

The Ericsson Bulletin

No. 8

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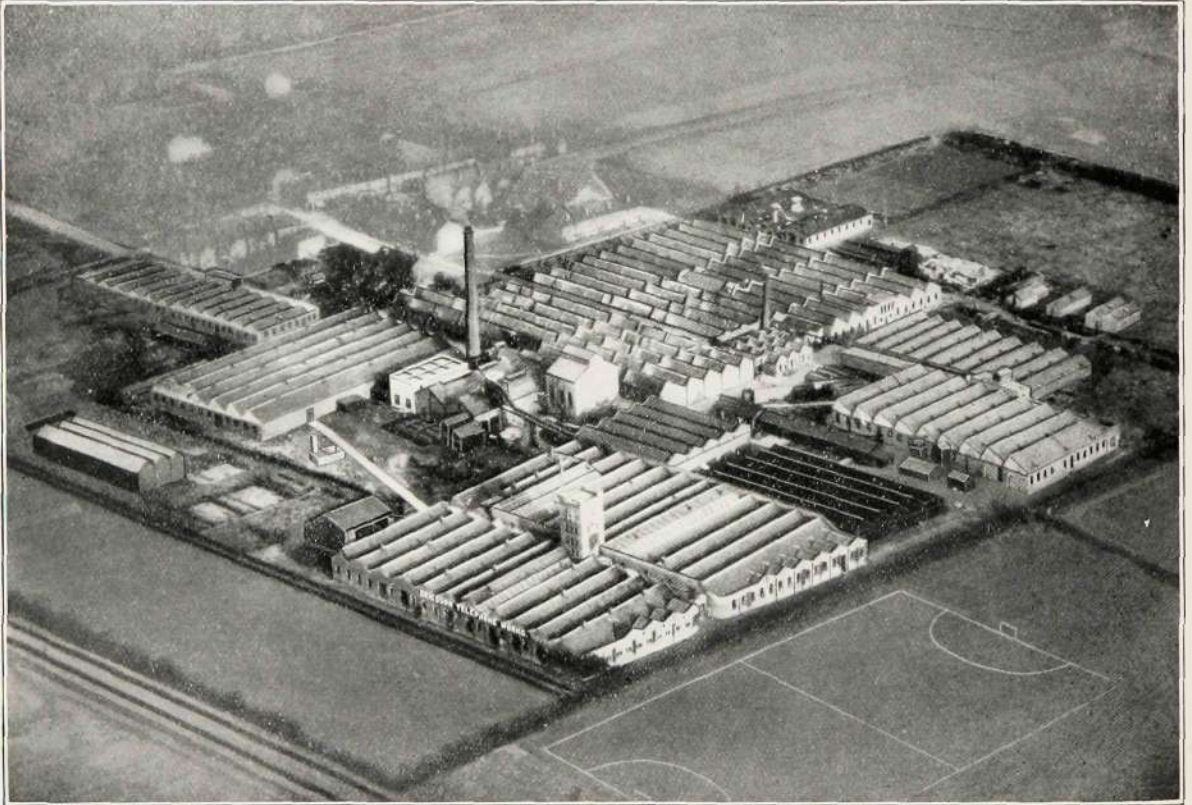


TELEPHONE WORKS,
BEESTON, NOTTINGHAM

Telephones : Beeston 54225 (3 Lines)


Head Office : 67/73, KINGSWAY, LONDON, W.C. 2

Telephones : Holborn 3271 (3 Lines)



Aerial View of the Works, Beeston, Nottingham

P.A.B.X's for New Zealand

 DURING the past year Ericsson's have received several orders for P.A.B.X. equipments from New Zealand, that zealous supporter of Empire trade. The size of these installations varies from 35 to 70 lines, but in a few cases the first switching level has been utilized and thus provides for an ultimate of 80 lines. The operation and circuit features conform to British Post Office standard practice except in one or two particulars outlined below.

The class of service given on all equipments is the "attended in" and "automatic out" with local automatic intercommunication. This service provides for the following:—

- (a) Automatic intercommunication of subscribers connected to the P.A.B.X.
- (b) Outgoing calls to the public automatic exchange set up automatically by dialling 'O' followed by the wanted subscriber's directory number.
- (c) Incoming calls from the public exchange completed via an attendant at the P.A.B.X.

Dialling 'O' to reach the public exchange is one of the variations from British Post Office practice, the latter requiring the digit "9" for this service. Digit "9" on these installations is the one dialled by subscribers requiring the manual attendant. The P.A.B.X. subscribers, or "extensions" as they are usually termed, are given two-digit numbers ranging from 20 to 88. The number "89" is reserved for testing purposes.

By means of a simple strapping arrangement any extension can be debarred direct access to the public exchange. Should a subscriber so restricted dial "O", the call would be routed to the manual attendant who could extend it to the public exchange under her own supervision.

The exchange lines are arranged for bothway working and night switching. With the latter arrangement certain predetermined extension lines can be connected directly to particular exchange junction circuits at night time, thus giving them, during the periods when the P.A.B.X. manual board is not staffed, all the facilities enjoyed by a subscriber on the public exchange.

It is worthy of note that the method employed for night switching is another departure from British Post Office standard practice, and it has proved a very satisfactory solution. For this purpose the dial key in the exchange line circuit is made a three position one, the key being thrown downwards for dialling and upwards for night switching. In the upward position the predetermined extension is connected straight through to the exchange junction circuit and both the exchange line and extension concerned are "busied" to calls from the connectors. As a result of these modifications the cord circuits are not used in connection with night switching, and the keys therein, usually employed for this purpose, are eliminated.

One of the difficulties encountered at the outset, originating from the existence of two types of public exchange equipment in New Zealand, was that some of these

boards had to function in conjunction with the standard British Post Office dial, numbered 1 to 0 in an anti-clockwise direction, and others with a dial numbered 9 to 0, also in an anti-clockwise direction. Thus on exchanges using the latter type of dial, if the digit "1" is dialled the equipment will actually receive 9 impulses.

In order to avoid differences in the equipment in use on the P.A.B.X's, varying with the type of dial employed, a cross-connection field between the line terminals and the connector outlets is introduced. Thus on boards using the British Post Office dial the line terminals are cross-connected to the connector outlets in a "straight" manner, viz. 20-20, 21-21 etc. to 89-89; whilst on the boards using the "reverse" dial the line terminals are

cross-connected to the connector outlets in the following manner:—

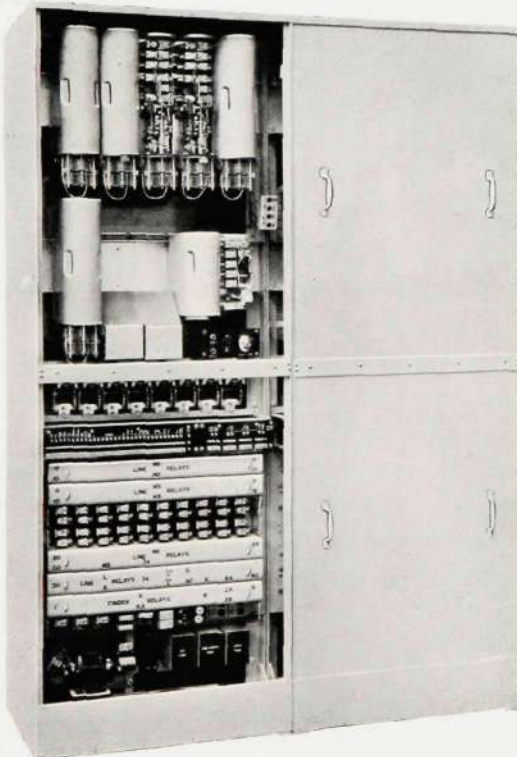
20-80; 21-89; 22-88	to 29-81
30-70; 31-79; 32-78	to 39-71
40-60; 41-69; 42-68	to 49-61
50-50; 51-59; 52-58	to 59-51
60-40; 61-49; 62-48	to 69-41
70-30; 71-39; 72-38	to 79-31
80-20; 81-29; 82-28	to 89-21

A typical instance of the sequence of operations on an installation using "reverse" type dials would perhaps make the arrangement more clear.

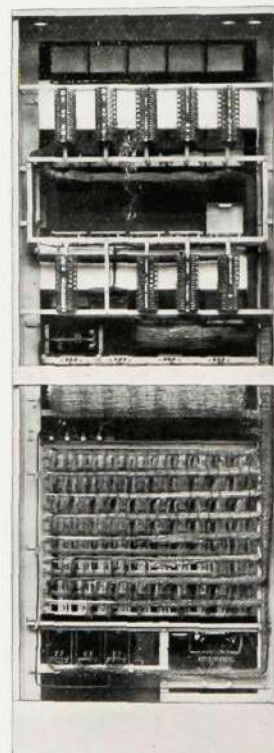
Assuming a subscriber dials "31", then the connector receives impulses equivalent to "79" from the standard dial. According to the table above connector outlet "79" is cross-connected to the line terminal "31"; thus the transposition is made and the right subscriber rung.

Having dealt with the special operating features connected with these boards, a brief description of the two main components, namely, the Auto Unit and the Manual Board, may be of interest.

The Auto Unit, as can be seen from the typical illustrations, is totally enclosed in a sheet iron cabinet with lift out doors at



Front of two Auto-Units fitted together, with one set of doors removed

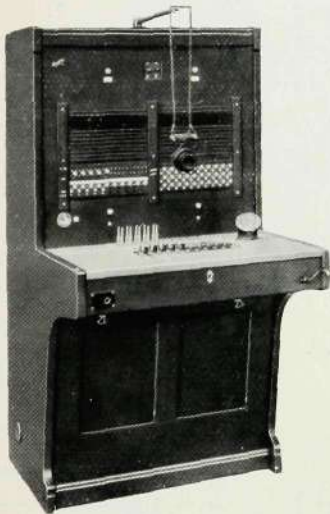


Rear view of Single Unit P.A.B.X's.

front and rear. When an exchange comprises two units, they are fitted side by side on site, and bolted together after the adjoining sheet iron sides are removed to permit of direct cabling between them.

The unit is complete with all the necessary switching equipment, fuse panels, alarm relays, cross-connecting field and also a small "jack-in" type ringing dynamotor with associated control gear and tone equipment.

The switching equipment comprises uni-selectors as line finders and two-motion switches of the 100 outlet type as connectors. All relays used are of the latest Post Office standard, "3,000" type, incorporating twin contacts, and the relay groups are fitted with dust-proof covers.



The manual switchboard

features of the board is the suspended transmitter, which is of a type standardized by the Customer for this class of installation.

The manual board is of the floor pattern type and of oak construction. The plugshelf and keyshelf are covered with red fibre to prevent scratching and chipping. The keyshelf is arranged to provide writing space for the attendant. One

of the special

Lamps are employed throughout for both calling and supervision. "Through" clearing is not used.

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 "0" calls.

The apparatus for the cord circuits and exchange lines is mounted on a small hinged gate at the rear of the board. The fuse panel is also mounted at the rear and is arranged so that if a fuse blows the circuit affected is automatically "busied."

This article would not be complete without a word about the packing of these boards; a feature of utmost importance when one considers that they are to be conveyed a distance of approximately 12,000 miles, representing a seven weeks sea voyage. It is a great compliment to our shipping department that we have not had any serious complaint of damage from New Zealand in connection with these orders.

The packing crates consist of $1\frac{1}{4}$ " tongued and grooved timber with 8 " x $1\frac{1}{4}$ " "pin ends." Each crate is bound all round by three sets of hooped battens 8 " x $1\frac{1}{4}$ ", pitched at suitable distances. On the inside of the case there is a "Pluvex" lining and then five inches of wood wool upholstery all round. The boards therefore are embraced in a "cushion" and are thus effectively protected from damage by vibration or jar.

In conclusion, it should be mentioned that the working voltage is fifty.

New Bakelite Telephones

IN designing a modern telephone instrument several important points must be taken into consideration. It must have a high standard of electrical efficiency both in volume and purity of speech, a pleasing outward appearance combined with rigid construction, and, for reasons of economy, simplicity in maintenance and adjustment. The most effective combination of these qualities has been the ultimate aim of the Ericsson Company, whose wide experience in this section of telephone engineering has resulted in the production of new bakelite table and wall telephones.

These instruments which are introduced as alternatives to the bakelite telephones described in Bulletin No. 4, are intended for use with either automatic or central battery exchanges, and facilities are provided for easy conversion from one system to the other. Figs. 1 and 2 show the instruments equipped with a dial for automatic working. When required for central battery working the dial is replaced by a dial blank as shown in Figs. 3 and 4.

The importance of standardization and interchangeability with respect to stocking and maintenance facilities has been closely



Fig. 1—Automatic Table Telephone



Fig. 3—C.B. Table Telephone



Fig. 2—Automatic Wall Telephone



Fig. 4—C.B. Wall Telephone

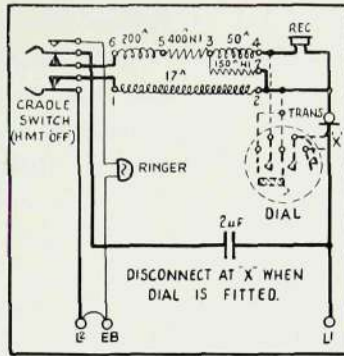
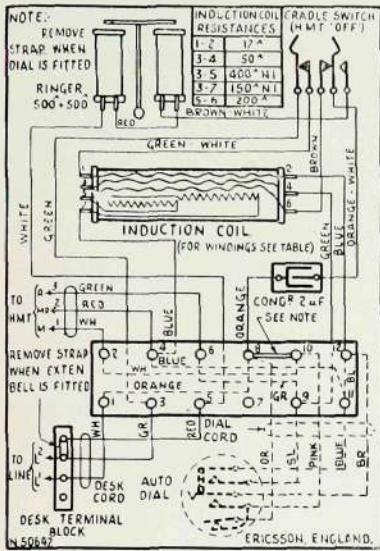


Fig. 5—The circuit of the instruments in explanatory and wiring form.
Wall Sets, omit terminal block and cord; C.B. Sets, omit dial wiring

considered, and in this connection the following standard British Post Office apparatus has been incorporated :

- Dial Auto. No. 10 F.A.
- Bell No. 59A.
- Bell Gongs No. 2.
- Coil induction No. 22.
- Condenser M.C. No. 102.
- Cradle springset, Tele. 162 Type.

At the first glance it would appear almost impossible to house the above apparatus conveniently in so small a space presented by the unique design of the casework, but a specially designed bracket arrangement of unit construction has made it possible to use not only standard British Post Office components but to mount them in such a manner that there is adequate spacing throughout. Moreover, these components, with the addition of the hand-micro-telephone, are fully interchangeable on both the table and wall instruments.

Fig. 5 shows the circuit of the table instrument in explanatory and wiring form. The connections of the wall instrument are essentially the same with the exception of

the desk terminal block and cord which are not fitted.

A high standard of transmission, reception and side tone reduction is assured by the use of the modern type of induction coil, whilst other features are undistorted dial impulsing, and disconnection of the bell during dialling and speaking. Conversion from central battery to automatic working may be easily carried out by adding a dial and dial cord, and removing

a metal strap fitted on the terminal block. Provision is made for the connection of an extension bell, and on the table instrument an extra conductor is included in the cord for this purpose.

The moulded bakelite body of both instruments follows the same distinctive lines as the intercommunication telephones with exchange facilities described in Bulletin No. 5. The improved type of cradle is a noteworthy feature and is designed to withstand extremely rough treatment. The cradle is formed by a recess in the upper portion of the body moulding ; this recess is shaped to support the handset and guide it into position even when carelessly replaced. Two chromium plated plungers operate the switch movement, and these are specially shaped to reduce friction and prevent sticking troubles.

The Table Telephone N1020

Accessibility is a characteristic feature of this instrument and has been obtained by mounting all the internal components on a separate frame, forming a unit which can be easily detached or replaced.

The frame, which is made from nickel plated metal, carries the ringer and switch on the upper side, and the bell domes,

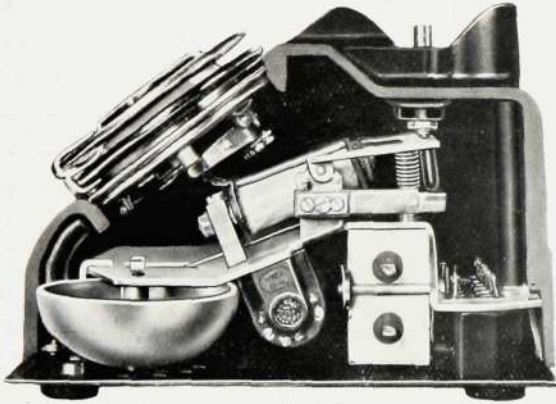


Fig. 6—Sectional view of an Auto Table Telephone

induction coil, condenser and terminal block underneath. Extreme care has been taken in positioning this apparatus in order that each component may be removed without disturbing any other. A sectional view showing the unit fitted inside the case is shown in Fig. 6. The unit is held in position by three screws, and after removing the baseplate, which is secured by a single captive screw, these screws are exposed so that by loosening two and removing the third the unit can be withdrawn bodily from the case, as shown in Fig. 7.

The main features of the ringer are simplicity in construction, ease of adjustment and high sensitivity. The polarizing mag-

net is of cobalt steel. One end forms a bearing for the armature with hammer stem and the other end is clamped into the yoke by a single screw. If necessary, adjustment to the armature can be made by loosening this screw and sliding the magnet in or out of the yoke. By rotating the domes, their relative position can also be adjusted since the fixing hole in each is drilled slightly out of centre. Each coil has two soldering tags fitted in one of the bakelite end cheeks and the resistance of each winding is 500 ohms, making the total resistance of the ringer 1000 ohms, i.e. with the coils connected in series.

The induction coil has five windings and embodies the latest anti-side-tone developments. The bobbin consists of a bakelized paper tube fitted with moulded bakelite end cheeks. The tube is packed with soft iron core wire. Seven soldering tags are provided on the cheeks for making the external connections to the various windings.

The moulded hand micro-telephone, described in Bulletin No. 4, is the same as fitted on the N1010 type of instrument, and is now too well known to warrant any further description. A recent development, however, is the improved transmitter inset which, in addition to the advantages of being repairable, having a robust construction and a suitability for use under tropical and semi-tropical conditions, now



Fig 7—Automatic Table Telephone with apparatus unit removed

has a higher efficiency as regards volume, articulation and freedom from frying. The resistance has been made sufficiently low to enable it to be used on both central battery and local battery circuits, giving standard efficiency under either condition.

The connecting block is of moulded bakelite and has 12 terminals with screws on one side for external or cord connections, and tags on the other side for the internal soldered connections. The end of the block protrudes through the outer case and is shaped to form an inlet for the hand-micro and desk cords, the ends of which are securely held inside the set by a bakelite clamping block, thus preventing any strain on the conductors.

The Wall Telephone N1070

Although somewhat different in construction from the table set, the wall set embodies the same components and retains the same facilities for maintenance and adjustment. The bakelite case is hinged to the back-plate and, when the set is fitted to the wall, the case can be swung downwards by loosening a single captive screw situated behind the handset grip. Thus any necessary adjustments to the ringer, switch etc., can be carried out from a position directly in front of the instrument. Fig. 8 shows the instrument with the case opened for inspection.

As in the table set, a form of unit construction has been employed and all the

internal components are mounted on a flat nickel plated metal plate which is clamped to the back-plate by means of three screws.

Slotted fixing holes enable the unit to be completely withdrawn by loosening these screws. The metal back-plate, which is black enamelled, has three fixing holes enabling the instrument to be screwed to the wall; these holes are recessed so that, when fitted in position, the back of the instrument is spaced about $\frac{3}{16}$ " from the surface of the wall.

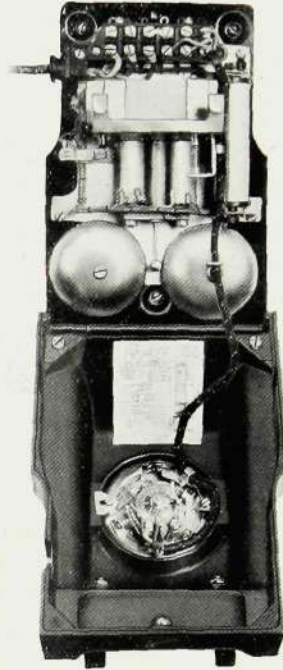


Fig. 8—Automatic Wall Telephone, open for inspection

For use in tropical climates and where protection against damage by insects and moisture is required both the table and wall instruments can be furnished with a special non-corrosive finish on the metal parts, impregnated coil windings and suitably constructed cords, making them specially adapted for use under adverse climatic conditions.

Chromium and Cadmium Plating



THESE comparatively young members of the group of electro-deposited finishes have been the subject of much discussion and experiment since their large scale application in recent years. Chromium and Cadmium plate each hold a firmly established position in industry, now that their properties and limitations are more widely known. The former is the decorative stainless finish par-excellence, while the latter is held in high esteem for the protection of ironwork where prevention of rust is the predominant function required.

Chromium Plate

The attractive and lustrous appearance of chromium plate is familiar to all. Extreme hardness combined with non-tarnishing properties under severe conditions are the main characteristics of the deposited metal.

It was first deposited, as far as is known, by Bunsen in 1854. Since then, the perfection of the process and methods used are examples of painstaking attention to minute detail. Only during recent years have developments resulted in processes being available to industry which are fairly simple and reliable in operation. From this time, however, the rate of expansion has been phenomenal.

Chromium plating practice differs in several respects from that used for metals such as nickel, copper, zinc, etc. It has not been found possible to obtain anodes of chromium or chromium alloy which will maintain the strength of the electrolyte to a reasonable degree. Consequently, inert plates, usually of lead, are used for this

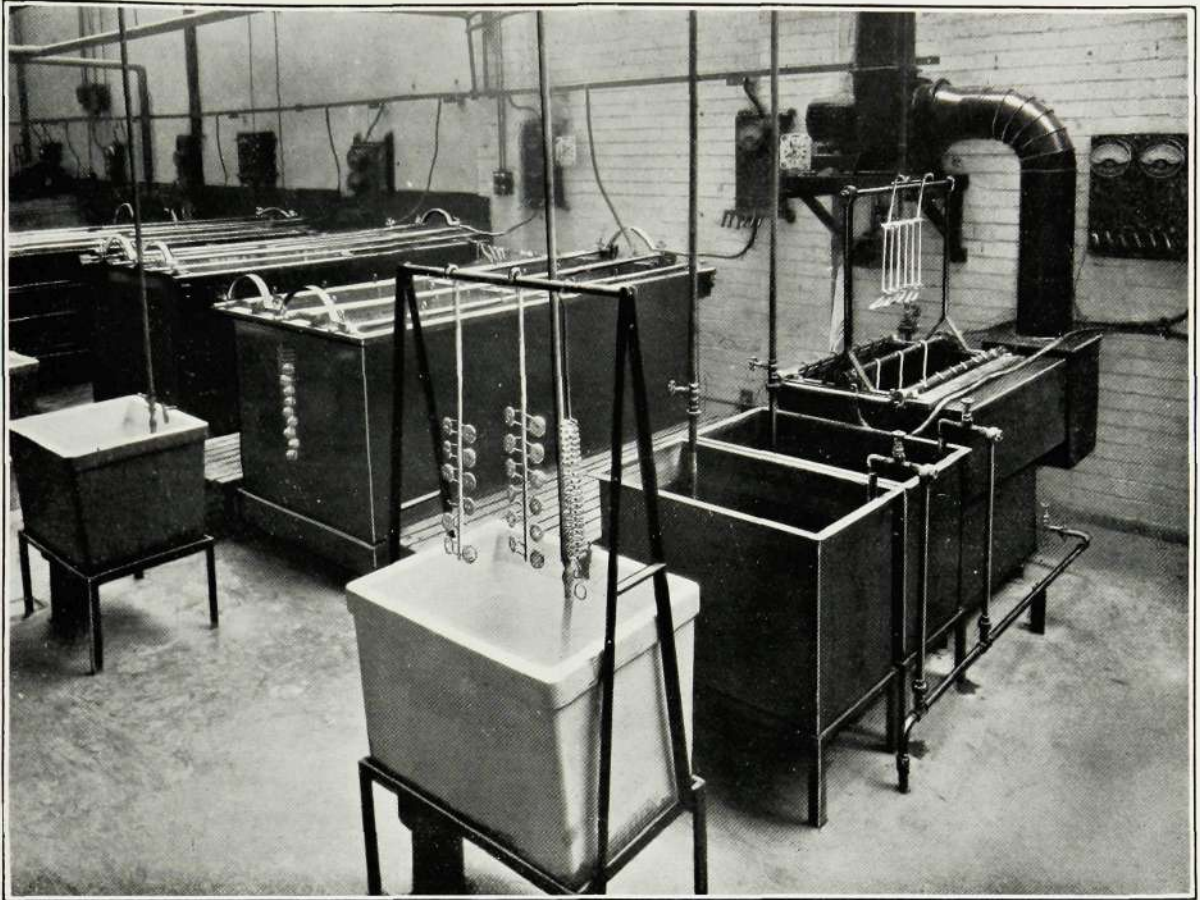
purpose. The electrolyte consists of a strong solution of chromic acid which contains a small proportion of sulphate. This may be introduced as sulphuric acid, and an accurately maintained proportion is necessary to yield the best deposits.

The solution is worked warm, at 90° Fah. to 100° Fah. Here again conditions are critical and close control must be maintained. High current densities in the order of 60 to 80 amperes per square foot at $2\frac{1}{2}$ volts are required for plating. This means that provision must be made for an ample supply of current with heavy connections. In practice parts to be plated are not suspended with the usual thin copper wires, special jigs of heavy gauge brass strip being designed to suit the various individual parts. The chromium deposited is drawn entirely from the chromic acid solution which needs replenishing with this chemical from time to time.

Chromic acid is a dangerous and highly corrosive chemical. In addition, the liquid is evolved as a fine spray during plating because of the large amount of gas liberated from the cathode. Consequently, vats are specially constructed, being fitted with fans and exhaust ducts which remove and condense the dangerous fumes.

It is necessary to comply with stringent Home Office regulations which ensure that the operators are adequately protected from contact with the liquid.

While chromium itself is quite stainless, a chromium deposit alone gives little or no protection to base metals against corrosion. This is because the deposits can be



Chromium and Cadmium Plating Equipment. Note the Cadmium Ball Anodes in cage hung at end of vat

penetrated by corrosive atmospheres, and rust develops below the plated surface. To overcome this, the articles are first heavily nickel plated, and finally treated in the chromium vat. Most of the original failures were due to lack of knowledge on this point.

When bright deposits are desired, the nickel plate is polished prior to chromium plating. The latter deposit, under these circumstances, is bright when deposited and needs little or no final treatment.

Lack of throwing power is at present the chief difficulty which confronts the chromium plater. By this is meant, that,

it is very difficult to deposit the metal in narrow recesses or in the interior of deep articles. Improvement in this respect is being gradually obtained as the technique of the process is more widely appreciated. In some instances, parts are being altered in design, so that shapes are simpler and therefore more suitable for the deposit.

In the telephone industry, the wide application of moulded instruments has decreased the demand for decorative plated parts. Were it not for this fact, chromium plate would undoubtedly be one of the most important of finishes. Nevertheless, the Ericsson Company has taken every opportunity to utilise the finish wherever

plated external instrument parts are demanded. These include intercommunication set fittings such as plates, push buttons, etc. certain auto dial parts, and a variety of equipment used on time recording clocks or similar apparatus. Users will no doubt appreciate the refinement.

Cadmium Plate

This element is a member of the group of metals which are anodic or electro-positive to iron. Extremely thin deposited films give excellent protection against rust even under severe conditions. This is because chemical corrosion is diverted by the minute potential which develops at the point of attack, between the cadmium and the exposed basic metal.

The generally accepted standards for deposit thicknesses to give good rust resistance to iron under adverse conditions are approximately,

Nickel	..	.001"
Zinc	..	.0005"
Cadmium	..	.0003"

For this reason the last named is finding its most important application in the finishing of accurately machined parts of mechanisms where minimum alteration to dimensions is desirable.

The high cost of Cadmium is one of the main reasons for the limited use of the electro deposit. As far as the actual plating process is concerned, little difficulty is presented. Cyanide solutions are generally used with anodes of the metal itself. These usually take the form of cast balls, suspended in iron cages, so that they may be used up entirely with practically no waste. The deposit is silver in colour, possessing an attractive appearance when

polished or scratch-brushed. The appearance of parts as they leave the vat is, however, inclined to be rather greyish. This is removed by a rapid dip in dilute acid.

In practice it has generally been found that deposits of cadmium tend to discolour, unsightly dark stains developing after extended periods. While this is no actual disadvantage from the point of view of rust protection, the effect has been to retard the utilisation of the finish. The effect can be largely overcome, however, by coating the surface with a thin film of mineral wax, from a suitable solution.

A number of concerns are employing cadmium plate as an undercoat, prior to the nickel plating of iron. It is claimed that the rust-proof quality of this finish is superior to that of nickel alone. Recent extensive tests by the American Electroplaters Society and other authorities tend to discount this, and evidently it is desirable that further investigations should be carried out regarding this point.

Other users have found that even when cadmium deposits are removed by wear, a definitely improved resistance to rust remains. This is explained by the theory that the cadmium alloys slightly with the iron surface. Designers are taking advantage of this feature by using the finish for cams and gears which are subject to wear.

At the present time, cadmium plate is not used to any great extent in the telephone industry. Where the properties outlined are found to be of advantage, however, the finish is being used with good results. Continued experiment with this deposit and patient observation of results will no doubt amply repay those who continue to investigate the possibilities in this field.

Telephone Traffic and Trunking

With Application to a Typical Exchange



TRUNKING is the name given to that branch of automatic telephony which deals with the estimation and provision of sufficient apparatus to carry the traffic of an exchange, and with the arrangement of that apparatus in the most economical manner, so that the traffic is routed most efficiently and with the minimum of inconvenience to the subscriber. It will be apparent that the subject covers a very large field, and that it will only be possible to touch the fringe of this field within the confines of a short article.

For the purpose of trunking calculations, the traffic originated by telephone subscribers is usually supposed to vary in accordance with pure chance, it being assumed that the subscribers originate calls in a perfectly haphazard manner with relation to one another; that is to say, each call is as likely to originate at one moment as another, without reference to the number of calls already being carried by the exchange. Although this assumption is not strictly true unless the total number of subscribers is infinitely large compared with the number actually making calls, it is reasonably true when applied to most practical cases, since the proportion of the total subscribers actually using their telephones at one time is usually very small.

In every exchange there occurs what is known as the "busy hour", this being the hour during which the greatest number of calls is originated. A typical variation in the number of calls in progress during a portion of the busy hour in an exchange is indicated in Figure 1.

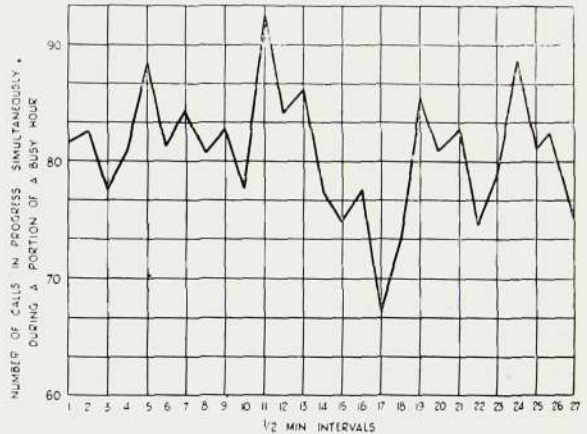


Fig. 1—Typical variation of number of calls in progress during busy hour

It must also be remembered that in addition to this moment-to-moment variation of the number of calls in progress during the busy hour, the total number of calls made during that hour varies from day to day, much greater demands being made on the exchange on some days than on others. Figure 2 illustrates a typical day-to-day busy hour variation of calls in a medium sized automatic exchange. Sunday traffic is omitted as this is usually very light.

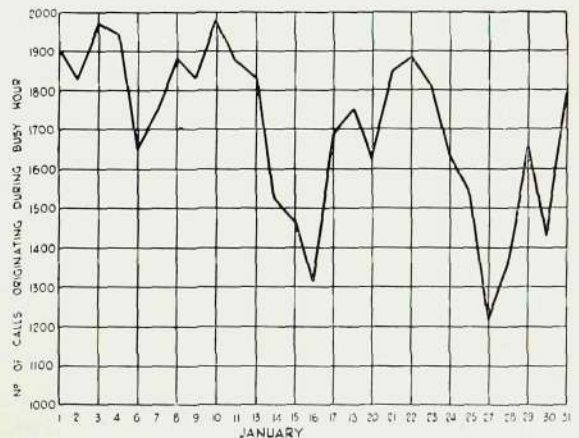


Fig. 2—Typical day-to-day busy hour variation of calls

When considering the provision of equipment for any given exchange, it is obviously

uneconomical to provide apparatus to cater for the demand during the busiest of all the busy hours, or even for the busiest period during any one busy hour; there would be too many switches standing idle during the more lightly loaded periods to allow of such an arrangement being a commercial proposition. It is necessary to average out the traffic over a large number of busy hours and work on the figures thus obtained. Of course, this means that there will be a number of lost calls during the very busy periods, due to insufficiency of apparatus, but this will be offset by the very good service given in the more lightly loaded periods.

In order to ensure that subscribers are given the best possible service consistent with economical working, the British Post Office provides switching equipment so that on an average not more than one call out of every 500 in the busy hour shall be lost *at each switching stage* due to insufficiency of apparatus, with the proviso that the loss shall not be more than 1 in 100 if the traffic increases by 10 per cent. With the object of avoiding frequent changes in the existing plant, it is usual to allow the grade of service to deteriorate to one lost call in 200 before adding further equipment; when this point is reached apparatus is installed in sufficient quantity to raise the grade of service to 1 in 1000.

It is not the purpose here to examine the many theories which have been evolved to determine the traffic capacity of numbers of switches in various arrangements. It may be stated, however, that all calculations are based upon an arbitrary traffic unit (T.U.) which, taking perhaps the broadest definition, consists of one circuit being occupied for one hour. This is, of course, the same as two circuits each occupied for half an hour, or twenty circuits each occupied for three minutes, and so on. It is therefore

possible to calculate the traffic carried by an exchange by taking into account the calling rate and the average holding time, while somewhat more detailed calculations will give the traffic units at any stage in the exchange.

Several investigators have produced formulæ to determine the traffic capacity of switches, and although these formulæ differ on account of the different assumptions made, they are found to agree remarkably closely when applied to practical numerical cases. Of these formulæ those of Erlang are considered to apply most nearly to the conditions met with in practice by the British Post Office.

Under "full availability" conditions, that is to say when each of the sources in one group has access to each and every trunk to another group, Erlang's theory states that :- If A is the traffic offered (in traffic units) B the grade of service (or proportion of lost calls), and N the number of trunks, then :-

$$B = \frac{A^N}{N!} \div \left(1 + A + \frac{A^2}{2!} + \frac{A^3}{3!} + \dots + \frac{A^N}{N!} \right)$$

where $N! = N(N - 1)(N - 2) \dots 3.2.1$.

The formula as given above is in the most convenient form for determining the grade of service which will be given for any traffic and any number of trunks; it is clear, however, that the formula can be easily manipulated, so that with a fixed grade of service the number of trunks necessary to carry a given traffic can be found.

A comprehensive series of tables and curves has been prepared by the British Post Office from trunking formulæ, and as soon as the traffic at any stage in an exchange has been determined, these tables may be consulted to determine the number of switches required.

It may be noted that, under full availability conditions, with a grade of service of

one lost call in 500, a group of ten trunks will carry 3.43 T.U. while a group of twenty trunks will carry 10.07 T.U. The average traffic per trunk in the first case is 0.343 T.U. and in the second case 0.504 T.U. This shows that one large group of trunks is more efficient than the same number split up into several small and isolated groups, a result which is confirmed by practical observations.

The quantity of equipment required at any stage in an exchange depends on several factors, the two most important being those already mentioned, that is to say, the traffic to be carried, and the grade of service which is to be given; factors of lesser importance are the nature of the traffic, the way in which it may be grouped, and the number of outlets from the switches.

That a gain in efficiency is obtained by keeping trunks in as large groups as possible has already been shown above. Where it is not possible to allow each switch in one switching stage to reach each switch in the next switching stage, on account of there being insufficient bank contacts, the process known as grading is resorted to. This permits some of the outgoing trunks being made available to two or more groups of outlets. With normal grades of service on full availability groups, the later trunks to be tested carry a very small proportion of the total traffic offered to the group, while the earlier choices are comparatively heavily loaded. The table below gives approximate

Number of Trunk	Traffic Carried
1	0.75 T.U.
2	0.66 T.U.
3	0.55 T.U.
4	0.42 T.U.
5	0.29 T.U.
6	0.174 T.U.
7	0.09 T.U.
8	0.04 T.U.
9	0.016 T.U.
10	0.005 T.U.

values of the traffic carried per trunk in a full availability group of ten trunks, when three traffic units are offered to the group; the trunks are numbered in the order in which they are tested. When grading is employed, therefore, it is

always the later choices which are made available to two or more groups; the number of groups served by one trunk is gradually increased towards the end of the grading. Arranging the commoning in this way clearly tends to even up the traffic on the outgoing trunks, since the later choices carry the sum of the traffic from a gradually increasing number of groups.

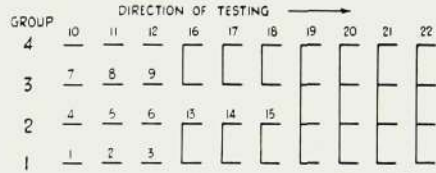


Fig. 3—4-Group, 10-contact grading with 22 trunks

In Figure 3 the horizontal lines represent the outlets from the four groups as indicated on the left of the figure, while the vertical lines represent commoning between corresponding outlets in the groups. Trunks to the next rank of switches are taken from the numbered outlets. It will be seen that each group has access to three individual trunks; the next three trunks are common to pairs of groups, while the last four trunks are common to all four groups.

Erlang's approximate formula for graded groups is as follows:— $B = \left(\frac{A}{N}\right)^k$

Where B , A and N each have the same significance as under full availability conditions, while " k " corresponds to the number of outgoing trunks which can be tested by one group and is known as "the availability of the grading". This formula applies theoretically only when A and N are very large, and it is necessary to make some modification to cover normal working conditions. It will be seen that the average traffic per trunk, using the formula as it stands, can be expressed as:— $\frac{A}{N} = B^{1/k}$

Two general types of traffic will now be considered, known respectively as "pure

chance" and "smooth" traffic. Pure chance traffic has already been described, and may be taken as the type of traffic which is fed from subscribers' uniselectors to 1st selectors. After the 1st selectors have been passed, the traffic is to some extent smoothed out, an attempt being made in the connections between 1st and 2nd selectors to even up the traffic on the 2nd selectors. Traffic such as that passing from 1st selectors to 2nd selectors is therefore known as smooth traffic. Each type of traffic requires different treatment from the trunking point of view, as follows:—

In determining the traffic capacity of a grading with smooth traffic, the traffic capacity of a full availability group of the same availability as the grading is first determined. To this is added the average traffic per trunk arrived at as above i.e.

$\frac{A}{N} = B^{1/k}$, multiplied by the number of trunks in excess of " k " in the grading. Suppose that it is required to find the traffic capacity of a grading with 15 trunks and an availability of $k = 10$ (i.e. each switch can test 10 trunks) for a grade of service of 1 in 500 (i.e. $B = .002$). The traffic capacity of a full availability group of 10 trunks, as mentioned previously, = 3.43 T.U.

Average traffic per trunk beyond 10 is

$$\frac{A}{N} = B^{1/k} = .002^{1/10} = .537 \text{ T.U.}$$

Traffic capacity of grading:—

$$3.43 + 5 \times .537 = 6.115 \text{ T.U.}$$

This method gives results agreeing remarkably closely with practical observations.

For pure chance traffic on a grading, a somewhat different method of procedure is adopted. Again the traffic capacity of a similar full availability group is determined, and from this figure the average traffic per trunk in the full availability group is calculated; the theoretical average traffic per

trunk in the graded group is also found from

$$\frac{A}{N} = B^{1/k}.$$

Each trunk in the grading is now supposed to be carrying the full availability average traffic, while all trunks beyond ' k ' are assumed to carry, in addition, 53% of the difference between the graded and full availability average traffics. The figure of 53% has been established by means of actual practical tests.

As an example, take a grading with 75 trunks and an availability of 20 (i.e. each switch can test 20 trunks) and assume a grade of service of 1 in 500 (i.e. $B = .002$). The traffic capacity of a full availability group of 20 trunks, as mentioned previously, is 10.07 T.U.

Average full availability traffic per trunk is therefore $10.07 \div 20 = .504$ T.U.

Theoretical average graded traffic per trunk,

$$\frac{A}{N} = B^{1/k} = .002^{1/20} = .733 \text{ T.U.}$$

Difference between full availability and graded average traffics:— $.733 - .504 = .229$ T.U. and 53% of .229 T.U. = .121 T.U.

The total traffic capacity then becomes:— 75 trunks at a full availability figure of .504 T.U. = 37.8 T.U., add $(75 - 20) = 55$ trunks of .121 T.U. = 6.655 T.U. making a total of 44.455 T.U.

Special tables and charts have been prepared to facilitate the estimation of equipment required to carry the traffic from graded groups.

Example of an actual exchange.

The exchange to be considered is one of 700 lines, 680 of which are ordinary lines and the other 20 P.B.X. lines. It is to replace an exchange of 620 ordinary and 11 P.B.X. lines, for which all busy hour particulars are known, and it is assumed that the traffic will increase in proportion to the increase in lines.

When estimating the apparatus required for a new exchange, it is usual to allow for 3 years development in the provision of switches, and 4 years development in the provision of banks, on the principle that it is much more difficult to add banks to existing equipment than to add switches. The figures which follow may be taken as representative of the number of switches required to cover the three years period. Bank quantities will not be calculated, as it is sufficient for our purpose to assume these to be provided 10% in excess of the switches.

The number of calls from the ordinary subscribers on the old exchange during the busy hour was 1600, and the number from the P.B.X. subscribers 110; the average holding time in each case was 1.8 minutes. Thus the figures for the new exchange become:—

$$\begin{aligned} \text{Local Traffic (ordinary)} &= \frac{680}{620} \times 1600 \times \frac{1.8}{60} = 52.7 \text{ T.U. } (1) \\ \text{Local Traffic (P.B.X.)} &= \frac{20}{11} \times 110 \times \frac{1.8}{60} = 6.0 \text{ T.U. } (2) \end{aligned}$$

The outgoing junction traffic for the old exchange was equivalent to 150 calls of 1.3 minutes duration, giving for the new installation:—

$$\text{O/G Junction Traffic} = \frac{700}{631} \times 150 \times \frac{1.3}{60} = 3.61 \text{ T.U. } (3)$$

The total trunk traffic was 19 calls of 6 minutes duration, and this was assumed to be shared equally between incoming and out-going trunks. For the new exchange:—

$$\frac{1}{2} \times \frac{700}{631} \times 19 \times \frac{6}{60} = 1.06 \text{ T.U. } \dots (4)$$

The following figures are obtained in a similar manner.

$$\begin{aligned} \text{Enquiries} &= 0.5 \text{ T.U. } \dots (5) \\ \text{Test and complaints} &= 0.39 \text{ T.U. } \dots (6) \\ \text{I/C Junctions} &= 3.85 \text{ T.U. } \dots (7) \end{aligned}$$

Traffic handled by line finders is the sum of (1) to (6) = 64.26 T.U.

It is decided to group the lines in four

groups of 175 lines each, as this gives a uniform arrangement of finders for each group and is actually found to be more economical in switches.

$$\text{Traffic per 175 line group, } \frac{64.26}{4} = 16.07 \text{ T.U.}$$

From tables:—

$$\begin{aligned} \text{Primary Finders per group} &= 30 \\ \text{,, ,, Direct} &= 14 \\ \text{,, ,, Indirect} &= 16 \end{aligned}$$

Traffic carried by 14 direct primary finders per group (from tables) = 11.95 T.U.

Thus, overflow traffic per group = 4.12 T.U.

$$\begin{aligned} \text{No. of secondary groups required} &= \\ &= \frac{\text{Number of indirect outlets} + \text{proportion of spare contacts}}{\text{Number of contacts on secondary switch,}} \end{aligned}$$

A reasonable proportion of spare contacts is taken as 16. Then number of secondary

$$\text{groups required } \frac{(4 \times 16) + 16}{50} = 2.$$

Total overflow traffic:— $4 \times 4.12 = 16.48$ T.U. This (from tables) requires 2 groups of 15 Secondary Finders.

No. of 1st selectors required = 4 groups of 14 (direct) + 2 of 15 (via secondaries) = 86.

Traffic to Level "O"

$$\begin{aligned} \text{Trunks} + \text{Enquiries} + \text{Test and Complaints} &= (4) + (5) + (6) = 1.95 \text{ T.U.} \\ \text{Number of circuits required} &= 8. \end{aligned}$$

Traffic to Manual Board 1st Selectors.

I/C Trunk Calls = 1.06 T.U. and enquiries reversed, say .25 T.U., making a total of 1.31 T.U. which requires 6 switches.

Final Selectors.

$$\text{Terminating traffic} = (1) + (2) + (4) + (7) = 63.61 \text{ T.U.}$$

Assume this to be divided over ordinary and P.B.X. groups in the same ratio as the local originating traffic which is (1) + (2).

Then traffic to P.B.X. final selectors is

$$\frac{6}{58.7} \times 63.61 = 6.5 \text{ T.U.}$$

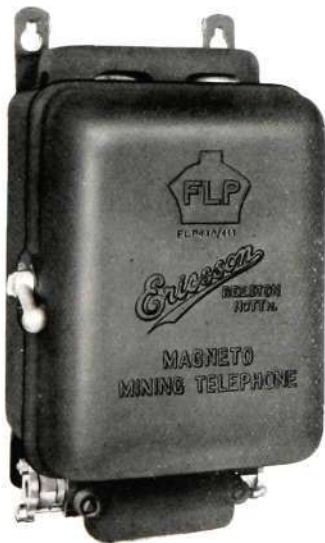
Total traffic to remaining 680 lines:—

$$(63.6 - 6.5) = 57.1 \text{ T.U.}$$

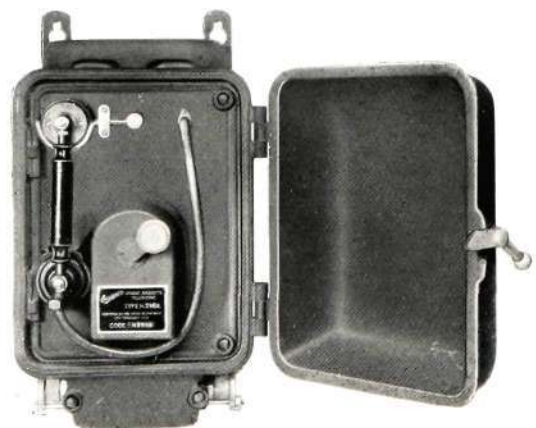
New Ericsson Mining Magneto Telephones

SINCE the article on "Mining Telephones, Switchboards and Apparatus" appeared (The Ericsson Bulletin, No. 3, July 1933), three new types of certified magneto telephones have been evolved. The two most important of these, Types N2974 and N2984, in addition to being "intrinsically safe" are also "flameproof." These two instruments supersede the "intrinsically safe" Types N2972 & N2982. The opportunity has been taken to include in the new production, apart from the flameproof feature, all the improvements that experience has shown could be effected.

and locating springs keep it securely held when not in use. The switch-hook operates through a flameproof bearing and actuates the transmitter and line circuit contacts by cam action. The N2984 type has the receivers on swing-out arms, the action of lifting the arms bringing the transmitter mouthpiece into the speaking position, and at the same time by special flameproof mechanism operating the switch contacts. This instrument has a solid-back type replaceable inset transmitter of the N7742A type, which has an extremely good frequency response and in addition to its high efficiency it is robust and as moisture resisting as possible. The remarkable frequency response of this transmitter is illustrated and those interested are referred



Door Closed



Type N 2974 Open for use

In general external appearance, with the doors closed, types N2974 & N2984 are identical. The N2974 type is a hand microtelephone instrument. The hand-micro has the latest pattern inset transmitter of robust construction and high efficiency,

to the article "Transmission Testing" which appeared in The Ericsson Bulletin No. 4, Jan. 1934. As an additional safeguard against interference with the diaphragm a wire gauze has been added to the grille. The high efficiency calling bell is

of comparatively high impedance and the powerful generator has its protective winding incorporated in the armature and connected directly across the active winding.

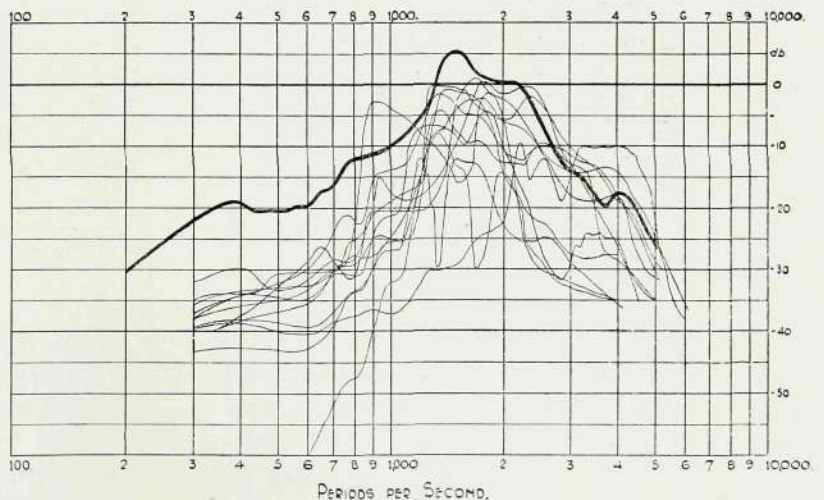


Type N 2984 Open for use

The N.2984 type is also made with an aluminium case which gives an approximate reduction of 42% in weight.

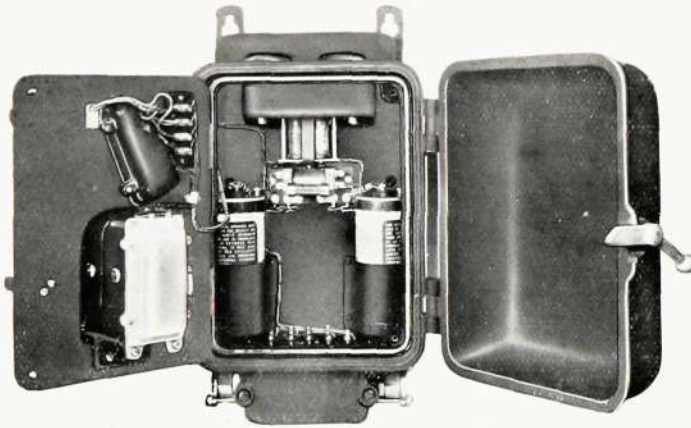
A Mines Department telephone safety condenser is fitted as standard to these instruments. The handle fixing has been improved. The wiring has been carried out in a special wire, enamelled, double silk and single cotton covered, finished with cellulose acetate lacquer. This cable has a smooth, highly polished surface and is easily cleaned, dirt does not readily accumulate, the colours are easily recognised, the moisture resistance is good, consequently the electrical properties are enhanced, while the inert cellulose covering is an excellent protection against accidental contact with any corrosive substances, oils, &c.

Turning now to the flameproof features, the principle was adopted of placing in individual flameproof enclosures the points where circuit interruption can take place, namely, the generator contacts and the switch contacts. By this means the volume of atmosphere involved can be made very small and as standard flame path lengths are maintained the highest factor of safety is achieved. The terminal chamber is normally provided for the connection of armoured cable. Three points of entry are provided with two sealing glands and one cap as standard. These cable entries are not drilled, but are centred for drilling. The sealing of the armoured cable is effected in the gland in a very simple manner, as can be seen in the illustration. One advantage of this method is that where desired the appropriate lengths of cable may have the glands fitted and sealed at the surface or other convenient place, the cables then being installed and the glands bolted to the instrument on site. The terminal chamber can also be arranged to receive $\frac{3}{4}$ " heavy gauge seamless screwed conduit instead of the armoured cable.



The heavy curve shows the Frequency Response of N 7742A transmitter compared with others

Tamper proof screws are fitted on both the terminal chamber cover and inner door. Each type of instrument carries the flame-



Inner Compartment

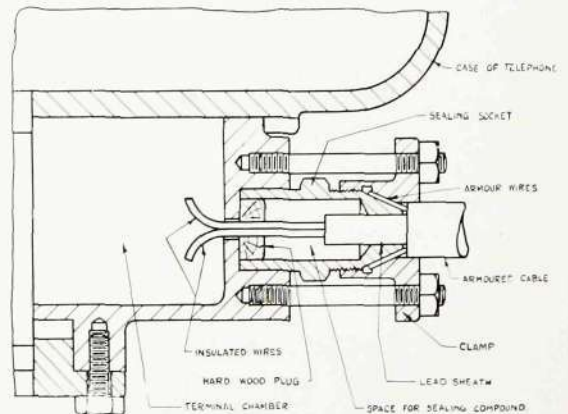
proof designation mark on the outer door and the intrinsically safe approval label upon the inner door.

These two types are thus fully equal to any requirement of service. They can be used as intrinsically safe instruments either on an all Ericsson system or in a mixed circuit using certified instruments of other makes, providing of course that the latter have been fitted with the telephone safety condenser as required by Mines Department Circular No. 75. Such circuits are perfectly safe and even if bare wires were used no risk of ignition would occur. Where, however, mixing is employed and even one instrument or subsidiary apparatus is not of certified type, then every portion of the circuit in question which comes within the danger zone (M.D. Circ. 75) must be provided with armoured cable and flameproof instruments. The new instruments, being flameproof, can equally be used on such circuits. One great advantage of this, apart from the question of main-

tenance stock, is that where a colliery embarks on a modernizing programme with complete intrinsic safety as their aim, these new instruments can be installed in the areas required to be "flameproof," the older non-safe equipment being apportioned to the portions not in the danger zone. Then as replacements of these older instruments are to be made they can be replaced by certified types until the system is completely in approved form as intrinsically safe.

For the termination of armoured cable outside the danger-zone a flameproof terminating box can be supplied. This is designed on similar lines to the terminal chamber of the above instruments, but the bakelite terminal plate carries four metal plates each with two connecting screws.

Where a safe circuit is connected to a surface telephone it follows that such an instrument must be certified also. The Wall Telephone, Type N2504 was already



Details of Combined cable-grip and sealing gland fixed to one of the entries to the terminal chamber which is fitted at the bottom of the telephone

available for this, but for those cases where the executive desires the telephone on his desk a new instrument has been developed. This Magneto Table Telephone, Type



Type N 2504

**Magneto Mining Wall Telephone
for use on the surface under
cover**

etc. is surmounted by the latest bakelite pedestal and cradle carrying a modern bakelite hand micro-telephone. The set is of particularly neat design and most accessible for examination and connection. The base plate is single hole fixing, while the removal of two screws permits the main



Type N 2155B

**Magneto Mining Table Telephone
for use on the surface under
cover**

N2155B, certified 30th September 1935, is a self-contained set with the calling bell and telephone safety condenser in the base. The metal case containing the generator,

cover to be withdrawn. Telephone safety condensers are of course required on the other instruments, if not already fitted, in accordance with M.D. Circular No. 75.

TELEPHONE TRAFFIC AND TRUNKING

continued from page 41

Traffic to 200 lines = $\frac{200}{680} \times 57.1 = 16.8$ T.U.

„ „ 80 lines similarly = 6.7 T.U.

Each 200 line group carries 16.8 T.U. requiring 31 switches.

The 100 line group with 80 ordinary and 20 P.B.X. lines carries $6.7 + 6.5 = 13.2$ T.U. requiring 25 switches.

Summary

Primary Finders	.. 120
Secondary „	.. 30
1st Selectors	.. 86
Final Selectors (ordinary)	.. 62
„ „ (P.B.X.)	.. 25

The main quantities of switches in the exchange are thus arrived at in a simple manner. On account of space limitations, it is not possible to discuss the calculations which are required to determine the number of switches for all positions, but the same principle applies throughout.

Stainless Steel in Telephone Equipment

THE wide range of iron alloys in the stainless class is the outcome of intensive research and technical progress in this important branch of metallurgy. Users requirements have been studied closely and grades developed to meet individual demands in the engineering, chemical and other industries.

There are several types of alloy. The one introduced early to industry, is a stainless steel containing 12% to 15% chromium, with varying proportions of carbon. This material has fairly good corrosion resisting properties.

The metal can be machined without great difficulty, while the higher carbon containing alloys can be hardened and tempered by usual methods of heat treatment.

engineers use the material widely for the manufacture of plant. Supplies can be produced in every form required for normal industrial requirements, including sheets, rods, wire, tube, castings and sections.

These alloys can be obtained in qualities suitable for deep drawing purposes or in sheets rolled to various degrees of mechanical hardness and possessing a very high finish, if desired.

Structurally, the steels are of the class described in metallurgy as "austenitic" and they are often referred to by manufacturers and in specifications under this name.

A metal in the stainless class containing 25% chromium and 25% nickel possesses



Low Carbon Stainless Iron x 200



Medium Carbon Stainless Steel x 200



Austenitic Steel Hard Rolled x 200

Courtesy of Messrs. Firth Ltd., Sheffield.

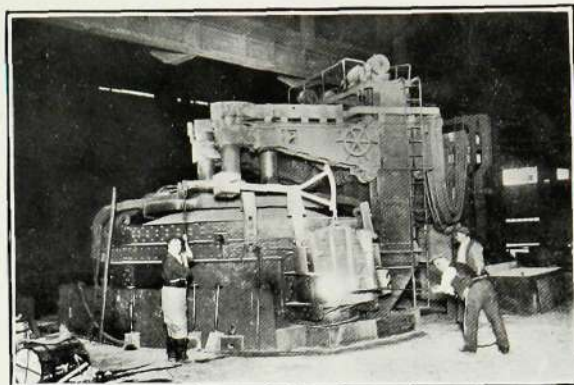
The next type is the high chromium, high nickel class of alloy. This metal contains 12% to 18% chromium with 8% to 13% nickel. The combined percentage of the two constituents is not usually less than 24% in these types. They are practically non-magnetic, having a permeability of about 1.1, and possess remarkable resistance to corrosion. Chemical

long life at high temperatures and is used for the manufacture of equipment for heat treatment. Electrical concerns make use of this alloy for annealing boxes for parts used in magnetic circuits.

Stainless steel which can be hardened and tempered, and possessing superior resistance to corrosion, contains 18% chromium with 2% nickel. This is used for heavy duty

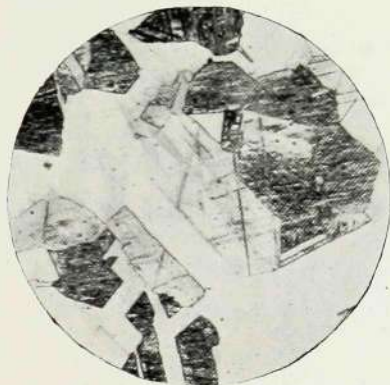
constructional parts which are highly stressed in service.

In the telephone industry the materials described are being used to an increasing extent. As with other manufacturers, the comparatively high cost, together with some difficulty in machining, are the limiting factors to more wide-spread use. At the same time, with careful selection of quality and purpose, stainless steel is a very important addition to the existing range of metals.



Courtesy of Messrs. Firth Ltd., Sheffield.

An Electric Furnace for Stainless Steel, 30 tons capacity



Courtesy of Messrs. Firth Ltd., Sheffield.
Austenitic Steel Normal Condition x 200

Here are the main instances where the alloys give greatest service in telephone equipment, as alternatives to other products:—

- (1) For tropical equipment where metal having good mechanical strength is necessary, combined with high resistance to corrosion.

- (2) In the place of steel parts which cannot be plated or finished owing to precise machining limits.
- (3) For details which are subject to mechanical wear or severe use when in service. Cases are often met where electro plate or enamel does not last sufficiently, particularly where surfaces are in rubbing contact.

Stainless steels have excellent mechanical properties. They possess high tensile strength combined with ductility and great shock resistance. Their use is often made worth while for this reason alone.

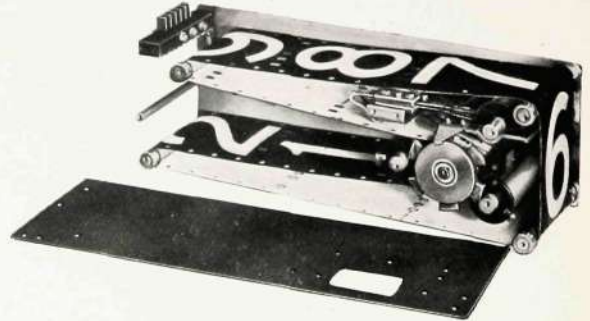
Little short of a metallurgical treatise could adequately summarise the properties of these chromium alloys, but the following table will give a brief indication of typical instances where the materials are used on telephone and allied parts:—

Description of Stainless Steel.	Type of Alloy.	Tensile strength. Tons, sq. in.	Elongation %	Form.	Purpose.
Low Carbon Stainless Iron	12/15% chromium	37	30	Bright Hard Drawn Rod.	Switchboard Plug centre stems, Small machined parts.
Medium Carbon Stainless Steel.	12/15% chromium.	40	30	Hard Drawn Precision Ground Rod.	Automatic Switch Selector Shafts, Bearing Pins.
Austenitic Stainless Steel.	18% chromium, 8% nickel.	50	35	Hard Rolled Polished Sheet.	Auto-Dial Finger Plates, Totalisator Springs, etc. Key Cams for Tropics.
do. do.	do.	do.	do.	Hard Drawn Wire.	Coil Springs, fine sizes.
Austenitic.	12% chromium, 12% nickel.	35	60	Sheet.	Pressings on Tropical and Exterior Equipment.

An Electric Time Indicator

SINCE the article on electrically controlled numerical display indicators contained in the July 1934 issue of the Ericsson Bulletin was written, a modified form of indicator of the individual-drive type has been developed. Although the new indicator has been primarily designed to meet totalisator requirements, it has a wider sphere of usefulness, and one of the accompanying illustrations shows four indicator units of the new type assembled to form an unusual kind of electric secondary clock.

The indicator units are driven by electric impulses, the movement of each band being effected by two specially shaped armatures rotated by the alternate energisation of a pair of field magnets. The armature

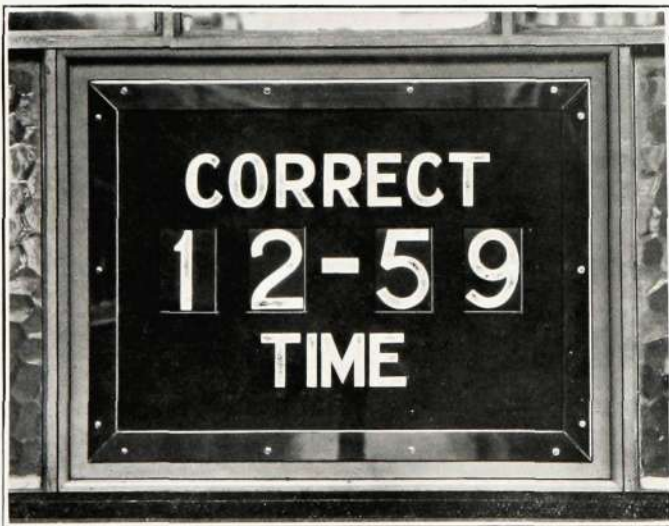


One of the indicator units with side plate removed, showing mechanism

spindles are mounted on ball bearings, and as there are no ratchet wheels, pawls, or similar parts, the action is almost noiseless. A view of an indicator unit with one side plate removed to disclose the interior arrangement is shown in the upper illustration.

The clock is controlled from a one-minute impulse circuit of the usual type, a small motor being employed to supply the driving impulses for the indicator field magnets. There are no controlling switches, and a special feature of the circuit is the method of transferring the drive from one indicator unit to the next at the end of the appropriate periods. This is accomplished under the direct control of perforations in the indicator bands, no separate relays or other intermediary apparatus being employed.

The height of the displayed figures is three inches, and their simple form ensures the utmost visibility.



Front View of the Electric Clock