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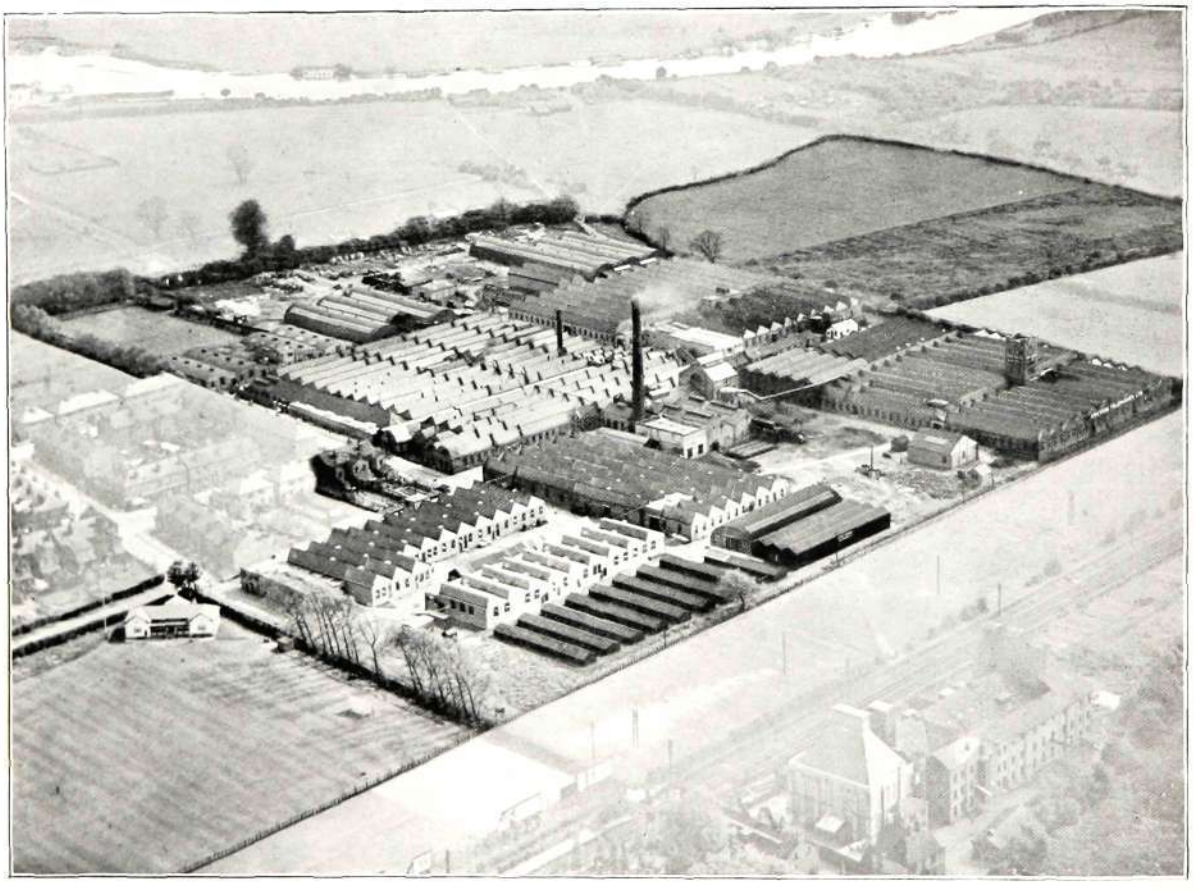

Aerial View of The Ericsson Works, Beeston, Nottingham

The Unit Automatic Exchange No. 14

THE U.A.X. No. 14 is the largest " unit " type exchange and supersedes the U.A.X. No. 7. It is designed for exchanges where the ultimate requirements exceed 200 but do not exceed 800 subscriber's lines.

TYPES OF RACKS.

Five of the racks in a U.A.X. No. 14 have been specially designed for this particular type of exchange, the others are similar to those in use for main exchanges. The special racks are designated Units 14A, 14B, 14C, 14D and 14E whilst the remaining racks required to complete an exchange are the meter rack, meter pulse machine rack, trunk distribution frame, combined main and intermediate distribution frame, traffic recorder rack and test rack.

Usually the test rack is provided only when the number of calling equipments exceeds 500.

Unit 14A Equipment. This Unit accommodates 100 subscribers' line relay equipments, 10 line finders, 7 selector hunters, 2 allotters and control relay sets and 20 final selectors, the last including 1 test final selector on every alternate rack. As the trunking equipments rarely justify the provision of more than 10 final selectors per unit, the top shelf, accommodating the last 10 switches of this type, is not fitted as a standard but can be added when desired.

The illustration Fig. 1 showing the front of the unit will make clear the disposition of the equipment referred to above.

Unit 14B Equipment. Accommodation is provided on this unit for five shelves of group selectors, each shelf taking ten switches. The shelf complete, consisting of shelf ironwork, selector banks, shelf jacks, connection strips and all associated wiring, is however an individual item and the number fitted is dependent upon trunking requirements.

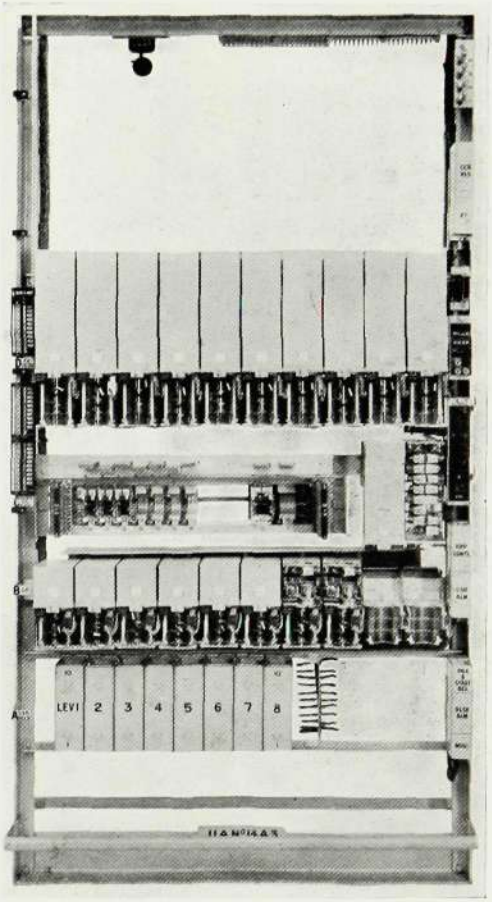

Fig. 1—Front View of Unit 14A

The shelf jack wiring is arranged so that either 1st or 2nd group selectors can be " jacked-in " as required.

Second selectors are provided only when the number of junction codes exceeds five, or where it is necessary to employ 2-digit junction codes.

The unit resembles in appearance the standard group selector rack used, in non-director main exchanges.

Unit 14C Equipment. The equipment of this unit is not of a standard character and varies according to the particular exchange requirements. It accommodates the equipment, mainly comprising "strip-mounted sets," required for junction working.

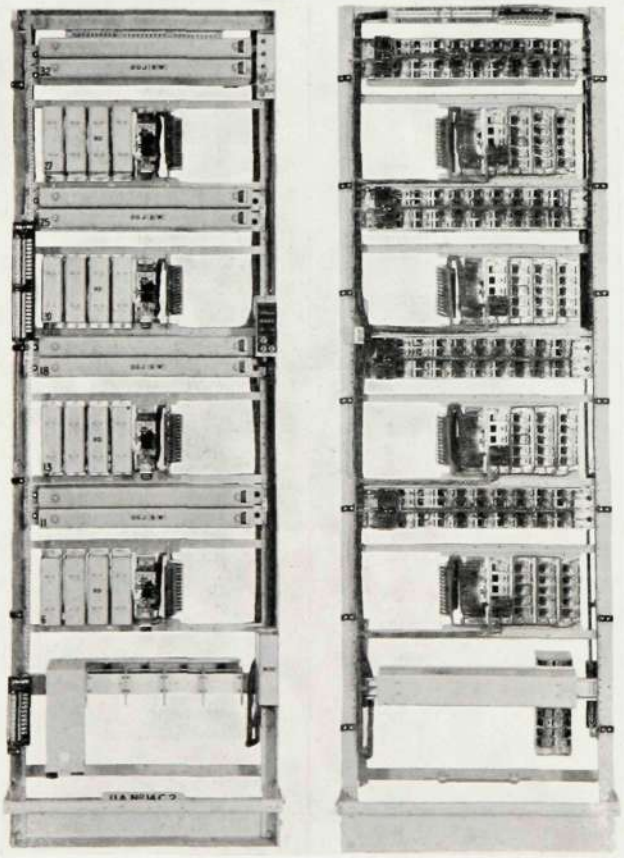

Fig. 2—Front and Rear View of Unit 14C

These strip-mounted sets deserve special mention. They consist of one or more relay mounting plates and, in some cases, a uniselector in addition, and cover the whole of the equipment associated with a particular circuit. The plates concerned are linked together to form one unit and all components are connected by means of a local cable to form a complete item. A small connection strip is mounted at the rear of the strip-mounted set for the termination of leads requiring external access. A test jack is fitted on each of these equipments and access is given to it without removing relay plate covers.

The drillings on the rack are of a universal character and although the strip-mounted sets are of various sizes they can be fitted in any desired position.

The illustration Fig. 2 shows front and rear views of a unit 14C with a typical equipment.

Unit 14D Equipment. This unit accommodates the following miscellaneous and special service equipment.

Shelf G. 1 service observation equipment.

Shelf F. 4 test and plug-up line equipments.

Shelf E. 4 changed number equipments and 1 alarm delay equipment (6 seconds).

Shelf D. 1 service interception finder, 1 howler and 1 P.G. milli-ammeter.

Shelf C. 4 N.U. tone relay sets.

Shelf B. 1 test number, 3 service interception and 1 alarm extension relay set.

Shelf A. 1 test selector, 3 alarm delay relay sets and 1 howler relay set.

Although space for the service observation equipment is allowed on the upper half of the unit it is an individual item, arranged as a complete and self-contained panel, and is bolted direct to the uprights when required.

The provision of service interception

equipment is also variable but the wiring for this is fitted as a standard.

When the exchange does not exceed 400 lines only two N.U. tone relay sets are fitted.

The illustration Fig. 3 shows a front view of a typical equipment, without service observation and interception sets.

Unit 14E Equipment. This unit is only fitted at exchanges which have routes to director areas. It has a capacity for mounting 30 route discriminating (junction) relay sets, 5 route discriminating (common) relay sets and 5 route discriminating (common) selectors.

The selectors are of the 8-level, 2-motion type, and function in a similar way to the "BC" selectors as used in directors.

Composition of a U.A.X. 14 Exchange.

An exchange is built up by a combination of the above described units and racks according to the number of subscribers lines, trunking and junctions required. The number of A units may be 1–8, i.e. one per 100 subscribers, B units, 1–4 according to the trunking requirements, C units, 1–33, as required for junctions, D units, one, E units, 0, 1 or 2 depending upon whether or not access is required to director areas, one meter rack, one meter pulse machine rack, one or two trunk distribution frames, as required, one traffic recorder rack, one combined main and intermediate distribution frame and 0 or 1 test rack as previously stated, together with a power equipment as described below.

General Rack Construction.

As the buildings housing these exchanges will be provided with heating it has been found unnecessary to totally enclose the units in sheet steel cabinets as in the smaller types of U.A.X. equipment.

Open type construction has thus been adopted throughout and the rack design is as far as possible in accordance with the G.P.O. standard 2,000 type equipment.

The units and racks are all 8 ft. $6\frac{1}{2}$ ins. in height and the width of the A and B units is 4 ft. 6 in. and that of the C, D and E units 2 ft. 9 in.

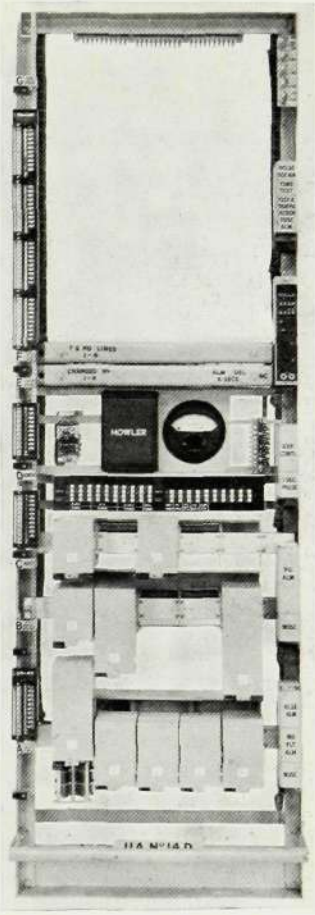

Fig. 3—Front View of Unit 14D

Apparatus Details. The selectors and relay sets are of the B.P.O. 2,000 type and incorporate ballast transmission bridges and balanced tone feeds.

All relays used are of the B.P.O. 3,000-type except those for the subscribers' line

circuits (L & K relays) which are the B.P.O. 600-type.

The miscellaneous equipment associated with a particular rack is mounted on the right-hand upright of that rack.

POWER PLANT.

The power plant standardized for all U.A.X.'s No. 14 is of the Post Office parallel battery float type, in which the two batteries are permanently connected in

Fig. 4—Power Control and Ringer Panels for a U.A.X. No. 14.

parallel and to the exchange. When they have become discharged to the extent of 4% the charging plant is automatically brought into operation and supplies energy direct to the telephone system via appropriate smoothing equipment. The batteries supply any current required by the exchange in excess of the output of the charging equipment and are eventually recharged when the exchange load falls. When the batteries are fully charged the charging unit is automatically shut down.

The voltage at the exchange bus bars is maintained between prescribed limits, during the charge and discharge cycles, by the use of counter E.M.F. cells which are automatically brought into operation under the control of a contact-voltmeter and a group of contactors.

The following equipment is provided :—

(*a*). *Batteries.* Two main batteries each consisting of 25 secondary cells ; a group of 8 counter E.M.F. cells of the alkaline type for voltage regulation purposes ; a group of 7 counter E.M.F. cells of the lead acid type for P.B.X. 30v. and a positive battery of 37 Leclanche cells.

(*b*). *Charging Equipment.* For A.C. supplies two rectifiers (initially) are connected in parallel. These are of the metal or mercury arc type according to the output required, and are provided with suitable smoothing equipment.

For D.C. supplies two motor generator sets are provided, one being a stand-by machine. A single smoothing unit is provided for use with either machine.

(*c*). *Control Panel.* This panel accommodates all the apparatus associated with the automatic control of the charging equipment in addition to that which functions to maintain the voltage of the battery between the allowable limits. Included on the panel are contact voltmeters, contactors, ampere-hour meter, ammeter and all the associated relays and miscellaneous equipment.

(*d*). *Ringer Panel.* This panel accommodates ringing machines of the tone

inductor type, ringing changeover equipment, ringing distribution circuit breakers, tone chokes and transformers and miscellaneous equipment. For an A.C. power supply one mains driven and one battery-driven ringer are provided; for D.C. supply both machines are of the battery-driven type.

Figure 4 shows a typical power board assembly comprising control panel and ringer panel mounted side by side.

Trunking arrangments and Numbering Scheme.

Figure 5 shows typical trunking arrangements. The subscribers line circuits terminate on the banks of 100-outlet 2-motion type line finders some of which are directly connected to first selectors while others are connected via selector hunters to a common group of first selectors.

A four-digit numbering scheme is employed for subscribers lines, the initial digit being either 2 or 3 which is used as a discriminating digit and is absorbed by the first selectors. Levels 1, 2, 3 and '0' of the first selectors are connected to four groups of 200-line final selectors, so that by this arrangement a numbering range of 2000–2399 and 3000–3399 is available.

Level 9 is used to gain access to the automatic equipment at the parent exchange. Dialling '0' routes the call via the group of junctions connected to level '9' but a discriminating signal, which results in the parent exchange operator being signalled, is passed over the junction.

By routing level '9' and level '0' traffic via the same relay sets an economy in junctions is effected.

Levels 4, 5, 6, 7 and 8 are used for dialling out to adjacent exchanges. When it is necessary to provide additional dialling out codes a rank of second selectors can be provided and connected to one of the levels, e.g. if the 2nd selectors are connected to level 4, then this will mean that additional dialling out codes 41–40 are available.

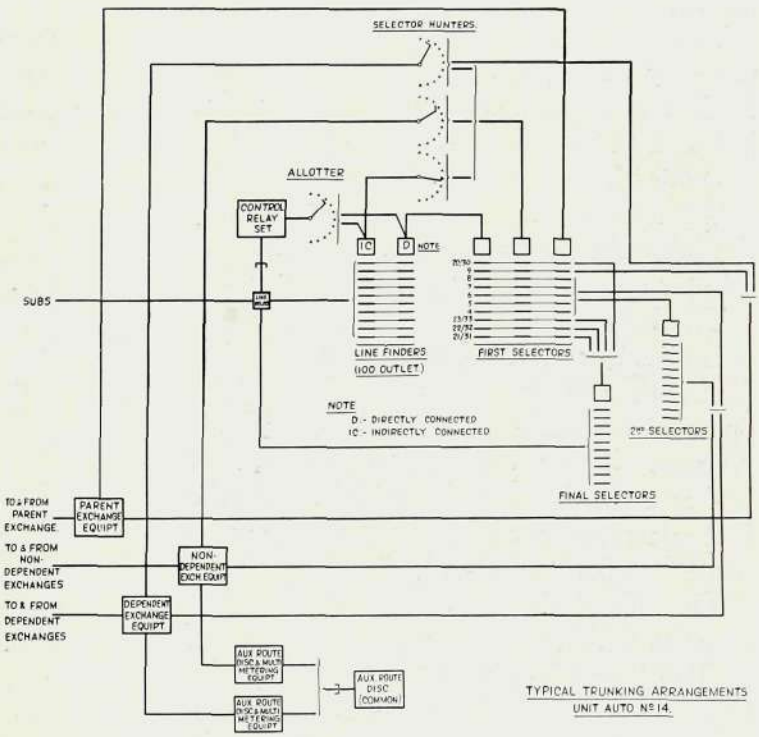

Fig. 5—Typical Trunking for a U.A.X. No. 14

The junctions from the parent exchange terminate on individual 1st selectors; junctions from adjacent exchanges are given access to a common group of first selectors via selector hunters.

Junctions can be bothway as shown on the typical trunking diagram or unidirectional, the particular arrangement provided depending on the traffic conditions for the exchange concerned.

OPERATION.

Local Call. When a subscriber originates a call the control relay set associated with the group in which the call is originated, connects itself via the allotter to a free line finder and causes the latter to search for the calling line. The allotter is arranged so that it routes calls via directly connected linefinders until all of these in the group are engaged, after which, calls are routed via the indirectly connected linefinders.

The control relay set and allotter are in use only during the searching time of the linefinder and immediately the calling line is found the allotter preselects another free linefinder in readiness for the next call.

When the linefinder finds the calling line the subscriber is extended through to a first selector and receives dial tone.

The initial digit dialled on a local call is either '2' or '3'. Assuming that '3' is dialled then the selector steps to level '3', operates a discriminating relay and then releases. The next digit will be 1, 2, 3 or '0' and the dialling of say '3' causes the first selector to cut in on level 3 and search for a free final selector.

The discriminating relay in the first selector, which was operated at the end of the first impulse train, now passes forward a signal to the final selector and causes it to connect the wipers ready for selection, in this case, in the 3300 group. If the first digit dialled had been 2 instead of 3 the wipers would have been connected for selection in the 2300 group.

The 3rd and 4th digits step the final selector wipers in a vertical and rotary direction respectively and the called party's line is tested. If the line is engaged the caller will receive busy tone. When the called line is in a P.B.X. group the selector will search for a free line in the group and return busy tone to the caller only if all lines in the groups are engaged. If the called line is free, ringing is connected and ringing tone transmitted to the caller in the usual manner. When the called party answers the calling party's meter is operated once and conversation can proceed.

Call to Parent Exchange (Manual Board). The calling party is connected to a selector as described above and dials 'O'. This causes the selector to step to level '9' the tenth impulse being absorbed. The first selector searches for a free junction to the parent exchange and signals a manual operator at that exchange. When the caller is barred trunk calls (e.g. coin box lines) the operator receives a visual indication which informs her that she must collect the necessary fee.

Call to Parent Exchange (Auto Equipment). In this case '9' is dialled and the call is routed via a parent exchange junction to an incoming selector at the parent exchange. The caller can now dial to subscribers in the parent exchange, or to exchanges connected to the parent exchange.

Call to Dependent or Non-Dependent Exchange. The calling party dials the call digit to reach the required exchange, i.e. 4, 5 or 6 etc. If the called exchange is manual the operator is signalled and can complete the connection in the usual manner. If the called exchange is automatic subsequent impulsing operates the auto equipment at that exchange to select the desired number or to route the call to another exchange.

Route Discriminating Equipment. When a junction to another exchange is seized the route discriminating and multi-metering equipment associated with the junction equipment counts the dialled impulses and performs one of the following operations :—

(1) Connects 1, 2, 3 or 4 unit metering to the meter wire.

(2) Connects N.U. tone to the caller if

the number dialled is a spare code or is barred to the caller.

(3) Provides manual hold.

In director areas the route restricting equipment is unsuitable for dealing with the required number of codes and in this case common equipment is provided which will cover up to 800 codes.

Incoming Calls from Parent Exchange Manual Board. The operator takes into use an outgoing junction and engages the first selector associated with the junction used. The operator can now dial any number on the exchange in the same way as a local subscriber.

If the called line is engaged the operator receives busy flash and tone. Provision is made so that the parent exchange operator can gain access to the engaged line for the purpose of offering trunk calls. This is achieved by the momentary operation of the ringing key, the call being offered to the engaged line and the subscriber is requested to replace the receiver. When the operator receives the clear on her supervisory lamp the ringing key is again momentarily operated to apply ringing to the wanted party's line.

Incoming Calls from Parent Auto Equipment. The calling party dials the digits to gain access to a junction to the U.A.X. The incoming U.A.X. first selector is seized and subsequent impulse trains will cause the selection of the desired number as for a local call.

Incoming Call from Non - Dependent Exchange. When an incoming junction is seized the selector hunter searches for a free first selector. If the calling party dials before a first selector is found, busy tone is transmitted to line.

Assuming that the calling party dials after a first selector is found ther the U.A.X. equipment functions as for a local call and the desired line is selected in the usual manner.

Incoming Call from Dependent Exchange. On calls to local lines the equipment functions as for a non-dependent exchange incoming junctions. When the calling party dials ' O ' a discriminating signal is passed forward to the incoming junction equipment which causes the selector hunter to search for a junction to the parent exchange instead of a 1st selector in the U.A.X.

Control Relay Sets. One control set normally serves each 100 lines associated with a particular unit, provision is made however so that in the event of failure of a control set the control relay set belonging to another 100 lines is arranged to serve both its own group and the group in which failure occurs. This is arranged by pairing units 1 and 2, 3 and 4 etc. these acting as partners. If failure of the control set serving unit 1 occurs then the control set for unit 2 will take over units 1 and 2 until such time as the fault on the control set for unit 1 has been cleared.

If the control set for unit 2 fails then the control set for unit 1 will serve both groups. Units 3 and 4 etc. are arranged to function in a similar manner.

P.B.X. Working. P.B.X. facilities for groups of 2-10 lines are provided throughout and when required it is possible to cater for 2-20 line groups.

Alarm arrangements. The alarm arrangements follow non-director auto exchange practice, provision being made to extend urgent alarms to the parent exchange. An exception to standard practice is the P.G. alarm scheme whereby P.G. alarm lamps are fed via a contact ammeter, an alarm being given when a predetermined number of P.G.s occur.

Other Facilities. Provision is made for service interception, changed number equipment, meter observation, service observation, traffic recording and test facilities. For the latter, test selectors and test final selectors are provided to enable tests to be made from the parent exchange.

A New Magneto Table Telephone

DURING 1935 the Ericsson Company introduced entirely new designs of moulded case type table and wall telephones suitable for auto/C.B. working. These instruments had the outward appearance shown in Fig. 1 & 2.

Fig. 1—Auto. Table Telephone

The popularity of this type of one piece moulded case was immediately apparent and further developments were subsequently undertaken with a view to increasing the scope of this type of telephone. Certain improvements in transmission and reception technique had become available during this period, and these improvements were incorporated in the new range of instruments.

Fig. 2—C.B. Wall Telephone

The outcome of these further developments, which were undertaken in collaboration with the engineers of the British Post Office, was a type of telephone which can be used for many purposes by interchanging a few pieces of standard apparatus. This new type is now adopted and standardized by the British Post Office.

The main features of the new design auto/C.B. table telephone are improved transmission efficiency of approximately 1 d.b. above the British Post Office standard fixed for telephone No. 162 and bell set

Fig. 3—Auto. Telephone with Key Units

No. 25, whilst reception is equal, and the inclusion of a new anti-side-tone induction coil providing much better side-tone conditions. Besides the foregoing improvements several key units were devised which can be added to the standard instrument when extension and operator-recall facilities are required. A further convenience was the provision in the telephone base of a sliding tray carrying a writing pad intended as a ready reference for the subscriber's personal use. Fig. 3 & 4 show views of this telephone and its outstanding improvements.

This latest design is now standardized by the Ericsson Company and all the usual telephone requirements can be met by this style of telephone, even to the inclusion of magneto working, using only the comparatively small one piece instrument in conjunction with the usual external battery.

Hitherto telephones for magneto working have been heavy and cumbersome on account of the ungainly nature of the

Fig. 4—C.B. Telephone Showing Sliding Tray

magneto generators available. Recent research has produced new magnetic materials which the Ericsson Company have incorporated in a new and highly efficient magneto generator of very small size and weight. This new generator is shown in Fig. 5 and comparative sizes are illustrated in Fig. 6. The efficiency of the new

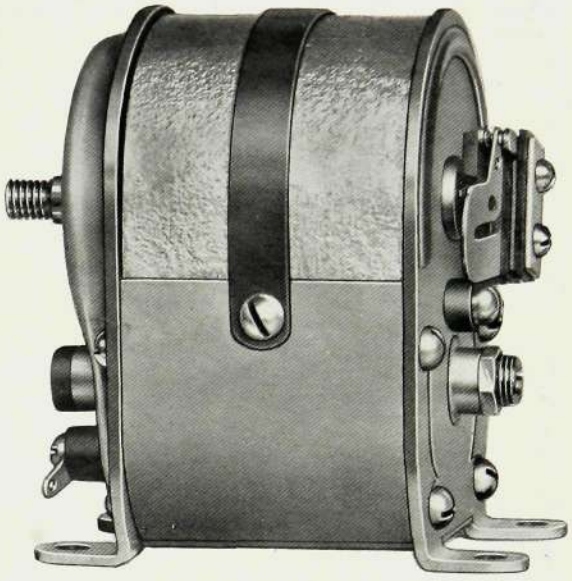

Fig. 5—The Generator, full size

" Alnico " magnet generator is given by the comparison curves shown in Fig. 7. It will be seen that the characteristic load curve for the new generator shows an output approximately twice that of the British Post Office No. 4C type and with this gain is associated a 25% decrease in size and weight. A slightly larger generator is available giving an output equal to the heavier B.P.O. No. 8A type.

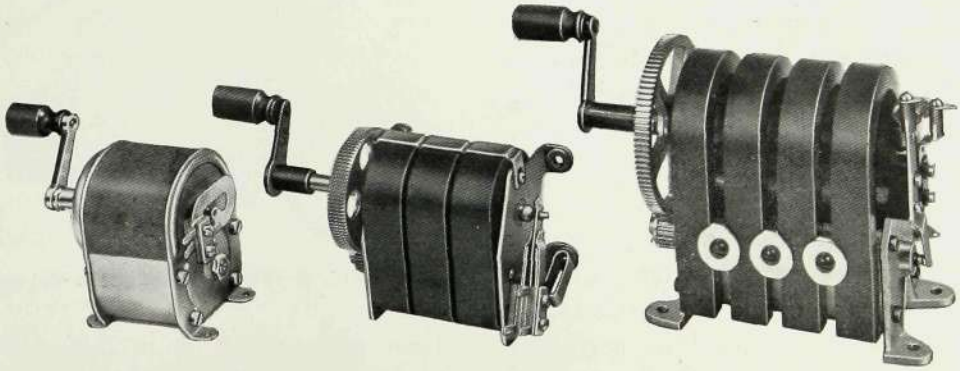

Fig. 6—The Generator Size compared with two others

This small generator was found to be eminently suitable for inclusion in the newest type moulded telephone case as used on the auto/C.B. telephones mentioned above, consequently further developments

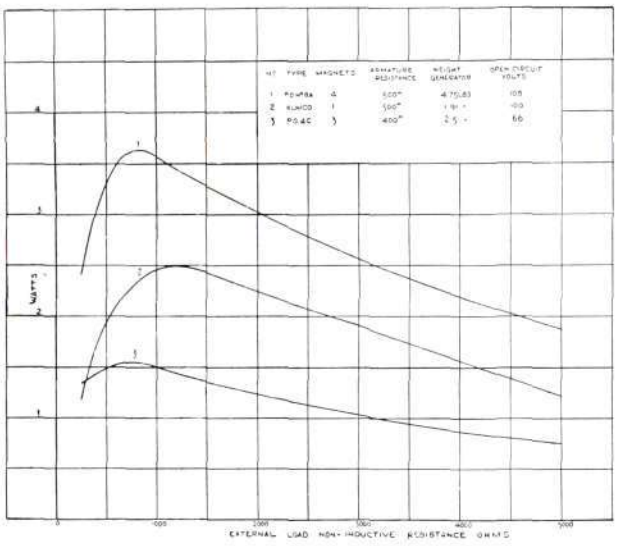

Fig. 7—Load Curves of three Generators

have resulted in a type of table telephone suitable for magneto working which is small in size and weight and at the same time pleasing in appearance.

The new magneto telephone is illustrated in Fig. 8. The standard auto/C.B. moulded case is used, and in addition to being a cover for the components, provides a cradle for the moulded micro-telephone. A metal base plate carries all the internal apparatus and is completely detachable from the case-work. This base with components is illustrated in Fig. 9. On it are a condenser, induction coil, generator, ringer, ringer gongs, cradle switch springset and cord connection block. The condenser is, of course, only required in particular instances and is not fitted in standard magneto telephones. The illustration, however, shows that space has been provided for its inclusion.

In view of the space required by the generator and other components, the sliding tray fitment provided on auto/C.B. types is not included, the aperture in the casework is therefore closed by means of a moulded strip fixed to the front edge of the base plate.

The dial aperture in the casework is used to accommodate the generator spindle and handle. A moulded escutcheon is provided which fixes in the aperture in the same manner as a dial or a dial dummy, and is arranged so that its centre hole can be brought concentric with the generator spindle. The escutcheon also carries a label holder of the type provided on dials and dial dummies.

The generator handle is fixed by a single screw and this must be removed before unscrewing the six captive screws in the

Fig. 8—The New Magneto Telephone

base plate when it is desired to obtain access to the interior of the telephone.

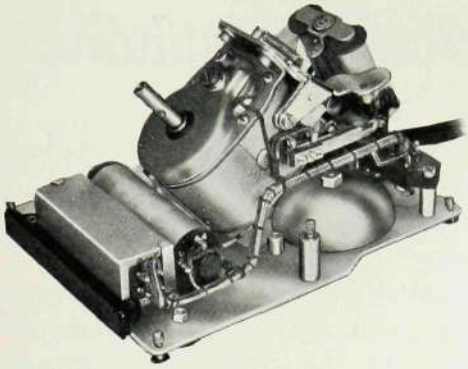

Fig. 9—Base Plate Removed showing Internal Apparatus

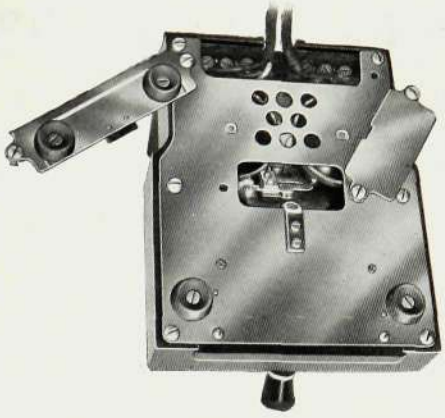

Fig. 10—Underside of Base Plate

The underside of the base plate is shown in Fig. 10 and illustrates the means provided for giving easy access to the generator cut-out and to the cord terminal block. It will be seen that subsidiary cover plates provided with captive fixing are employed, so that it is only necessary to remove these for immediate access to the cord connections and generator cut-out.

A noteworthy feature of this new set is the micro-telephone, which is identical with that used on the auto/C.B. instruments. In fact this handset is common to all these modern moulded case type telephones, any difference in working conditions between CB and LB being covered by the induction coil, whose physical dimensions are the same in each instance, the variation in requirements being covered by the windings only.

The approximate weight of the new magneto table telephone is $7\frac{1}{2}$ lb., which is 4 lb. lighter than instruments of similar efficiency of the older types.

Telephones destined for use in tropical climates are given special attention, and precautions are taken to provide good insulation for these exacting conditions. Also the ingress of distructive insects through the ringer sound holes etc. is prevented by means of metal gauze covers.

The Ericsson Mine Rescue Telephone

THE Coal Mines General Regulations (Coal Mines Act 1911) require owners of mines to which the regulations apply, to make definite provision for rescue work in mines after an explosion or a fire, or otherwise in any atmosphere which may be dangerous to life.

Coal mining being an extra hazardous industry there are many occasions when the services of trained rescue workers are required, in addition to those cases of major disaster which bring vividly before the general public the risks involved.

Central Rescue Stations are maintained at positions convenient to serve a group of mines and affiliation to such a station is compulsory, except that the Divisional Inspector of Mines may exempt a mine situated more than 15 miles from a central rescue station, subject to such conditions as he may require, or where effective independent rescue provisions have been made. Such exceptions are, however, rare.

There are 30 associations or authorities controlling in all some 36 rescue stations and in addition there is one private rescue station. These stations are so placed as to cover the coalfields of England, Scotland and Wales. The permanent rescue corps are trained and equipped to undertake the rescue and fire fighting underground at the pits affiliated to their station.

Each pit is in telephonic communication with its rescue station and calls on it in case of fire, explosion, or other accidents requiring the services of rescue men trained in the use of breathing apparatus.

At fourteen central rescue stations a permanent corps of from eight, the minimum, to eighteen men, including instructors, is provided. With the exception of one station, the men live on or near the premises and do not work underground. At the remaining twenty-three stations the only persons employed are from two to four instructors and the men work regularly underground.

Eight central rescue stations are each provided with a fire-engine for surface work; some, but not all, have fire fighting apparatus and equipment for use underground.

All mines employing 100 or more men underground must have certain of their men trained in mine rescue work; the actual number varies according to scales included in the General Regulations (Rescue) 1928 First Schedule. All the colliery men are trained at the central rescue stations. These trained rescue workers, who are selected for their knowledge of the mine in addition to coolness, powers of endurance and general suitability, co-operate with the permanent corps, who form the spear-head of the attack in cases of emergency. Similarly the professional corps is assisted in fire fighting by the pit fire brigade, where one exists.

At the central rescue station the statutory equipment consists, among other things, of a minimum of twenty suits of breathing apparatus, with supplies of oxygen or liquid air for two days continuous use, four smoke helmets, four reviving apparatus, 20 electric and 6 flame safety lamps, motor transport, first aid boxes, etc., caged birds

for carbon monoxide testing and two portable signalling devices. From this list it will be seen that a considerable amount of the work has to be undertaken in irrespirable atmospheres. The duties include dealing with underground fires, exploration and recovery of mines after fires and explosions, and the taking of samples of gas, all of which entail entering and working in foul, noxious or inflammable atmospheres. The men are trained regularly in active work for continuous periods of at least two hours in a hot and irrespirable atmosphere in order to accustom them to their duties.

When a rescue corps is called and it commences operations, a base is established as soon as possible in fresh air but as near the irrespirable zone as possible.

Communication is obviously of considerable importance. The base should be in telephone communication, if possible, with the surface or the shaft bottom. Often the existing mine telephone system will provide for this or an instrument can be connected on to a line. For communication between the rescue brigade and the base, however, greater difficulties exist. As the brigade or team, of five to eight men, will be wearing breathing apparatus, speech is impracticable and communication has to be established by other means. Uniform codes of signals are prescribed, one for use between members of a brigade, for which each man carries a bulb hooter, and one for electric signalling. Each code consists of five simple signals only. It will readily be appreciated that while the existing telephone or bell system may provide a signalling medium to the base, it cannot be depended upon and it would but rarely prove convenient.

The provision of continuous communication was under consideration by the rescue apparatus Advisory Committee of the Mines Department as long ago as 1933. The commercial possibilities of equipment for this purpose were so obviously limited as to preclude manufacturers undertaking development on a competitive basis. Finally, Ericsson Telephones Limited were invited to collaborate with the Mines Department Testing Station and Mine Rescue Stations in the development and to undertake the production of a Mine Rescue Telephone at a price within reach of all rescue stations and low enough to encourage equipment of mine brigades. They accepted this invitation and initially the essential requirements and secondary desirable features were decided. Following this the circuit principles were considered, the electrical components and their associated safety devices designed. As the equipment was to be used under conditions of very real danger as regards ignition, specially keen attention was paid to safe operation, and the suggested electrical arrangements were checked for safety in hydrogen also by the Sheffield Testing Station of the Mines Department.

Safety considerations and the technical performance once settled, the service form was developed and the first model made. This was then tested out under working conditions both at rescue stations and in mines. This work was completed, and early in 1937 the various detail requirements and suggestions resulting from these practical trials were discussed and the final form agreed upon and engineered. Patterns and tools were put in hand and finally production models were made and put forward for official test and certification. The Certificate (T/Tel 28A) was granted on

18th June 1938 and production was then authorized.

The Mine Rescue Telephone consists of two units, a base station and an advance station, connected continuously by a light but tough cable. Fig. 1. In the constructtional features of the design, particular attention has been paid to strength with low weight and to making the equipment convenient to carry and handy to operate, so as to add as little as possible to the arduous task of the rescue party. Both the case of the base station and the frame of the advance station are cast in aluminium-silicon alloy to obtain a robust yet light housing for each unit.

signals only from the advance party. Among these may be mentioned technical considerations of efficiency, increased weight and cost, and the reduced mobility of the advance party if both-way speech were provided. When oxygen breathing apparatus is worn, clear and reliable speech is not practicable. Even if special transmitter and receiver were fitted, as smoke helmets would permit, the use would tend to be restricted to one man and would probably need the services of an extra man in the advance party. Also the emergency value of the code of signals is such that it is undesirable that any apparatus should tend to cause its disuse.

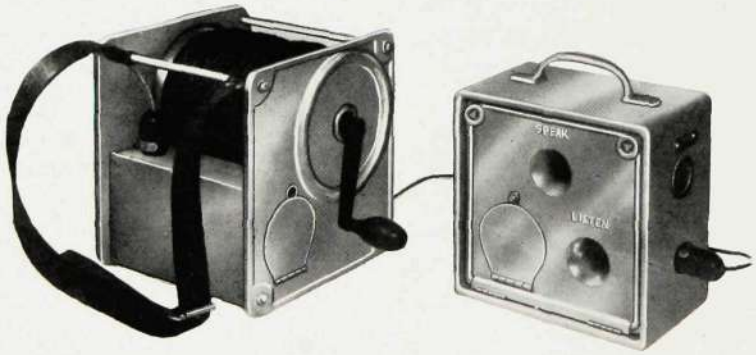

Fig. 1—Mine Rescue Telephone Units

Signals in both directions are effected by high-note buzzer, using the code set out in the regulations. The note is distinct and penetrating, the comparatively high frequency avoiding any chance of confusion or obliteration by other noises. In addition the base party can speak to the advance party, both speech and signals being received on the loud speaker at the advance station unit. Key signalling only is provided from advance party to base. Much thought was given to the facilities provided and many considerations were reviewed before deciding to limit to key

The base station unit is about $9\frac{1}{2}''$ square with a depth of $6\frac{1}{4}''$. The weight is 15 lbs. On its front is fitted a sensitive transmitter, a small loud speaking receiver and a high-frequency buzzer. Provided in the buzzer mounting is a small key which when depressed connects the buzzer, via the induction coil, to the adjacent receiver, so that the former can be tested to confirm that signals are being sent out. A convenient handle provides for adjustment of the buzzer when the test indicates this to be desirable. A hinged metal flap protects test key and adjustment handle from dust

and accidental damage. On the left of the unit is a "speak" key which must be operated to speak to the advance party. This connects the transmitter battery and at the same time disconnects the local receiver circuit, thus ensuring the highest efficiency of operation. To be seen on the right hand side is a similar key marked "signal" for calling the advance station. This operates the buzzer and a high-note call is transmitted via the induction coil.

The line cable is connected by plug and socket on the right of the case. This cable is of special design having a composite conductor of copper and steel with tough, impregnated insulation.

The strong alloy frame of the advance station unit bears the cable drum and the totally enclosed case containing the communication apparatus. The size is slightly less than an 11" cube, and the weight, with

Fig. 2—A Rescue Brigade ready for Service

As this coil transmits both speech and signals no direct current is passed to line. The keys are sealed, against the entry of dust, by flexible leather diaphragms.

When the keys are in their normal position the loudspeaking receiver is connected directly to the trailing cable and hence to the advance station unit. Any signal sent out by the advance party is thus immediately reproduced by this receiver.

a full reel of 280 yards of cable, about 25 lbs. Particular attention has been directed to producing a form as convenient as possible to carry, easy to operate and immune from minor mechanical damage, so that the advance party enjoy the advantages of communication without having their activities impeded. During the advance, while the cable is being unreeled from the drum, the line is continuously connected to both sets and speech and signals can

be transmitted. The communication apparatus is similar to that of the base station except that no transmitter is fitted. The same facilities for test and adjustment of the buzzer are also provided.

The batteries are of the ordinary cycle lamp type so that replacements of the correct type are readily obtainable. To cover the possibility of use abroad under tropical conditions, approval has been given to the alternative use of a standard type of inert cell. Battery voltages are 6 V and 3 V respectively for base and advance party units. The safe operation of the system in dangerous atmospheres is a feature of the electrical design. The well known high sensitivity obtainable with a good receiver is used to advantage and by combining high note buzzer signals with speech there is no direct current flowing in the line. The line currents themselves are of small dimensions, incapable of producing ignition in the most dangerous of atmospheres. As regards the local circuits at each unit, the buzzers are fitted with non-inductive shunts and with condensers : as an additional safeguard the induction coil primary of the base unit has a safety shunt provided.

If during rescue operations it is desired to extend beyond the first cable length, a further advance party instrument can be connected by a simple plug and the circuit transferred from the first to the second unit.

Fig. 3—Advance Party about to Commence Operations

The illustrations, shewing a permanent rescue corps' regular practice of at least two hours, in various stages, conveys a good general idea of the equipment to be carried, and some impression of the service use of the rescue telephone. Fig. 2 shows a brigade leaving their ambulance ready for immediate service in an irrespirable atmosphere. Oxygen breathing apparatus is in use and the nose is clipped so that respiration is entirely through the mouth. Across the front of the harness is the hooter for signalling between members of the brigade. Among the equipment can be seen a case containing reviving apparatus, stretcher, canary for carbon monoxide detection, the two units of the telephone, flame safety lamp, etc.

In Fig. 3 a fresh air base has been established and the advance party are

going forward to commence operations.

Fig. 4 shews the men at work in a practice gallery. The operations are devised to represent those underground and include the repeated handling of heavy weights, building and removing temporary stoppings

the necessity for any connection between the rescue party and the set. Thus all can hear the incoming messages and any one may answer as convenient. This is an advantage as no question of loss of communication due to incapacitation of the operator can arise.

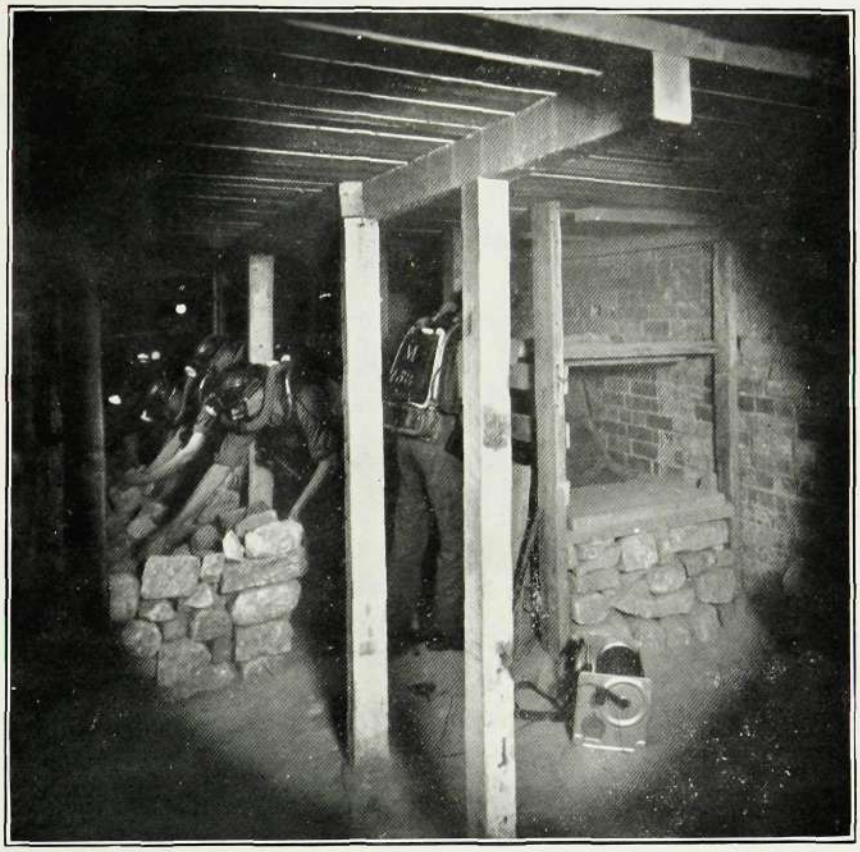

Fig. 4—Advance Party at work in a Practice Gallery

of stone, brick, etc., including transport of material, removing debris as from a fall of roof, setting roof supports, practice with a loaded stretcher, etc. The advance party unit is seen in operation, and it will be noticed that the loud speaker call avoids

It is hoped that the introduction of this certain, continuous and speedy means of communication will both materially assist the work and add to the confidence of the advance party in the course of their rescue and exploration duties.

Reactor Controlled Battery Charging Equipment

NE of the most important problems associated with accumulator maintenance has been the provision of a means of controlling the charge current rate without the aid of manual attention, or resorting to mechanical methods of control. Where the main supply is alternating a solution to this problem is provided by the development of automatic charging equipment in which the charge rate is raised from a low or trickle value to a high value, and vice versa, by the change of impedance of a saturable reactor.

When operating in conjunction with a suitable battery the combination forms the best arrangement known for supplying direct current power to equipment in which any interruption of the main power supply must in no way affect performance or service.

The charging equipment is connected permanently to the battery and load circuits, and as long as the battery voltage is above a predetermined value, a trickle charge current only will flow. As the battery volts fall to the reserve value due to loading, the trickle charge current builds up to a heavy charge rate, under the application of which, the battery volts rise slowly until the predetermined top limit is reached. At this point the charge rate reverts to the trickle value and the equipment is in readiness to repeat the cycle whenever the battery voltage again reaches the lower limit.

A drawback to this type of equipment in the past has been due to the liability of the mains voltage to come accidentally into contact with the battery circuit, thereby causing high risk of shock to anyone attending to the equipment while not switched off, or even to anyone using the low tension circuits. On the improved equipment described hereafter this risk has been reduced to negligible proportions without in any way sacrificing other desiderata, in fact several important points have been gained and are stated, together with the other general advantages of reactor controlled equipment.

THE PERMEACHARGER.

The new type of equipment is referred to by the name of Permeacharger—a title which is exclusive to equipment of Ericsson manufacture.

The main difference between this and other reactor controlled equipment is, that in the latter case the control coils of the regulating chokes are connected directly in the high tension supply circuit, whereas in the former they are connected in the secondary or low tension circuit.

In order to operate satisfactorily on the secondary side however, resonating windings (J-K Figure 3) have been added to the control reactors, thus making the reactors serve in the dual capacity of control chokes and impedance matching transformers. This feature is protected by letters patent and enables the necessary control resonance to be established on the secondary or low tension side of the main transformer without the need for an excessively large resonating condenser block.

The voltage values at which it is desired to commence and terminate charge are controlled quite simply and independently by two adjustable resistors, which are firmly

locked in position when once the correct setting has been established.

A battery voltage alarm relay is fitted when specified and serves to indicate that the battery is not receiving charge at the appointed voltage value ; failure may be due to any reason e.g. mains breakdown, fuse blowing etc.

Complete manual control is arranged so that any abnormal conditions of charge can be met, for instance, a prolonged failure of the main supply voltage may cause the battery to become exhausted, and when the mains are restored maximum traffic conditions may prevail simultaneously with the mains voltage being low. Under such a combination of circumstances, the Permea-charger would meet the load demand and maintain the battery voltage, but the rate of charge replacement would be low and a temporary boost therefore becomes desirable.

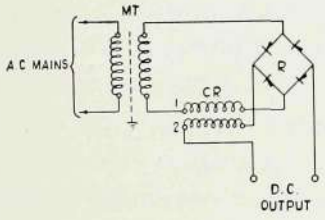

Fig. 1—Schematic Circuit

The ideal adjustment of reactor controlled equipment ensures that a large proportion of the battery capacity is always available for reserve purposes, hence in the case of lead acid cells it is arranged that the charge is applied when the cell voltage falls to something in excess of two volts, the best value however depends on the discharge rate of the battery.

Nickel-cadmium batteries are frequently used with these equipments, and the combination is very satisfactory. The voltage per cell however is much lower than for the lead acid battery and therefore must be given special consideration.

DESCRIPTION OF OPERATION.

Figure 1 indicates the broad principle of the scheme. The alternating current mains are isolated and stepped down to a suitable value by transformer M.T. The output of this transformer is applied via the choke winding CR.1 to the back of the rectifier bridge R. The rectified alternating current is then fed out to the load circuit via the saturating or magnetizing winding CR.2 of the choke coil. With such an arrangement the output current, by virtue of winding 2 changes the impedance of winding 1 and hence influences considerably the shape of the output characteristic.

A typical output curve is shown in Figure 2 and refers to performance when on resistance load. When a system having a characteristic of this shape is connected to an accumulator battery the voltages of both battery and charger are identical and the combined performance becomes as follows :—

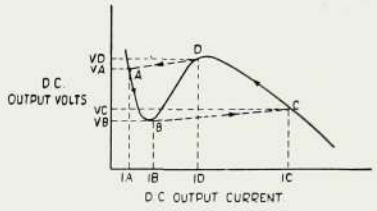

Fig. 2—Typical Output Curve

Assume the battery voltage coincides with the point VA in Figure 2 ; then current IA is delivered by the charger and is of a trickle charge value. As the battery volts decrease due to loading, the section A-B of the characteristic is traversed slowly until point 'B' is reached, and current IB is flowing. At this point a rise in output voltage and hence current takes place, and is due to the combined effect of the rapidly decreasing choke impedance and decreasing rectifier resistance which are both now occurring. This current increase, by

virtue of magnetizing winding 2 on the choke, causes a further rise in output current and so on until a degree of choke magnetization and rectifier current density is reached, at which no further rise in current is possible. This state occurs at point C and full charge current IC flows. The time taken to change from point B to point C is from one to two seconds. The battery voltage now rises slowly, due to the presence of the full rate charging current, and the section C-D of the characteristic is traversed, the time taken in this instance however is dependent on various factors such as battery capacity, condition, voltage

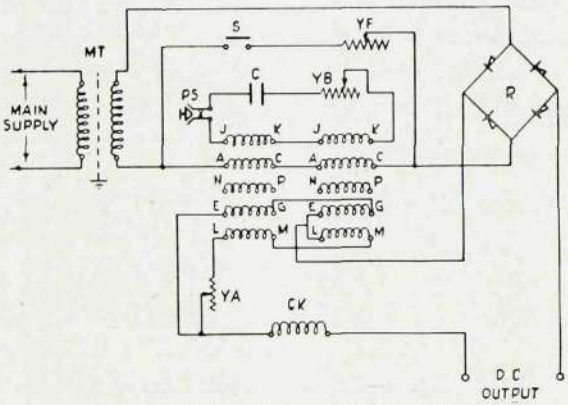

Fig. 3—The Circuit Diagram

limit etc. When point D is reached eventually, the choke impedance and rectifier resistance commence to rise rapidly, and the reverse process to that described above occurs, with the result that point 'A' is regained quickly, and the charge current re-assumes the trickle value 'IA' The whole cycle is completely automatic and occurs just so often as the discharge rate and battery condition demand. It will be seen that voltages VB-VD represent the extremes of the battery voltage range and are dependent on the positions of points B and D of the curve.

This completes the outline of the general principle of operation, but several important elaborations are necessary when operating under practical conditions. These consist essentially of (*a*) Preventing a.c. interference in the direct current circuit, due to coupling between the reactor coils, (*b*) Enabling the critical voltage values VB and VD (Figure 2) to be readily adjusted or altered, (*c*) Preventing the critical voltage values from changing due to ambient and internal temperature changes, (*d*) Maintaining the critical voltages against changes in supply voltage, (*e*) Providing manual control to deal with abnormal conditions, arranged as follows :—

(*a*) Alternating current interference with the direct current circuits is prevented by dividing the control choke C.R. (Figure 1) into two units as shown in Figure 3, and reversing one of the connections to the magnetizing windings E-G. Thus the alternating electromotive forces induced in the two half windings in the direct current circuit, cancel out and are harmless.

(*b*) Control of the 'on charge' and 'off charge' voltages is effected by shunting the magnetizing windings E-G with an adjustable resistance YA, also mutually coupling up a resonant circuit, consisting of choke windings J-K, condenser C and resistance YB with the impedance windings A.C. The resistance YB provides adjustable damping to this circuit. The function of the shunt is to allow the degree of direct current saturation to be varied in relation to the magnitude of the output current; the core permeability is therefore changed, and hence also the internal impedance of the equipment, thereby resulting in a changed voltage output characteristic. Altering the value of the shunt therefore enables the voltage characteristic shewn in Figure 2 to be raised or lowered as required. The resonating circuit is arranged so that resonance occurs during the early part of the characteristic, in the region of point B,

Figure 2, hence this part of the characteristic only, will be affected substantially by the resonant effect. The degree to which this effect influences the internal impedance of the equipment is determined by the magnitude of resistance YB. It can be seen therefore that by manipulating resistances YA and YB the shape of the characteristic can be controlled to a nicety, and wide or narrow voltage limits selected as desired on any one equipment. Push key PS Figure 3 enables the resonant circuit to be disconnected fleetingly and thereby provides a simple means of bringing the battery on charge manually yet allowing normal automatic conditions to prevail immediately charge has been established.

(*c*) Effects of temperature on the voltage limits are minimized by incorporating a part of the control shunt YA in the choke coil assembly, and making it of pure nickel wire, winding L-M in Figure 3. By this means the ratio of shunt resistance to magnetizing winding resistance is kept reasonably constant over quite a useful range of temperature variation.

(*d*) In cases where the permissible variation of battery voltage is low, say ± 4% of nominal, it is necessary to provide a mains voltage compensating unit. This unit is mounted inside the main equipment and automatically prevents excess variation of the "on" and "off" charge voltages of the equipment even if the mains voltage varies between limits of ± 6% or more. The unit contains a wheatstone network with barretter lamps in two of the bridge arms, and the out of balance (or compensating power) is fed via a miniature metal rectifier to the choke coil windings N.-P. In common with the main equipment the design of this unit has been carefully chosen so that deterioration of the components is kept to a minimum, for instance, the barretter lamps operate always at filament temperatures well below the incandescent point, and a three fold factor of safety is given to the small output metal rectifier.

(*e*) Manual charge is brought on by closing switch S (Figure 3) and the charge rate is controlled by resistance YF.

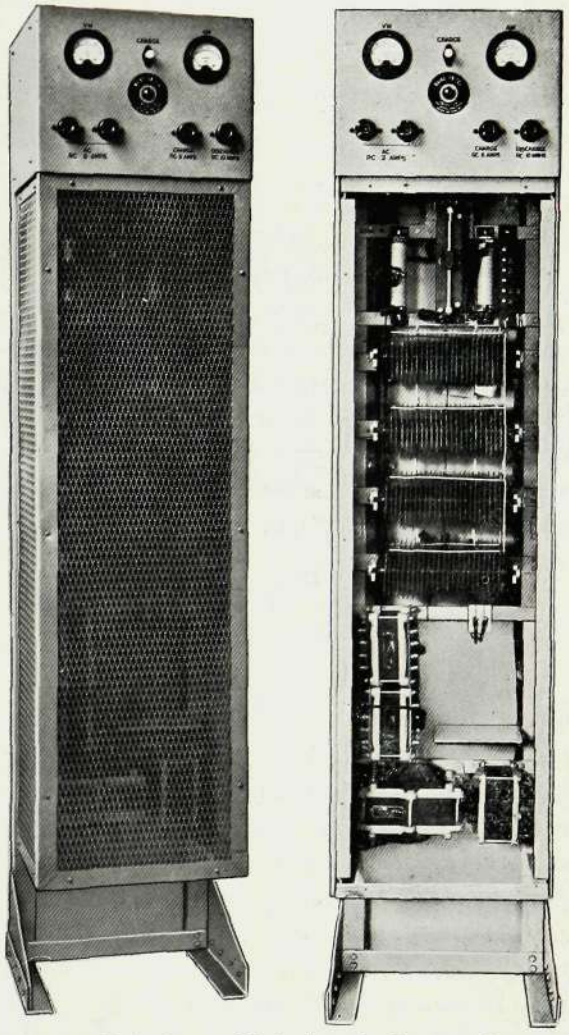

Fig. 4—Exterior and Interior of a Permeacharger

Exterior and interior views of a Permeacharger equipment are shown in Figure 4.

Figure 5 shews a typical performance characteristic of the equipment which is compensated for both mains voltage variation and temperature variation. The curve shows that up to a load of 2.75 amps the

battery will be floated at voltages between 47.5 and 52. With a 24-cell lead battery, this represents a minimum cell voltage of 1.98 volts per cell, which means that when discharging at the 10 hour rate an approximate full capacity reserve will always be available.

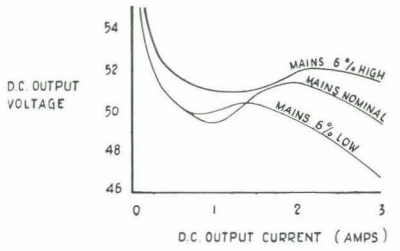

Fig. 5—Performance Characteristic Curves

The low voltage alarm unit is accommodated within the main equipment and has been designed to avoid the danger of premature operation due to extraneous vibration, also to afford extreme ease of alarm voltage selection.

Features of "Permeacharger" Battery Charging Equipment.

All control gear i.e. chokes, condensers etc. is connected to the low tension (or secondary side) of the mains isolating transformer. This enables the H.T. mains to be restricted to a single short run of conduit enclosed cable between incoming points and the transformer primary terminals only. Hence when a cover is removed, any part of the exposed equipment may be touched with absolute safety. Also the need for protective earth screens in the control chokes is avoided.

All voltages on the 110V and 220V ranges can be easily accommodated on one equipment. This feature is ideal for stock purposes and most useful where a change in mains voltage by the supply company occurs.

Due to the isolation of the mains voltage it is quite possible to operate these equipments off the " outer " conductors of 3-wire distribution systems. This is of importance when tropical conditions are under consideration, and low voltage supplies are not always available. Since it is possible to operate safely these equipments off the " outer " conductors, extremely large single phase equipments could be constructed without disturbing the balance of the distribution network.

The system of operation provides a stable source of low tension a.c. for operating thermal signal devices etc.

Permeacharger equipment offers the above in addition to the advantages afforded by reactor controlled apparatus generally, and which may be summarized as follows :—

(1). There are no moving parts of any kind, and no maintenance whatsoever is required by the charger.

(2). Owing to the gradual reduction of charging current as charging progresses, more amp-hours can be put into a given battery, over a restricted voltage limit, than with mechanically controlled equipment.

(3). Owing to the absence of moving parts, reliability is higher than with any other class of equipment. For tropical conditions, or where atmospherical pollution is present, this feature is of particular value.

(4). Since there is nothing to wear or deteriorate, no replacements are required.

(5). The equipment is more compact than the mechanically controlled type.

(6). Adjustment is simple, and more accurate and permanent than on mechanically operated types.

(7). The equipment is exceptionally robust for transit, etc.