impulse is sent to the auto-

A number of Post Office exchanges in the London area have been equipped with this system, where it has proved extremely successful, observation results indicating a much improved service to that obtained under the "B" position conditions.

Fig. 1 depicts, diagrammatically, the disposition of the apparatus units employed in the setting up of a call, and Fig. 2 shows a Voice Frequency Relay.

The 3,000 Type Relay

SINCE the early days of automatic telephony the facilities demanded of an automatic telephone exchange have increased considerably, and in consequence, telephone circuit design has become more complex, and the conditions imposed upon the switching apparatus have become more severe. These two facts have necessitated the adoption of the very soundest of principles in the design of both the circuits and the apparatus, and developments in these two directions have gone hand in hand to ensure good telephone service.

The British Post Office engineers have had considerable experience of the performance of all types of circuits and designs of apparatus under service conditions, and during recent years this knowledge has resulted in the adoption of certain "standards" which are now specified for use on all automatic exchange contracts. The majority of the switching functions in the more recent exchanges are performed by equipment of uniform design, each of which represents the best all round solution of its particular mechanical and electrical problem when all factors are considered.

The latest and most important apparatus component to be standardized is the telephone relay. One design of relay, known as the 3,000 type, has been adopted for use in all the main switching circuits and incorporates the best features of previous well known designs. In addition it has certain new features which are particular to itself.

The responsibility of choosing a design for so important a component as a telephone relay is indeed a great one, and this fact will be readily appreciated when one bears in mind that a director exchange may contain as many as 120,000 relays, and that 1,500 contact operations may be involved in completing a call.

It is not, however, on account of quantities alone that the relay must be considered important, but primarily because of the precision of performance expected of it in many cases. The circuit designer is often forced to take full advantage of the possibilities of the relay, demanding controlled operate and non-operate current figures or close hold and release; in addition, definite time sequences must be guaranteed, involving operate and release lags controlled between fixed limits. Moreover, the contact carrying capacity of the relay must not be too limited or the number of necessary "relief" relays will be seriously increased.

These and many other considerations affect the choice of a relay design, and a nice balance must be obtained between reasonable initial cost and easy maintenance. This latter requirement is of vital importance, not only on account of low costs but also because it is so very closely allied to good maintenance.

In the design of the 3,000 type relay the maintenance aspect has received very careful consideration, and the method of adjustment and test has been laid out on a straightforward mechanical basis.

Details of Relay. Fig. 1.

Magnetic Circuit. In considering the features of the 3,000 type relay it will be noticed that the magnetic circuit is made up of three items, coil, yoke and armature, the

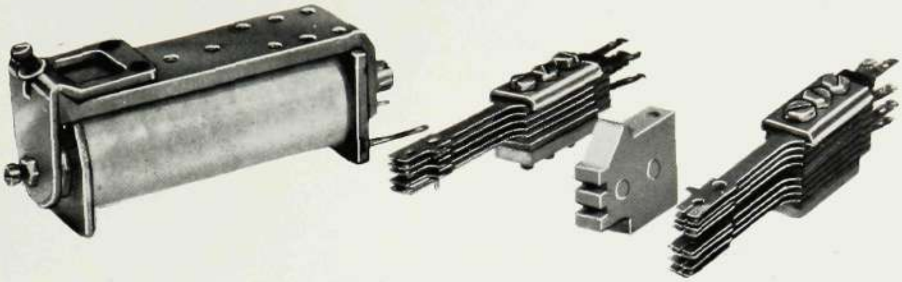


Fig. 1—Components of the 3,000 Type Relay

latter being suspended on the yoke in the familiar knife edge manner. This magnetic system is highly efficient and is further improved by increasing the core cross-section at the armature end by a disc of soft iron, and by the use of nickel finish on all parts.

Such a magnetic circuit is a sound foundation upon which to build a relay design, for high magnetic efficiency offers the possibility of good contact pressures, consistent time lags, economy in current consumption and minimum flux leakage to adjacent relays.

The cheek at the armature end of the winding assembly is made of copper and serves to reduce parasitic armature oscillation. This feature contributes to a reduction of contact bounce on release of the relay. In certain particular instances, however, e.g. impulsing relays, the fitting of this metal cheek is not desirable and the usual bakelite cheek is fitted instead.

The bobbin can be fitted with 5 connecting tags, thus allowing the relay to carry several windings depending upon the number of " common " points permissible in any particular circuit.

In order to limit the dust collecting area of the springs, the relay is designed for side mounting, consequently a means of holding the armature in position when current is not flowing has been arranged. This takes the form of a spring washer, kept in position by the armature retaining screw which passes through a clearance hole in the armature and screws into the yoke. When screwed home this arrangement applies a small but sufficient pressure on the armature to ensure a correct location on the knife edge.

Depending upon the particular circuit requirements, armatures with fixed studs or adjustable screws are used, the stud lengths having nominal values of 4 mils. 12 mils and 20 mils.

Spring Set. Fig. 1.

The contact springs are of nickel silver and are split at the free end in such a manner that two independent tips are formed, each of which carries a contact. The moving springs are controlled by brass pins which project through a hole in the spring below, the pins being set centrally between the two contacts thus ensuring equal pressure on both contact points. Silver contacts are used for light current circuits but selector magnets etc. are controlled by platinum. The springs forming a contact unit are clamped together by means of one screw, while two screws are used to fix the contact assembly to the yoke.

Contact assemblies are fixed one on each side of the buffer block, the latter occupying a central position on the yoke (Fig. 2).

conform to definite tension limits, and tests to confirm these adjustments are made by direct measurements on the springs

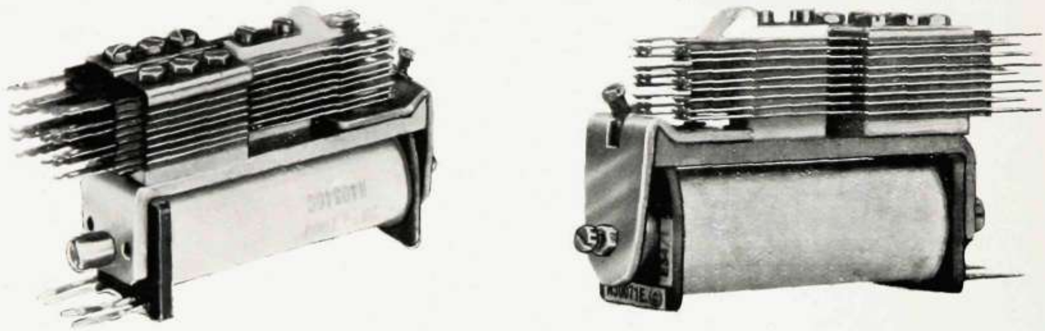


Fig. 2—Two Views of a Typical 3,000 Type Relay

themselves. Electrical tests normally have no place in confirming the existence of correct mechanical adjustment.

This method of adjustment has advantages over any method which uses "gauging" to ensure a certain minimum travel after two springs have made contact, for in the latter case, as the control of the tension is indirect, it is impossible to control tension variations as closely as might be desired. With a buffered spring, however, spring tensions are set directly, and variations in spring thickness do not prevent a small tolerance on a nominal figure from being guaranteed.

The procedure for the adjustment of the relay is firstly to set the residual and travel within the specified limits, measurements being made by means of a feeler gauge. All the buffered springs are then tensioned against the buffer block to a certain figure and each lever spring is tensioned until its associated back spring is just moved away from the buffer block. This latter movement is not measured as it is only necessary to ensure that the contact pressure is something in excess of the pressure

Buffer Block (Fig. 1).

The buffer block is made of a resinous compound and is moulded to form a number of steps, which in conjunction with a lug on each fixed spring provide a means of controlling minimum contact pressures irrespective of the travel of the moving springs. The block is white in colour and in addition to acting as a background to facilitate the observation of spring movements during adjustment, it also serves to a certain extent as a protection for the relay springs when a relay-set cover is being removed.

Several sizes of block have been standardized to cover the requirements of any combination of spring units, the smallest size accommodating three springs on each side while the largest allows nine springs on each side. This maximum is limited by the requirement of mounting two relays, side by side on a standard selector mounting plate.

Method of Adjustment.

As previously mentioned, the adjustment of the 3,000 type relay is on a mechanical basis, that is, the springs are adjusted to previously applied between the back spring and the buffer block.

All lever springs are tensioned to definite limits against the lever spring below or the armature itself, thus ensuring a uniform load on the relay and avoiding clearance between stud and pin.

The physical tolerances on the component parts of the relay and the tolerances on each nominal adjustment are such, that if the relay springs are reasonably straight the contact opening is always a safe figure, and the front springs are lifted clear of the buffer block by their associated lever springs.

A test current is finally applied to the relay as an overall operate test to confirm that the relay is up to specification as a complete unit.

By using this standard method of adjustment it is possible to adjust and maintain, without reference to individual relay adjustment cards, all relays which do not have difficult circuit conditions to fulfil.

All standard adjustments are given in a general specification and can be readily memorized ; but residual lengths may vary between one relay code and another without making a relay "non-standard," so to cover this point the required residual length is shown on the label at the bottom of the relay coil cheek (Fig. 2). Further, when a definite sequence of action exists between contacts on a relay, a longer travel is necessary, and to emphasize this the label is marked "X"—early action—or "Y"—late action—as the case may be. These sequences are arranged in the build up of the relay and are not obtained by the bending of springs.

All relays, therefore, equipped with standard 14 mil springs and requiring standard adjustments carry a white label on the coil cheek, and this label in conjunction with a knowledge of the general adjustment specification, constitutes a particular mechanical specification for that relay.

When a relay carries a green label, it indicates that 12 mil springs are equipped and the relay must therefore be adjusted to figures given in the general specification applicable to springs of this thickness.

In cases where a relay must operate over a long junction line or satisfy some difficult circuit condition, it is generally necessary to control the functions of the relay between close current limits, and in such instances it is not possible to produce the required adjustment by working to the general specification only. A red label in place of the white or green is used therefore to indicate that the relay requires some special attention, and a study of the individual relay adjustment card must be made before re-adjustment is commenced.

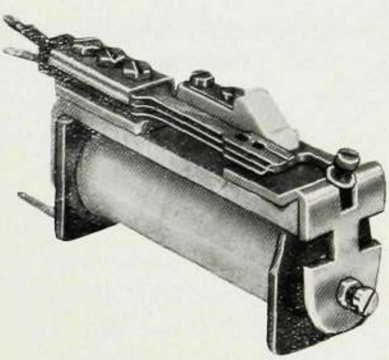


Fig. 3—Relay with Isthmus Armature

Impulsing Relays. (*Fig.* 3).

Relays which have to respond to dial or other trains of impulses are fitted with a special type of armature which is made in such a way as to form an isthmus shaped link between the core and yoke. This degradation of the magnetic circuit, by causing saturation at a lower flux value, makes for more constant release lags when the relay has to work over lines of varying length.

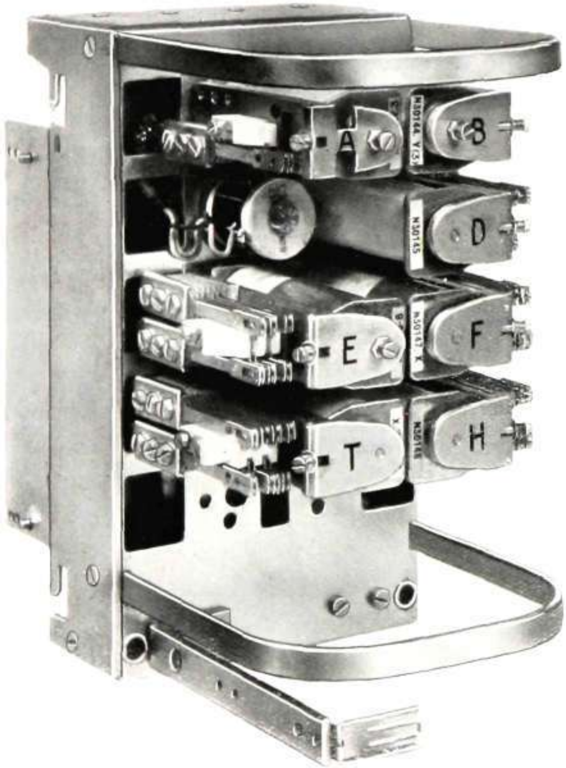


Fig. 4—Typical Relay Mounting Equipped with 3,000 Type Relays

Impulsing relays forming part of a transmission circuit, or any relays similarly situated, have three nickel iron sleeves fitted over the core before the winding is put on. This produces a coil which has high impedance to speech currents without affecting to any marked extent its sensitivity on direct current.

Slugged relays for use in impulsing and other circuit elements are catered for, and various sizes of slug are available for either fore-end or heel-end purposes to meet the requirements of various circuit timing conditions.

From the foregoing comments it will be appreciated that the 3,000 type relay has been designed on very sound lines, particularly in respect to minimum contact pressures of approximately 20 grammes, twin contacts, and straightforward methods of adjustment. Sound design and high standards of production guarantee equipment that gives trouble-free service for practically unlimited periods.

The New Post Office Subscribers' Meter

IN conformity with the policy of standardization pursued by the British Post Office, a new design of subscribers' meter has been evolved. In this model, advantages of existing types have been retained and close attention has been given to economy in maintenance by the use of a minimum number of wearing parts. Another outstanding feature is its compactness, resulting in a saving in both space and weight.

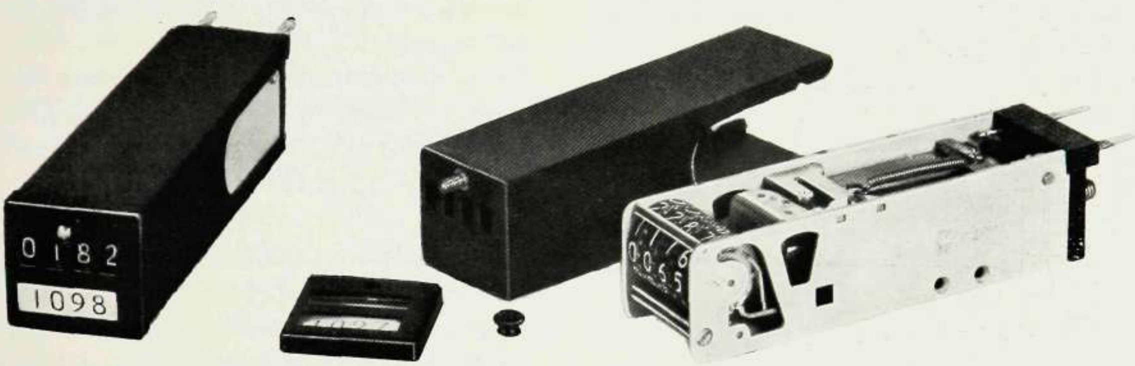


Fig. 1—The Meter Complete, and also with Cover and Label Cap Removed

The overall size of the meter and the display face have been kept to a minimum consistent with reasonably legible figuring for the counter, and space for the subscriber's number or other identification matter. Its compactness has been made possible by the arrangement of the armature which is pivoted towards the rear of the meter and lies parallel to the axis of the coil.

The armature is electro-magnetically operated, and during its movement, the pawl, which is pivoted on the forward end of the armature, slips over one tooth of the ratchet wheel without moving the number drums. Breaking the current allows the spring loaded armature to return, and the pawl which has dropped into engagement with the ratchet wheel carries the latter forward one-tenth of a revolution. The "units" drum is secured to the ratchet wheel and advances with it. At the end of a revolution a tenth position notch in the "units" drum engages with a tooth on the first intermediate pinion which is also in mesh with the teeth on the "tens" drum. The movement given to the pinion by the "units" drum advances the "tens" drum one tenth of a revolution, and the subsequent drums are similarly operated. The counter registers a total of 9999. No provision is made for restoring the counter to zero.

A long box cover with an aperture to display the counter encloses the meter, and a detachable cap, in which is housed the label and celastoid window, is secured to the front. This may be clearly seen from Fig. 1.

A pair of contacts mounted on the frame which "make" on the operation of the meter can be fitted when required.

Details of the components forming the magnetic circuit will be readily followed from Fig. 2.

The armature has a knife-edge pivot and is held in position by a helical spring. Residual studs are fitted on the underside of the armature to prevent sticking and to take the impact when the latter is attracted. The armature bearing is formed by a plate mounted on the yoke or heel piece. This plate is capable of adjustment for aligning the armature in the frame and correctly spacing the secondary air gap. An extension on the plate provides the anchorage for the helical armature spring.

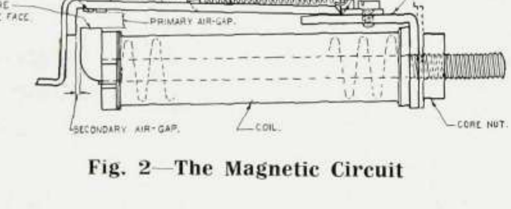


Fig. 2—The Magnetic Circuit

The front end of the core turns upwards at right-angles to form the pole face. The front cheek is of moulded insulating material and has a spigot on each side which registers in slots in the frame to position the coil. Moulded in the cheek is a recess which forms ledges to act as rests or buffers for the local contact springs. A circular nut clamps the coil and yoke to the frame. The ends of the windings are brought out to a tag block attached to the heel end of the frame.

The actuation of the number drums is illustrated in Fig. 3. The ratchet, having ten teeth, is keyed and riveted to the " units " drum. The pawl is pivoted on an angular-shaped plate secured to the reciprocating end of the armature. An extension on this plate acts as a stop to prevent forward movement of the ratchet when the armature is in an unoperated position. On operation, the armature withdraws this extension so that the ratchet wheel may be stepped round. A wire spring keeps the pawl lightly pressed against the ratchet wheel.

An " L " shaped plate, the vertical part of which is slightly bent at the top, forms the pawl, and edges on the underside of the horizontal part constitute the pivot.

Movement of the " units " drum in a backward direction is prevented by a detent, which is a leaf spring with facilities for adjustment in relation to the ratchet teeth. The detent also exerts a backward pressure on the ratchet wheel to lock it against the tip of the pawl.

The back-stop against which the armature rests when the meter is unoperated, is shaped to allow of adjustment by bending. This adjustment is essential for positioning the units drum in relation to the viewing aperture in the cover. Raising or lowering this stop advances or reverses the units drum.

The tag block to which the ends of the windings, and, when fitted, the leads from the contact springs are brought out, is of moulded insulating material. A projecting portion, across the width of the rear face, engages with a slot in the mounting plate to position the meter and prevent rotation.

As previously mentioned local controls may be fitted. These are mounted singly on opposite sides of the frame and each has a short limb turning inwards so that the contact points come opposite each other. The contacts are " made " at the end of the downward movement of the armature when the meter is operated. An appreciable movement is obtained at the contact points notwithstanding the shortness of the inward limbs. This is accomplished by the special shape of the springs. As can be seen from Fig. 4, the point where the limbs bend inwards is curved and tensioned

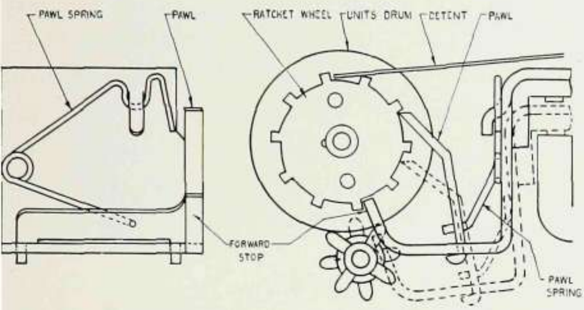


Fig. 3—The Action of the Number Drums, Armature, Pawl, Ratchet and Detent

to rest against the side of the frame to form a pivot about which the limbs can rock.

The number drums are die-castings of tin-antimony alloy running on highly polished steel spindles. The absence of spindles for the pawl and armature eliminates the possibility of shake in their bearings. The long stroke of the armature allows an ample margin on the pawl movement.

This meter will operate reliably at 320 impulses per minute and can be adjusted

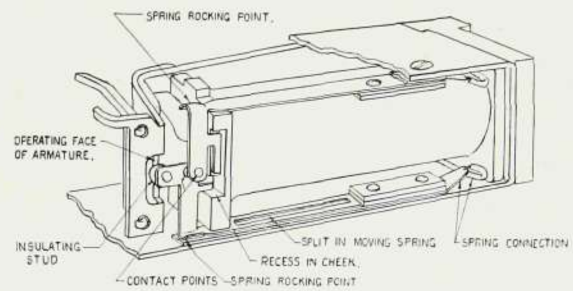


Fig. 4—How the Local Contacts are Arranged

for marginal operation with a difference of 4 m.A. A 500Ω meter will operate on 25 m.A., so that the speed of operation, sensitivity and low current required are features which are outstandingly good and provide an all-round performance considerably in advance of previous types.

Vibratory Tone and Ringing Supply Generators for Small Telephone Exchanges

FOR many years past the vibratory tone generating set has been proving itself a convenient and reliable means of generating the alternating current supply used for signalling purposes on small telephone exchanges. Recently the demand for this type of equipment has shewn a marked increase, due largely to a much wider field of application. To meet these new conditions we have drawn on our many years of manufacturing experience with this equipment, and have developed a completely new tone and ringing supply unit, the ideal of which is to afford a high electrical performance within the minimum of space, together with long life and negligible maintenance attention.

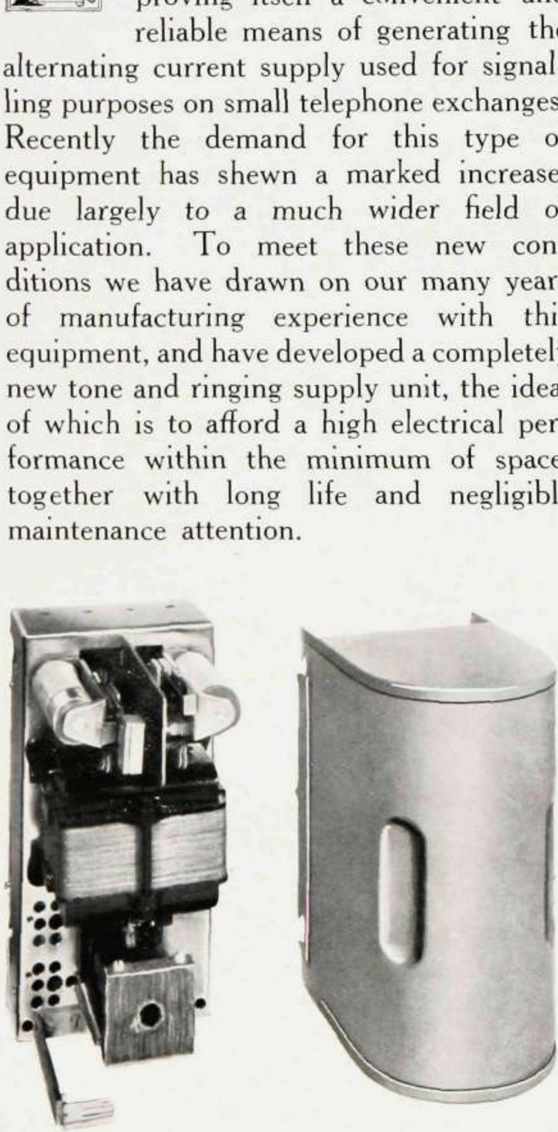


Fig. 1—A Vibratory Tone and Ringing Supply Generator Unit complete with Cover

The complete unit is illustrated in Fig. 1 and consists of two independent alternating current generating systems mounted side by side but separated by a screening plate to prevent mutual interference. The low frequency generator output (20∼) is used for providing the A.C. power necessary to operate the subscribers' bells, and affords low frequency tones, while the high frequency output (400∼) produces the well-known high pitched tone used to indicate engaged conditions on telephone networks.

In principle the general operation of the unit remains as in former types, but the improvements mentioned are due to the following modifications :— (*a*) new method of exciting the reeds, (*b*) changed values of the electrical components, and (*c*) new layout. These have resulted in the following desirable features being gained in addition to those already mentioned :—

- i. Less mechanical noise
- ii. Good operation when tilted to an angle of 20° in the most adverse direction
- iii. Slightly increased electrical output
- iv. Greater accessibility.

Dealing with the design of the 20∼ generator first ; all springs, including the ribbed and weighted reed armature, are mounted in one spring pile — a form of assembly which, apart from being very neat in appearance, considerably facilitates assembly and adjustment. This system of springs is energised directly from a slugged electromagnet via an adjustable pole face (see Fig. 2). The copper slug in conjunction with the ribbed reed ensures a good starting torque on low input volts, and yet keeps the amplitude within bounds when the supply volts are really high. The success of this device is illustrated by the fact, that with a driving contact pressure of 40 grams, a voltage range of 18-40 volts can be negotiated safely on a

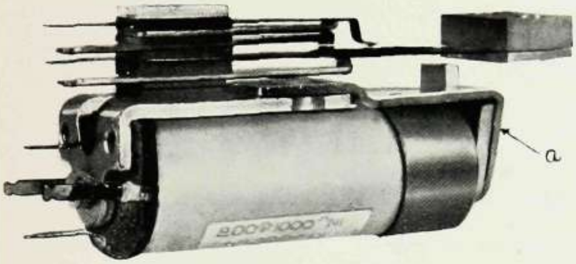


Fig. 2—The 20∼ Ringing Generator

24-volt equipment. A refinement which has been retained from the old design is the choke in the transformer feed circuit; this definitely reduces to negligible proportions any noise likely to be occasioned on the telephone system due to heavy loads on the unit, particularly when operating on an old battery.

The re-designed transformer gives a smoother voltage regulation than previously with an output of 2 watts at 40 v. R.M.S.—a greater output is not desirable since any excess over and above that which is really required produces an appreciable reduction in the life of the tungsten switching contacts.

The 400∼ tone generator consists of a free steel reed of correct frequency mounted on a rigid base and energised by an electromagnet the inductance of which is matched to the reed frequency. Fig. 3 indicates the arrangement. The chief features of the mechanical design are: (1) rigid construction, (2) forward location of drive contact, (3) good magnetic circuit.

The solidity of the whole assembly is due to the linking of the fore and rear ends of the mechanical system by a bridging member of non-magnetic material (*a* in Figs. 2 and 3). This results in a positive location between reed to poleface, and reed to drive contact, under all operating conditions, hence promoting an exceptionally stable reed movement.

This bridging member also forms a convenient forward mounting for the interrupter contact, the dimensions and location of which are most important in the interests of good tone. The best arrangement of this contact assembly entails the use of a short and flexible contact lever of high natural frequency which will exert only a very low damping action on the main reed. The present scheme takes advantage of these considerations, resulting in a contact follow of approximately .005″ being obtained, in contrast to the more usual value of .0015″, and accounts for the fact that much less attention to the contact adjustment is necessary in order to compensate for

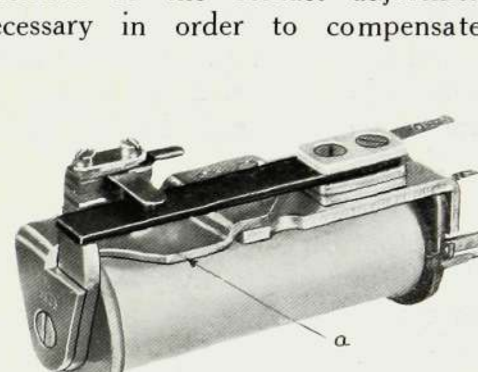


Fig. 3—The 400∼ Tone Generator

contact destruction. A further point is, that due to the lightness and flexibility of the contact spring, the tone from the relay remains unaffected by the development of contact wear.

The magnetic circuit is entirely closed except for the small contact gap between reed and poleface, thus directly reducing to a minimum the amount of electrical power controlled by the drive contact and resulting in a considerably reduced rate of contact destruction for a given output. The positive pole of the contact is of tungsten, a material which offers exceptional resistence to burning and which, moreover, will not build up on to the negative contact and cause breakdown by fouling the contact opening.

The output of the 400~ supply is capable of supplying 8 busy connections simultaneously.

Large numbers of the new unit are now in use throughout this country and have proved themselves to be completely satisfactory, in particular, the high degree of reliability aimed at has been achieved.

The layout of the complete unit is arranged with a view to giving a maximum of protection to the components, while at the same time maintaining good accessibility. The only tools necessary for adjustment are a small screwdriver and a pair of the usual type of spring adjusting pliers. For telephone work the whole is enclosed in a pressed steel cover, and jacks in along with the other exchange equipment.

Up to the present these sets are supplied for operation on supply voltages of 24 and 50 only, but other input voltages and output ratings can be arranged for as occasion demands.

A schematic diagram of the connections of the complete unit is shown in Fig. 4.

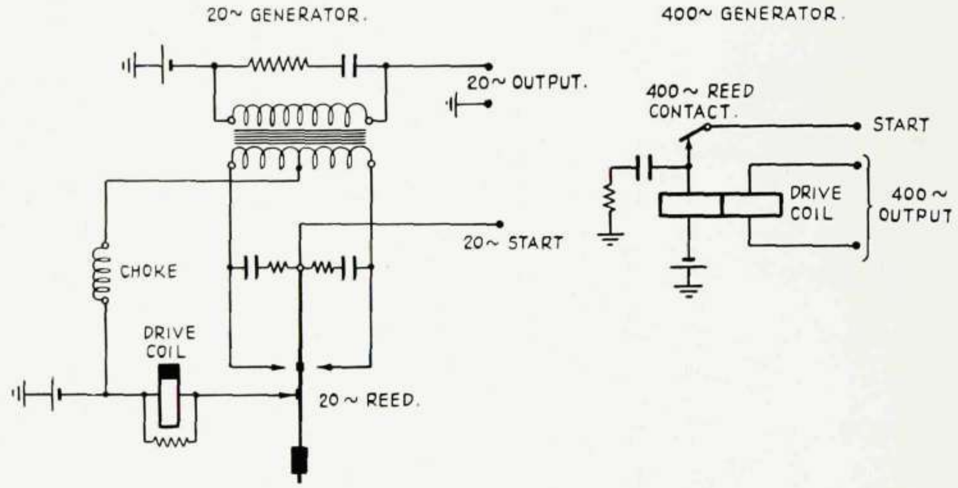


Fig. 4—Diagram of the Ringing Supply and Vibratory Tone Generators