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Group Selector Rack with Grading Facilities

THE group selector rack with grading facilities, as used in British Post Office exchanges of the " 2000 " type, is primarily designed to facilitate the speedy re-grouping or extension of exchange equipment in response to increased traffic demands, with the minimum disturbance of existing cabling and subscribers service. This aim has been achieved by introducing a cabling and grading arrangement more flexible than heretofore and by a greater degree of standization in equipment.

Use of 200-outlet Selectors.

Variations in equipment peculiar to group selector racks of earlier design have been eliminated, one important decision being to discontinue the use of 100-outlet selectors. Statistics prove that the percentage of such switches in service is negligible compared with the number of 200-outlet selectors and, therefore, the slight increase in initial cost incurred by always using the larger switch, is amply justified by the following advantages :—

(*a*) Full interchangeability.

(*b*) Reduction in the number of parts to be stocked by the customer and manufacturer.

(*c*) Fewer drawings and diagrams to be prepared and accommodated.

(*d*) Easier maintenance.

(*e*) Greater availability of supplies due to smoother flow of production.

Cabling Scheme.

Ample proof of the limitations in flexibility of cabling schemes utilizing centralized T.D.F.s has been obtained through past experience in extending exchanges in this country. As most of the interference with existing cabling is due to the re-grouping and extension of group selector equipment, it was apparent that this could be largely obviated by making the group selector rack and its associated cables into a self-contained unit, with sufficient trunks provided initially to meet all reasonable ultimate requirements. Accordingly, development proceeded on these lines and resulted in the cabling arrangement shown schematically in Figs. 1 and 2.

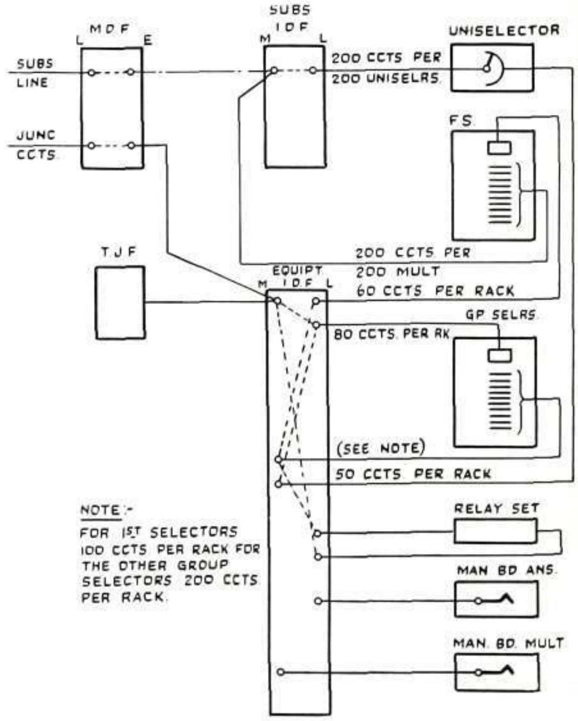


Fig. 1—General Cabling Scheme

Eighty incoming and 200 outgoing trunks per rack are cabled to the I.D.F.—excepting first selector racks, when the number of

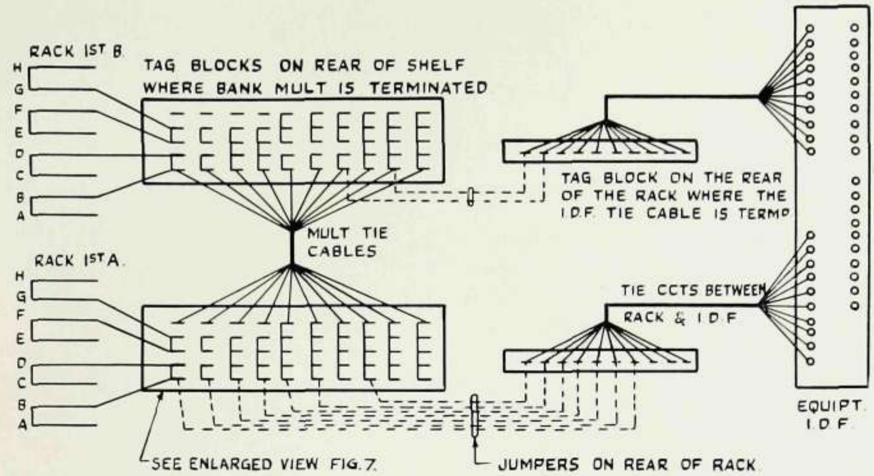


Fig. 2—Rack Wiring Scheme, showing Jumpering and Strapping Facilities

outgoing trunks is 100—and the full complement of tie cables is provided initially between all racks in any particular rank of selectors, connections between ranks being made at the I.D.F.

A study of Figs. 2, 4 and 7 will indicate how the outlets of each set of 20 banks are terminated on the multiple connection strips, from whence they can be strapped to the rack-to-rack tie cable tags or jumpered to I.D.F. tags, so that, by means of jumpers on the I.D.F., and jumpers and bare tinned copper straps on the rack, any desired grouping and grading can be arranged.

Initial cabling costs are rather high, but this is counter-balanced by the saving in material and labour through the avoidance of scrapping and rearranging existing cables and running in new ones when exchanges are extended.

The increase in the number of I.D.F. verticals necessitated by the new scheme, particularly at the larger exchanges, where the I.D.F. is already somewhat cumbersome, has resulted in a division of the frame. The subscribers I.D.F. is located near the M.D.F., and the equipment I.D.F. near the group selector, relay set, etc., racks, giving the advantage of shorter cable runs.

Rack Design and Equipment.

The degree of standardization achieved has made the rack suitable for all "2000"-type switches of the group selector class in either director or non-director areas, the only variable being the multi-metering feature which can be quite simply added when necessary.

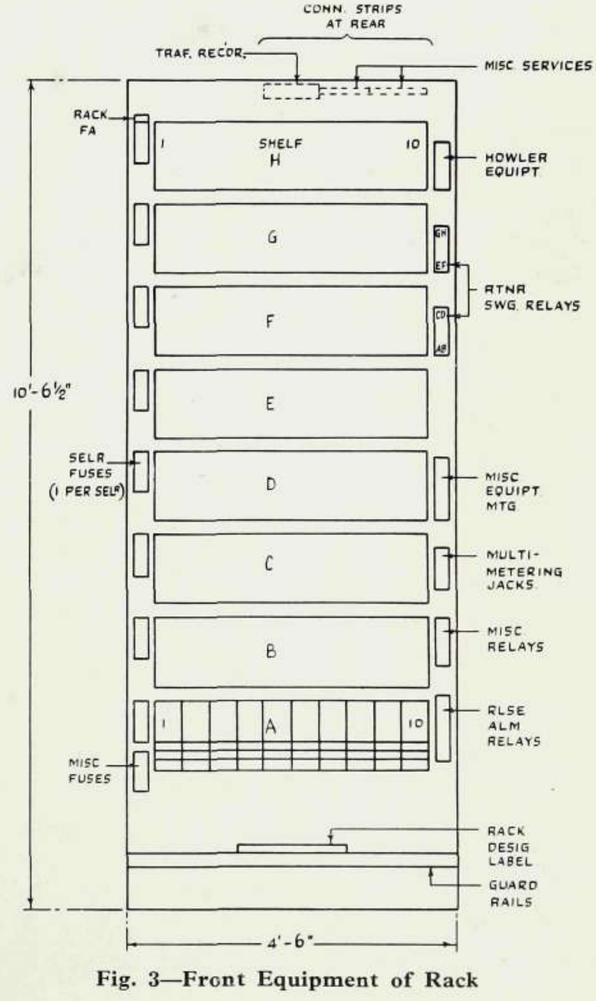


Fig. 3—Front Equipment of Rack

Two sizes of rack are provided for, viz.:

(*a*) 10′—6½″ high x 4′—6″ wide, with capacity for 8 shelves of 10 selectors.

(*b*) 8′—6½″ high x 4′—6″ wide, with capacity for 6 shelves of 10 selectors.

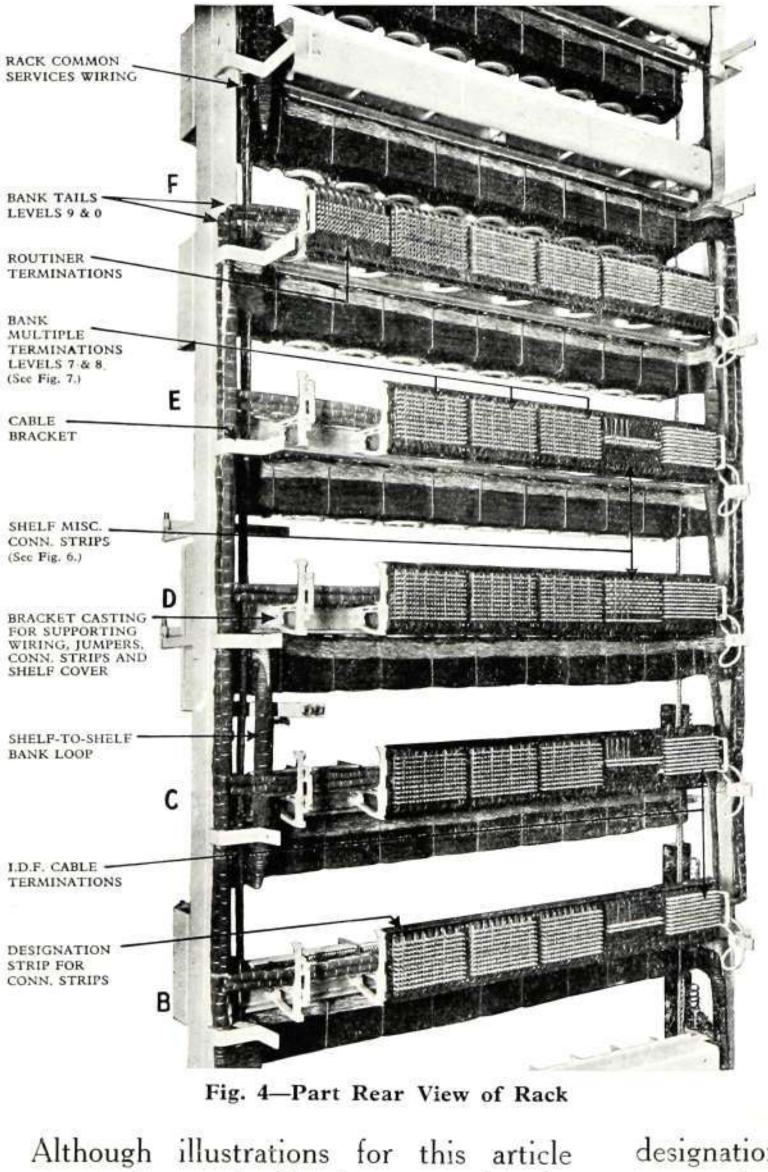


Fig. 4—Part Rear View of Rack

Although illustrations for this article present views of the larger rack, the principles and general layout apply to both (*a*) and (*b*) above.

Rack and shelf construction is similar to that of other selector racks of the "2000" type, as are also the arrangements for mounting bus bars and common services equipment.

The main variations from previous practice with regard to equipment are as follows:—

(1) Location and arrangement of common services equipment.

(2) Provision of one fuse panel per shelf (Fig. 3).

(3) Arrangement of connection strips at rear (Fig. 4).

(4) New design of bracket casting to facilitate jumpering and to accommodate a metal designation strip for tag marking (Figs. 4 and 5).

(5) New design of cable support for rear of rack uprights. A jumper ring is attached to the cable supports on the right-hand upright (Fig. 4) to allow for jumpering between shelves.

(6) Excepting jacked-in units, racks are always fully equipped.

Certain innovations which are also applicable to other equipments have been included, these are:—the provision of designation strips on the ends of shelf connection strips for marking the rows of tags, and the employment of transfers in lieu of printed labels and signwriting. The transfers are arranged to show black characters on grey, and silver characters on black surfaces.

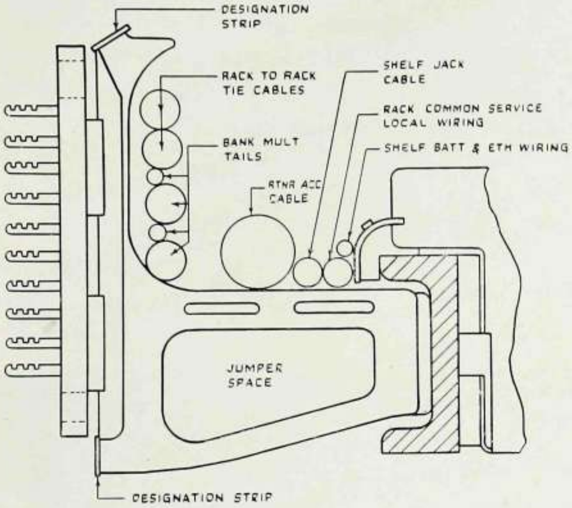


Fig. 5—Cross-Section of Shelf, showing Location of Cables and Wires

All services are included in the rack local cable which is fed down both uprights to limit build-up. The provision of one fuse per selector enables battery and earth local cables to be individual to each shelf, as are also the 11th contact connections.

A separate local cable per bank multiple is fitted for multi-metering facilities when specified. Three spare level circuits are terminated on the miscellaneous strip on shelf " F " and are multipled to other shelf miscellaneous strips so that NU tone can be applied to any level by straight jumpers along the shelf.

The appearance of the rear of the rack with external cables and vertical jumpers connected, can be seen in Fig. 8.

Rack Wiring.

Fig. 4 is the rear view of a rack illustrating the local wiring prior to the fitment of switchboard cables.

A tail from each group of 20 banks is arranged to terminate two levels on each of five shelves, in the manner shown in Figs. 6 and 7, the routing providing for two tails on each upright, and four along each shelf to the connection strips. The provision of a separate tail for each pair of shelves facilitates wiring, as only two wires of the same colour leave each stitch of the cable arm to be fed through any one fanning hole, and discrimination between the two levels terminating on the same connection strip can be made by having skinners of different length.

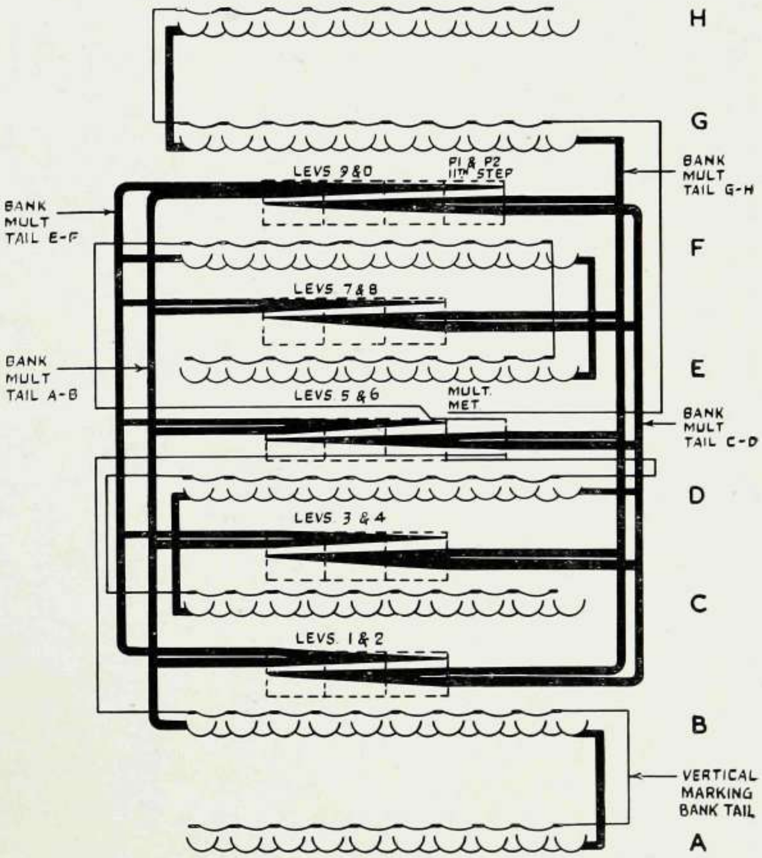


Fig. 6—Arrangement of Bank Multiple Tails at Rear of Rack

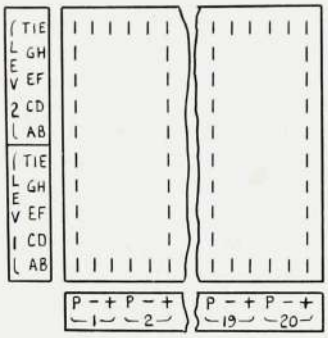


Fig. 7—Allocation of Tags on Bank Multiple Connection Strips

GRADING AND CROSS-CONNECTING.

As grading is carried out on the individual racks, it is not possible to obtain the true "picture" which could be seen at the T.D.F. under the old scheme. A typical 18-trunk grading is shown in Fig. 9 but the actual physical arrangement is illustrated in Fig. 10 which gives details of the B.T.C. strapping, the jumpers and the tie cables. The number on each jumper—represented in Fig. 10 by an oblique line—is the number of the tie circuit to the I.D.F.

It will be seen that rack-to-rack tie cables are wired from the "tie" tags of the first rack to the "AB" multiple tags on the succeeding rack, therefore, to extend a group to the next rack it is necessary only to complete the connection in B.T.C. between the "TIE" and shelf "GH" tags.

Spare outlets of working levels are "busied" by applying an earth to the "P" wire. This is accomplished by commoning all such outlets on the bank multiple connection strips, a jumper being run from the 20th outlet to an earth tag on the shelf miscellaneous strip.

For spare levels, outlets 4 to 20 are earthed and outlets 1 to 3 are jumpered horizontally to the appropriate spare level tags on the shelf miscellaneous strip.

The P1 and P2 wires of 11th step outlets are brought out from each multiple to a connection strip on shelf F (Fig. 6) on which they are strapped to the tags

Fig. 8—Rear View of Rack with External Cables and Jumpers

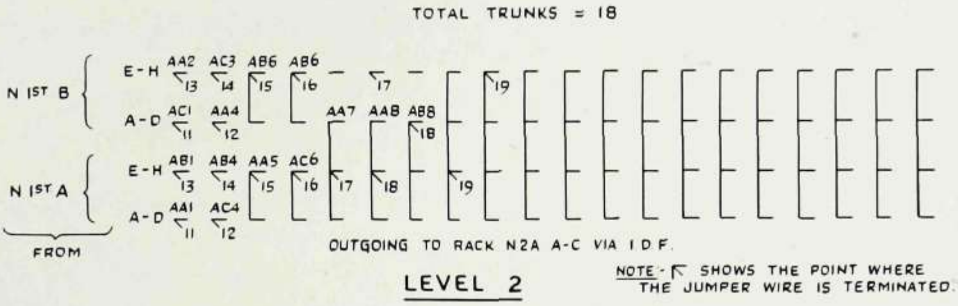


Fig. 9—Typical 18-trunk Grading

terminating the traffic overflow meter cables. A similar strapping arrangement is employed on a special connection strip on shelf " D " for associating the vertical marking bank terminations with the pulse supply circuit tags for multi-metering, and routiner leads are wired to a separate strip on shelf F. One set of routiner switching relays is supplied for each pair of shelves and the test line is busied successively by each set of relays covering the particular grading.

It will be appreciated that only the main features of the new scheme can be described in an article of this nature, and, as the development is comparatively recent, some time must elapse before its long-term economic benefits can be fully realized.

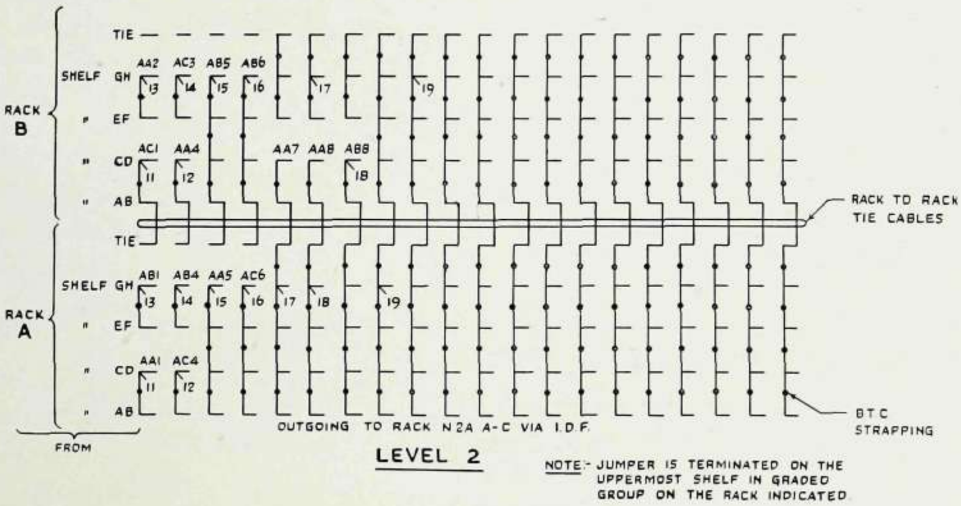


Fig. 10—Strapping and Jumpering Diagram for Grading shown in Fig. 9

Some Vibratory Mechanisms and Their Applications

THE vibratory mechanisms described in this article are of the type which incorporate a freely oscillating armature, the natural periodicity of which is determined by the stiffness and moment of inertia of the moving system. Electrical contacts are fitted and are used for producing electrical pulses in associated circuits at a frequency dependent upon the armature periodicity. Simple mechanisms operating on this principle appear in the telephone world in the form of tone and polechanger relays, and are used mainly for generating 400-cycle tone and 25-cycle ringing supplies for signalling purposes in certain types of exchange equipment.

Vibratory mechanisms, however, have also a wide application in the sphere of light current engineering. For example, in conjunction with suitable equipment they are used for generating the high tension A.C. and D.C. supplies needed by battery operated electronic equipment, for aerial switching purposes in radar equipment, and for chopper purposes in sensitive bridge detector devices etc. Applications of this nature became of great importance during the war years with the result that a large amount of government sponsored research was undertaken to produce vibratory equipment of specialized types capable of meeting the high standard of performance demanded from service equipment.

The Company collaborated with the various research establishments in this interesting and important programme, the outcome of which has been the standardization of a number of original designs. The new units operate at frequencies of 25 to 110 cycles and are suitable for purposes additional to those for which they were originally designed ; for this reason it is considered that a description of them, and of our post-war designs of tone and polechanger relays, will be of general interest.

The apparatus described, in this necessarily brief article is as follows.

1. Miniature 25-cycle oscillating motor switch with high-voltage, low-capacitance contacts.
2. 110-cycle synchronous split-reed vibrator.
3. Miniature 3-watt 25-cycle DC/AC converter for portable use.
4. 25-cycle polechanger relay for telephone exchange use.
5. 400-cycle tone relay.

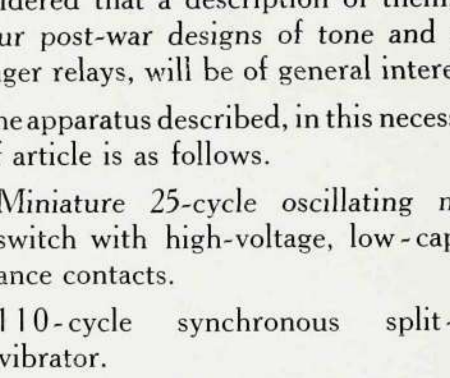


Fig. 1—25 c/s Oscillating Motor Switch

25c/s Oscillating Motor Switch.

This unit is designed for use in airborne radio location equipment, and replaces much larger rotary gear. It is illustrated in Fig. 1, and consists essentially of a small fly-wheel armature mounted on a specially selected ball bearing. A single changeover springset (twin contacts) is coupled to the fly-wheel and the whole is driven by a small electro-magnet. A separate cam-operated spring-set is provided for interrupting the magnet circuit.

The standard unit operates on a voltage range of 18 to 30, over which the frequency change is less than 1·25c/s. Contact time efficiency is 45% make for each side of the changeover, and contact bounce is limited to 5% of the early make period. The operating power is extremely low, being of the order of 0·7 watts.

A small filter unit is built in, and allows the single changeover contact to function simultaneously in two frequency channels of differing periodicities.

The unit is unsealed but is panclimatically finished. Aluminium alloys are used wherever possible and result in the total weight being kept down to 9 ozs.

110 c/s Synchronous Vibrator.

This mechanism is primarily intended for use in power packs which produce high tension D.C. voltages from a low voltage battery source. It was developed during the early stages of the recent war to meet the need for a synchronous split-reed vibrator of high performance capable of operating for at least 1,000 hours when developing 30 to 40 watts D.C., also, as it was required for use in airborne equipment, it had to be capable of operating reliably in the low air pressures encountered at high altitudes. The term "high performance" in the case of a vibrator, *inter alia*, infers a low order of contact bounce, uniformity of frequency, and low power consumption.

The unit which eventually met the requirements is shown in Fig. 2, and is well known as the A.M. Type 14 vibrator. Its layout differs considerably from the more conventional types and enables good reed length to be obtained in relation to overall height. The springsets are accessible and their design enables tensions and clearances to be adjusted simply and independently, so enabling a close specification to be met under production conditions.

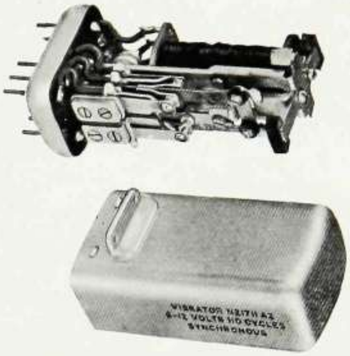


Fig. 2—Vibrator A.M. Type No. 14

The unit is sealed with bonded rubber, a method which is particularly suitable for vibrators on account of the fortunate combination of electrical and mechanical properties that exist in properly compounded rubber, making possible the production of a seal that is sound absorbent, shock proof and immune from expansion troubles over a wide range of temperature. In addition good electrical insulation is obtained. Some of the more important performance data and features of the unit are given below :—

Operating voltage:–6 and 12 volts ± 25%, (operation on higher voltages is possible by connecting a suitable impedance in series with the drive coil).

Driving Power : 1·7 watts.

Frequency : 110 ± 2·5 c/s.

Contact ratio :—
L.T. contacts 40 ± 2% make.
H.T. ,, 35 ± 2% ,,
Minimum overlap = 3%

Contact bounce :—
Max. of 5% at the early make period.

With regard to load rating, it is difficult in the case of vibrators to quote hard and fast values as so much depends upon the conditions of use, system voltage, circuit and load conditions, etc. In all cases, therefore, where applications differ from those specified it is strongly recommended that the makers' advice should be sought.

A new edition of the type 14 unit is in course of preparation ; the mechanism however will remain substantially unchanged but the container will be cylindrical and will be fitted with an octal plug-in base.

Fig. 3—Miniature 3·5-watt DC/AC Converter

MINIATURE 3·5-WATT DC/AC CONVERTER.

This converter produces a 60-volt, 25 c/s alternating current supply from a 12 or 24-volt D.C. source. It is a self-contained unit (see Fig. 3) and includes a miniature balanced armature vibrator relay, transformer, spark quench and buffer condensers. Due to the balanced armature on the vibrator the unit is free from orientational troubles. This new design was developed to provide a compact and reliable source of ringing power for field exchange use. It is only half the size and weight of earlier equipments and, moreover, affords a 15% greater output with greater efficiency.

The problem of voltage stablisizing the low frequency vibrator relay is solved by the introduction of an electrical feed-back device. This permits a small component of the A.C. output to be fed back into a winding on the drive coil of the vibrating relay, so confining the amplitude of the oscillating armature to within reasonable limits over an input voltage change of ± 20%. This problem of amplitude stabilization has been one of the chief obstacles to the miniaturization of low frequency oscillating relays, and becomes progressively acute as size is reduced in relation to frequency.

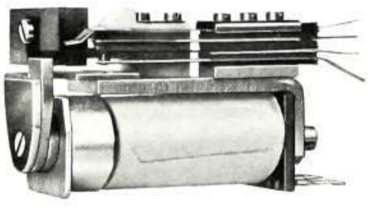


Fig. 4—25-cycle Vibrator Relay

25-CYCLE VIBRATOR RELAY FOR EXCHANGE USE.

This relay is used, in conjunction with suitable equipment, for producing a ringing supply of the order of 3 V.A. and is illustrated in Fig. 4. It is built on the lines of P.O. 3000-type relays and mounts on a standard mounting plate, occupying the space of only one relay. Amplitude is stabilized against voltage variation by means of a copper slug fitted to the fore end of the coil. This slug allows a high initial magnetization to be reached during starting i.e. before conditions have become cyclic, but reduces the effective magnetization when the reed is in motion. A high and reliable contact pressure is therefore obtained on the drive contact, without risk of starting failure under low volt conditions.

The changeover springset is not complicated by buffering and is extremely simple to adjust. The contacts are of tungsten, and the windings are suitable for 24 and 50-volt supplies.

400-CYCLE TONE GENERATING RELAY.

This relay is primarily intended for exchange use and is shewn in Fig. 5. It is of the essentially free reed pattern and like the 25-cycle relay just described, is similar in construction to P.O. 3000-type relays. The design retains a number of the well proven features introduced by its predecessor, chief of which are, an exceptionally rigid reed platform and a compliant drive contact spring of high natural periodicity. The combination of these two features enables a degree of contact-follow to be obtained considerably beyond the usual amount for this class of relay, with the result that maintenance attention is correspondingly low.

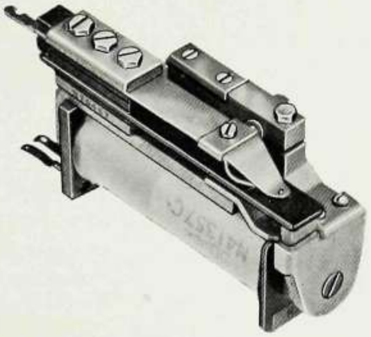


Fig. 5—400-cycle Tone Generator Relay

Adjustment of the drive spring is facilitated by the introduction of an eccentric cam which enables the position of the spring to be controlled to a nicety from the front of the relay.

The unit produces tone of good quality over a voltage variation of ± 25% and is suitable for use in the majority of tone circuits associated with exchanges of moderate capacity, e.g. rural automatic exchanges, P.A.X.s, etc. Tone may be taken from primary or secondary windings on the unit or from a separate transformer operating in parallel with the driving coil.

Owing to space limitation it has been necessary to confine this article to little more than descriptions of the more useful types of mechanisms and some of their applications. It is hoped nevertheless that the versatility of this class of equipment has been demonstrated. Field experience during the war years has proved that when properly designed and constructed, the standard of reliability is of the highest order. The confidence so won has led to the demand for new types of mechanisms to meet ever increasing applications. New development programmes have therefore been instituted, and the long period of collaboration with the Services in this useful field of light current engineering is to continue.

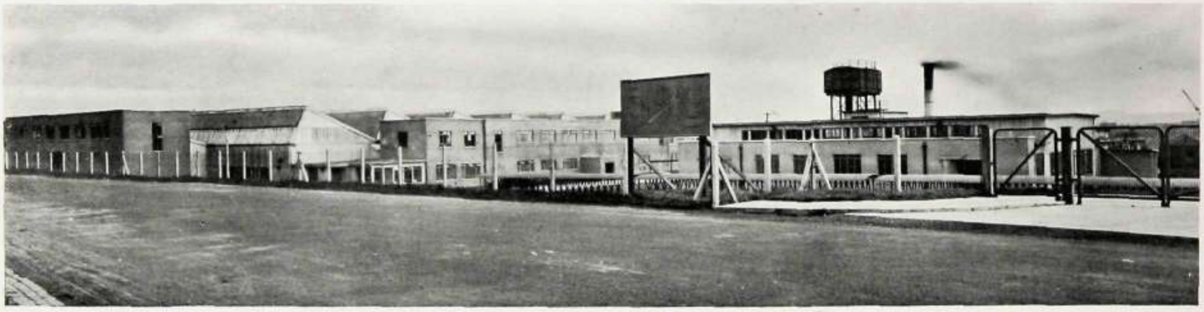
Scope for scientific treatment is greater than may be at first apparent as many branches of applied physics are involved; e.g., the studies, of the strength and fatigue of modern materials, of the mechanics of oscillatory mechanisms, of gasfilling and pressurization of contact performance, etc., all require specialized treatment in order to produce the well balanced designs necessary to accord with present day standards.

Application of the mechanisms also creates many problems; in the case, for example, of DC-AC power converters the questions of automatic voltage regulation and commutation of contact current exemplify some of the factors that require sound analysis from the electrical point of view.

New equipment now in course of preparation includes low consumption miniature DC-AC power converters for "walkie-talkie" radio equipment, medium power high frequency converters for aircraft and general mobile use, and high power converting equipment for miscellaneous application.

Some of these developments it is hoped will be reviewed in future bulletins.

Sunderland Factory



DURING the war, because of the vital nature of communications equipment, telephone manufacturers were encouraged and assisted to expand production by taking over factories and premises which were vacated due to the suspension or telescoping of peacetime industry. As a result of this policy the Company at one time was using as additional production space part of a printing works, two textile factories and parts of two others, a large garage, and part of the office block of a large brewery. Most of these premises were within a ten-mile radius of Beeston works and all of them within a twenty-mile radius, but they enabled a greatly increased labour force to be reached, which stepped up war potential considerably.

When the war ended and the big swing-over to peacetime production began, some of these satellite factories returned to their normal peacetime uses, while others were found to be uneconomical under the new conditions, owing mainly to some of the personnel resuming their peacetime occupations. It was evident at this time, that the Company would be called upon to supply increasing quantities of telecommunication equipment in the post-war period and that it could not therefore complacently contemplate the surrender of all this space. On the contrary, the programme of work ahead was such that expansion even beyond war-time capacity seemed necessary. Extension of the Beeston works by new building could only be regarded as a long-term policy and, in any case, was a doubtful economic proposition due to the severe shortage of female labour in the district. The need was for modern factory space in a location where labour, particularly female labour, was readily available.

Help was solicited from the Government and some possibilities were examined, notably at Spennymoor in Yorkshire, and at Blyth, just north of Newcastle.

None of these was entirely suitable, however, but eventually, in June 1946, the Board of Trade was able to offer the Company a factory at Sunderland which provided all the required facilities.

Built during the latter stages of the war, the factory had become redundant when the war ended. Of modern construction, with fifty thousand square feet of production space in one large workshop (Fig. 1), and located in an area where shipbuilding was the staple industry, ample female labour was available. It was at once realized that this was a sound economic proposition in spite

Fig. 1—Interior View of Production Shop in the Early Days

of the considerable distance (165 miles) from the main works at Beeston. Furthermore, it aided the Government's plan of providing new and regular work in development areas.

The factory is built as a complete unit and in addition to the workshop, has an administrative and office block, tool room, covered incoming and outgoing bays for unloading and loading lorries, first aid and rest rooms, cloakrooms, and employment and timekeeping offices. Ventilation is by fresh air intakes in the roof and the incoming air can be heated by steam-fed unit heaters as required. The natural lighting is excellent and ample fluorescent tubes provide first-class artificial lighting. A covered way leads from the factory block to the canteen, a few yards away. The canteen building is adequate for the requirements and is fully equipped with food storage and cooking facilities. The dining-hall can be converted at short notice into a recreation room. All the heating for the factory and the canteen is supplied by two modern, automatically fired boilers in a separate boiler house. Working conditions are therefore of a very high order.

Although the class of work to be done at the Sunderland factory had been broadly defined by the dearth of female labour in the Beeston district, it had to be decided exactly which of the Company's many products would be most suitable for transfer and it was also necessary to get the new plant into production as quickly as possible. Complete manufacture from raw material to finished article was impracticable because of the duplication of many technicians that would be required at Sunderland and also because this procedure would necessitate a considerable number of male operators for the heavier operations, a class of labour in rather short supply in that area.

Because of these considerations it was decided that Sunderland should be essentially an assembly factory. Piece-parts fabricated at Beeston would be sent there to be made up into components which would be further assembled into complete units, wired-up and, as far as possible made ready for despatch to customers.

In general, it was decided that the work to go to Sunderland should :—

(*a*) Be suitable for female labour.

(*b*) Embody as many operator hours of work, in proportion to its bulk, as possible.

(*c*) Be low in bulk to keep transport charges down.

Investigation of the transport problem showed that for the class of products, road transport was more economical than rail, that it was more flexible and had the further advantage of being directly under the Company's control. After weighing all the factors, including the possibility of adverse winter weather conditions, a decision was made in favour of road transport. The general scheme of inter-working is illustrated diagrammatically in Fig. 2.

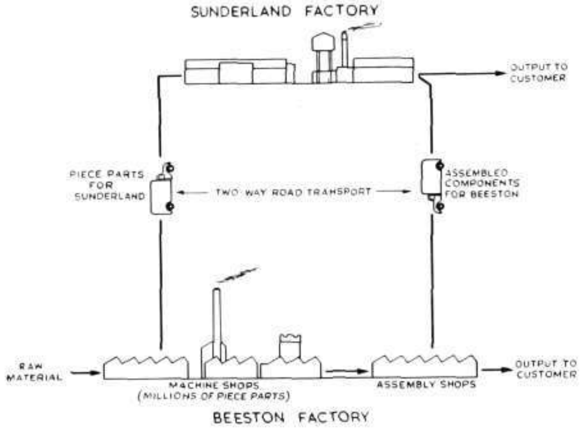


Fig. 2—Inter-working of the Beeston and Sunderland Factories

After eighteen months operation, including the severe winter conditions of early 1947, the road transport system has been proved in every way and has well justified its choice. The two-way teleprinter service which was set up between the two factories in the early days has also proved invaluable.

After the initial plans had been made it was not long before heavy transport began to move the equipment necessary for production from Beeston to Sunderland. A superintendent and a number of supervisory staff were selected from Beeston and transferred to Sunderland as residents. On these rested the responsibility, in conjunction with visiting specialists from Beeston, of setting up the new venture, training the new employees, and getting into production as quickly as possible. The rapid development of the Sunderland factory, and its present success, reflect credit on all concerned. Careful selection and training of the local labour, and the general high quality and adaptability of the new employees have also been of considerable help and encouragement. Training, except in a very few cases, was carried out on the actual production lines.

The first work to go to Sunderland, and which initiated the Assembly Section of the factory, was the assembly of P.O. " 3000 " type relays (Fig. 3). This section has since become responsible for assembling lever keys, heat coils, "alnico" generators and selector banks, in addition to sufficient P.O. " 3000 " and " 600 " type relays to meet all the requirements of the Beeston and Sunderland factories. The flow line assembly method is used in connection with the work on generators, banks and relays and adjustment of the relays is done on the beam-balance principle.

The Assembly and Wiring Section, part of which is shown in Fig. 4, began operations with the wiring-up of selector multiple banks and later extended its activities to the assembly and wiring of relay sets and line assembly and wiring of bakelite telephones.

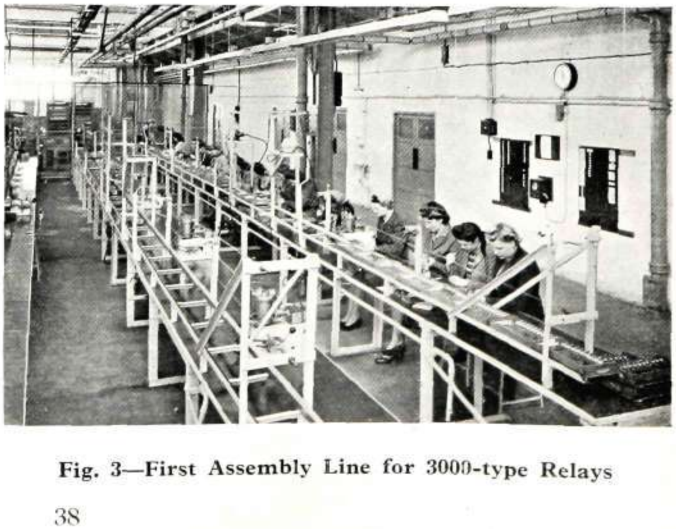


Fig. 3—First Assembly Line for 3000-type Relays

Fig. 4—Wiring Jack-in Relay Sets

Coil Winding is the latest section to be set up, the object being to provide coils for the use of the other sections. Relay coils, ringer coils, and receiver coils are already in production, and these will be followed by induction coils and generator armatures. Automatic and hand winding machines are in operation on an increasing scale, and equipment for impregnating and stoving has been provided so that coils with tropical finish can be produced. This section is responsible for the assembly of its own bobbins.

With the foregoing three main sections in operation, Sunderland factory constitutes an integrated production unit through which a valuable contribution is made to the Company's output of finished products.

It will be appreciated that setting up a new factory on the scale indicated required continuous planning and constant liaison between all concerned. An essential requirement was that production should not be interrupted, and this meant that transfers of work had to be carefully timed, labour had to be available and ready to start when required, and in many cases, tools and other equipment for production had to be duplicated. In view of the distance from the parent works, with its comprehensive maintenance and repair services, reserves of machinery and tools were provided.

The development of the new venture from the date of taking over the premises is illustrated in Fig. 5. Plans have been made to employ eventually a total labour force of more than 1,000 people.

Every attention has been paid to the well-being of the employees, and it has been gratifying to learn that both the local authorities and firms in the vicinity have been warm in their praise of the factory conditions and welfare arrangements. The first aid and rest rooms, both of which are well equipped, are under the supervision of a fully qualified nurse, and importance is attached to the athletic and social activities.

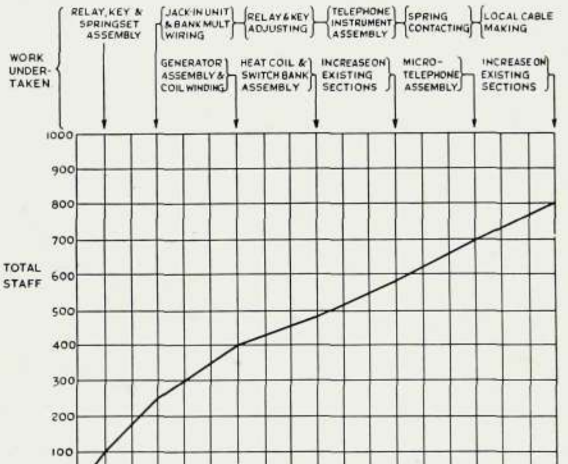


Fig. 5—Graph Illustrating the Progressive Development of the Sunderland Factory

Already a section of the Company's Athletic and Social Club has been formed, with 100% membership and it is hoped in the near future to extend the scope of the club to cover every kind of sport and recreation for the benefit of the employees.

Telephones for Railway Services

THE telecommunication system used for controlling traffic on the British railways has created one of the principal demands for the battery call telephone. The majority of railway circuits are omnibus working, with some form of selective ringing depending upon the operational needs. These forms range from simple discrimination between a special station and the ordinary stations, which are called by simple code ringing, and quite complex forms, such as an eight-code selective system with code ringing on some if not all of the code units.

Problems of supply and interchangeability of telephone equipment arose quite early in the history of traffic control and a solution adopted by at least one railway company was to instal simple telephone instruments having only speech and local bell circuits, providing separate key and relay equipment for calling. This arrangement simplified the position to some extent but was by no means as successful or economical as had been expected. With the growth of this type of communication, circuits were resolved into a small number of forms with a large measure of uniformity only in the equipment used by any one company, no general agreement having been reached.

At about this time, the Company was asked by one of the railway authorities to develop a polarized relay that would be smaller and more robust than the one then in use and would be interchangeable with the normal relay. As a result, plain, differential and polarized relays of the older pendant armature type were submitted, all three being interchangeable.

The formalization of circuits already mentioned and the quantities involved had led to the consideration of some measures of internal standardization in equipment, but at least one company was providing the call facilities integral with the telephone instrument, employing three types appropriate to their main classes of circuits. This practice reacted on the telephone manufacturer in that it complicated stock problems and owing to lack of uniformity led to increased production costs ; the Company therefore took the opportunity to discuss the problems with its chief customers, and with their co-operation introduced a somewhat limited form of internal standardization which overcame to a large extent the supply difficulties and gave the desired reduction in prime cost of the principal types of equipment then in use.

Fig. 1—Three-button Table Instrument

This was certainly a step in the right direction but it is only in comparatively recent years that complete standardization has been effected through the efforts of the Railway Signalling Committee.

In 1944, this Committee issued five standard specifications setting out the basic circuit and component requirements, and the disposition of equipment for table and wall battery call telephones. In preparing these specifications consideration was given to the operational needs and efficiency standards of the railway companies of Great Britain and the linking of these with the production resources of the telephone manufacturers, with the object of simplifying supply problems. From the commencement of the work the Company was invited to co-operate, and submitted a list of suggestions for standardization, with particular reference to manufacturing problems. Active association with subsequent development led eventually to the production at Beeston of samples embodying the final recommendations of the Railway Signalling Committee.

As is usual with standard specifications, these cover the essentials of size, performance, interchangeability of principal components, etc., to ensure efficiency yet reduce maintenance and spares to a minimum. This limitation of the range of components tends to increase the volume of production, thus keeping prime cost at a reasonable level. Freedom in certain detail is permitted and future improvements are not excluded so long as they are submitted and approved at the tender stage.

The speech circuit is specially devised for railway use and employs a standard Post Office No. 21 induction coil. The local circuit of 1 ohm winding, battery and microphone, is entirely separate and isolated from the line, thus the possibility of the line obtaining an unwanted earth or any stray current from this source is almost negligible.

The speech circuit has improved anti-side-tone properties and a 2μf blocking condenser prevents it from acting as a shunt across the signalling bell or relay.

In the range of instruments conforming to the specifications there are two groups :— wall telephones for general use, with bell calling, and table telephones, mainly for office use, with buzzer calling. Typical examples are illustrated in Figs 1 and 2 and wiring is uniform in plan throughout each group.

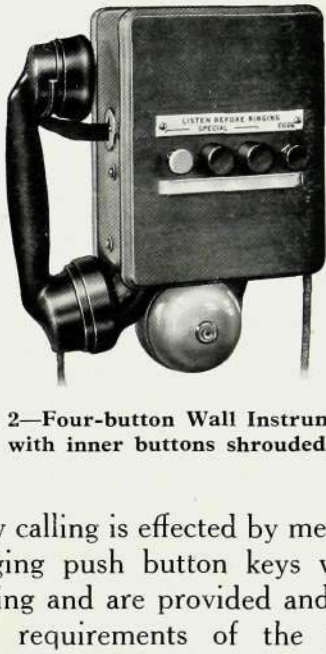


Fig. 2—Four-button Wall Instrument with inner buttons shrouded

Battery calling is effected by means of the code-ringing push button keys which are non-locking and are provided and wired to suit the requirements of the particular system for which the instruments are intended, as is explained later.

The simple 1-button telephone is arranged for the direct operation of its bell or buzzer but the 2, 3 and 4-button instruments are provided with a relay for operating the audible signal.

This relay may be of the plain or polarized type and it will be seen, by reference to the list of instrument codes at the end of this

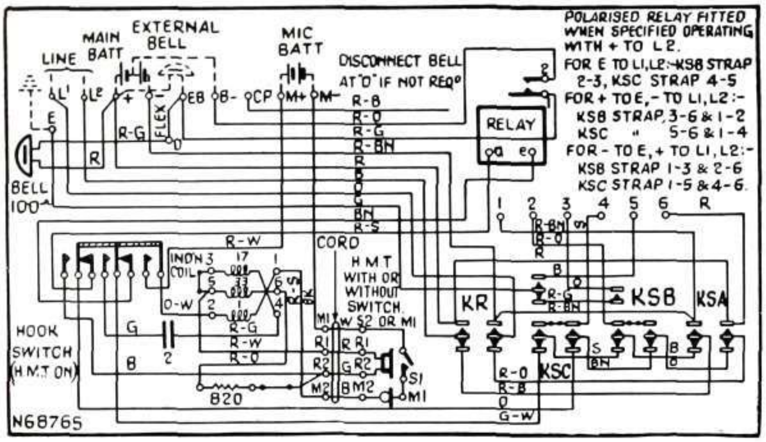


Fig. 3—Paster Wiring Diagram for Four-button Wall Instrument

article, that calling arrangements are comprehensively covered by the association of the different key combinations with each type of relay.

The only other variable item is the micro-telephone which may or may not have a pressel switch in the transmitter circuit and is of British Post Office standard pattern. A cradle switch contact is normally provided in this circuit irrespective of whether or not a pressel switch is fitted. By cutting out extraneous sounds, the H.M.T. switch is an aid to listening in noisy situations.

Bells and buzzers are 100 ohms resistance and operate on 50 m.a.

Relays are of the B.P.O. 3000-type, 5000 ohms resistance and in order to facilitate interchangeability, instruments with polarized or non-polarized relays have an extra wire in the local cable for connecting to the centre point of a differential relay if this should ever be wanted. One end of this wire is connected to a CP terminal, as may be seen in Fig. 3, the other end being tied back ready for connection to the relay.

The CP terminal is conveniently placed for easy wiring to the earth or battery terminal, as required by the system of signalling. To provide for the use of an external bell where the bell in the instrument is not required to operate, a terminal plate D is fitted to which one side of the instrument bell is connected, the connection to the EB terminal, and thus to the relay contact, being by a flexible wire with spade termination. This latter can be disconnected and turned out of position, leaving only the extension bell in operation, but allowing simple reconnection of the local bell at any time.

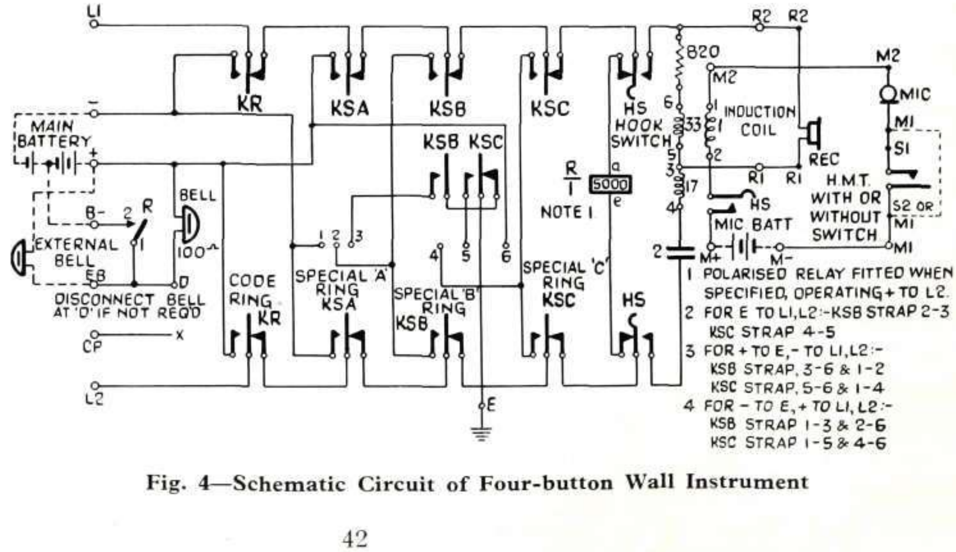


Fig. 4—Schematic Circuit of Four-button Wall Instrument

In order to provide for the differences in the wiring of the code-ringing keys to suit the various systems, as previously mentioned, the keys are wired to a terminal strip inside the instrument and their functioning is controlled by strapping the appropriate terminals in accordance with the paster wiring diagram in the telephone.

Means of " blanking off " unwanted keys by a shroud or cover to prevent their use, can be provided, so that a multiple key instrument can be used for any lesser key combination.

All equipment is readily accessible in both the wall and table instruments as the front of the wall set is hinged in the usual manner and the whole chassis of the table set can be removed from the moulded case by releasing three screws.

A typical schematic circuit, of the type N1181 (RSC.1002) is shown in Fig. 4. Other instruments follow the same general circuit in principle.

List of Codes of the Standardized Telephones.

WALL SETS.

Code No.	Railway Code	Relay	Ring Keys	HMT Switch
N.1181	3 RSC.1002/B/P	Polarized	4	Switch
N.1181A	4 RSC.1102/B/NP	Normal	4	Switch
N.1181B	1 RSC.1002/A/P	Polarized	4	None
N.1181C	2 RSC.1002/A/NP	Normal	4	None
N.1182	3 RSC.1001/B/P	Polarized	2	Switch
N.1182A	4 RSC.1001/B/NP	Normal	2	Switch
N.1182B	1 RSC.1001/A/P	Polarized	2	None
N.1182C	2 RSC.1001/A/NP	Normal	2	None
N.1183	2 RSC.1004/B	None	1	Switch
N.1183A	1 RSC.1004/A	None	1	None

TABLE SETS.

Code No.	Railway Code	Relay	Ring Keys	HMT Switch
N.1200	7 RSC.1000/D/P	Polarized	3	Switch
N.1200A	8 RSC.1000/D/NP	Normal	3	Switch
N.1200B	5 RSC.1000/C/P	Polarized	3	None
N.1200C	6 RSC.1000/C/NP	Normal	3	None
N.1201	3 RSC.1000/B/P	Polarized	2	Switch
N.1201A	4 RSC.1000/B/NP	Normal	2	Switch
N.1201B	1 RSC.1000/A/P	Polarized	2	None
N.1201C	2 RSC.1000/A/NP	Normal	2	None
N.1202	2 RSC.1003/B	None	1	Switch
N.1202A	1 RSC.1003/A	None	1	None

NOTE :—Since this article was written, the railways have been nationalized.

Push-Button Intermediate and Extension Telephones

THE merit of this Company's intermediate and extension telephones, by the use of which two stations share one line to the public exchange has long been proved, nevertheless the Company's policy has ever been progressive and recent development work on these instruments has been undertaken to make them more consistent with modern practice.

Fig. 1—Intermediate Telephone, External System

Two systems have been devised, one termed "external working", for use where the extension and intermediate stations are some distance apart, and the other "internal working", for conditions where the stations are relatively close, as, for instance, when they are in the same building. The only difference between the systems is that the external sets operate over two wires, with magneto signalling, while the internal sets are fitted with push buttons for battery signalling between extension and intermediate, necessitating two additional wires between these stations. Basic facilities, switching and circuit operation are identical in each case, therefore, the following description of the external type instruments should suffice, with the relative illustrations, to make both systems clearly understood.

Figs. 1 to 4 show the new telephones fitted with P.O. pattern dials for exchange calling but dials of other types can be fitted. Equivalent sets for manual CB working are available. The intermediate telephone resembles the House Exchange instrument and similarly utilizes push-buttons for switching purposes, while the extension telephone is the standard CB/Auto table set with a plinth to provide extra space for a generator. The moulded bakelite cases are dust and insect proof and components and wiring are suitably finished to withstand tropical conditions.

Improvements on previous methods in the design of the new circuits have been made to provide the basic facilities of

Fig. 2—Extension Telephone, External System

British Post Office "Plan No. 7", as represented schematically in Fig. 5. An additional facility is offered, when required, by which audible indication of the termination of extension-to-exchange conversations is given at the intermediate station.

Fig. 3—Intermediate Telephone, Internal System

EQUIPMENT FEATURES.

The group of four push-buttons used for setting up the desired connections can be seen in the top panel of the intermediate telephones in Figs. 1 and 3. These buttons are inter-acting, so that the operation of one automatically releases any other previously depressed.

They are designated as follows :—

EXCHANGE	•	•	EXTENSION (EXCH. HELD)
EXTENSION	•	•	EXTENSION TO EXCHANGE

Visual indication that an extension-to-exchange call is in progress is given at the intermediate station by a flag device fitted to a P.O. 3000-type relay inside the set and displaying "engaged" through a window just below the switching keys, when the relay is operated.

The intermediate instrument contains a bell which is actuated by ringing current from the exchange, while a similar bell in a bakelite wall case which also functions as a terminating point for the outside cables and is connected to the instrument by a flexible cord, is used for incoming signals from the extension. This definite association of each bell with its particular line is an improvement on previous practice in which the rotary key switched the bells from one line to the other.

The extension instrument is self-contained, the bell being included in the set, provision is also made for connecting a remote extra bell if required. Alnico magnet generators are used in both instruments, and provide ample ringing current. Other components also, are of standard pattern. The disposition of the apparatus inside the intermediate instrument may be seen in Fig. 6.

WORKING CONDITIONS.

The system will work with any standard subscriber's line circuit on automatic or CB exchanges and no line earthing or unbalanced line condition is used at any stage of operation.

The 50-ohm indicator-relay which is in the line during extension-to-exchange conversations, requires 30 m.a. minimum current to operate, is shunted by a condenser and has a negligible insertion loss of less than one decibel.

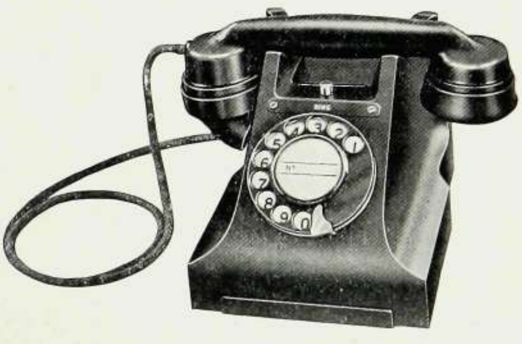


Fig. 4—Extension Telephone, Internal System

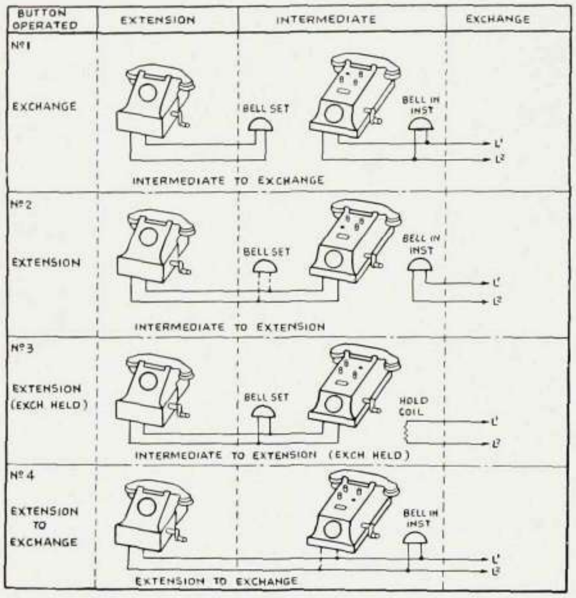


Fig. 5—Schematic of Connections set up by the Operation of Switching Buttons

The maximum loop resistance between exchange and extension with which satisfactory working is assured depends upon the exchange battery voltage and the resistance of the feeding coils in the transmission bridge, e.g., allowing 30 m.a. for the indicator-relay, a 50-volt system with a 200/200-ohm feeding bridge will work effectively with an 800-ohm line loop, the position of the intermediate station in the line being immaterial.

A battery of from 6 to 9 volts is required at the intermediate point for speech current for extension-to-intermediate conversations.

CIRCUIT OPERATION.

The following brief description of the circuit conditions set up when the respective switching buttons are depressed, will enable the reader to readily associate the facilities depicted by Fig. 5 with the operation of the intermediate telephone circuit reproduced in Fig. 7:—

Intermediate to Exchange (*Button No.* 1):— KX contacts operated. KX1 and 2 connect intermediate to exchange line and KX3 completes the dial circuit. Bell in wall case is in circuit for reception of signals from extension.

Intermediate to Extension (*Button No.* 2):— No key contacts operated. The required condition of connecting intermediate to extension is set up by this button restoring all operated key contacts. Exchange ringing operates the bell inside the telephone.

Intermediate to Extension, Exchange Held (*Button No.* 3):—KH1 operating, connects holding coil to exchange line, thus bridging bell and condenser. Cradle-switch contact in hold circuit opens when hand-set is replaced, as a safe-guard against intermediate omitting to press button No. 4, to complete the connection, or No. 1, to restore the exchange line to normal.

Extension to Exchange (*Button No.* 4):— KEX contacts operated. KEX1 and 2 connect extension to exchange, with the bell in the intermediate telephone in circuit for the reception of ringing from either end of the line. In this condition a call from exchange will also ring the bell at the extension. KEX3 and 4 are associated with terminals which can be strapped to

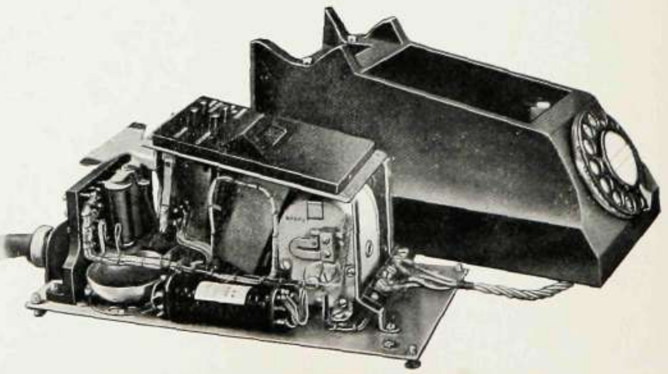


Fig. 6—Interior View of Telephone in Fig. 1

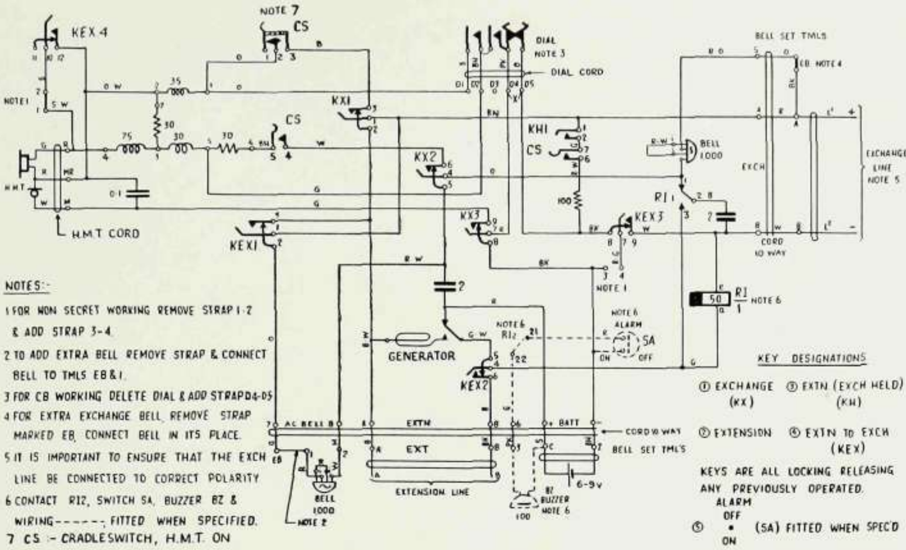


Fig. 7—Circuit of Intermediate Instrument (External System)

make extension-to-exchange conversation secret or non-secret from intermediate. Indicator-relay, RI, operates when hand-set is lifted from extension instrument and remains operated during dialling, contact RI1 opening bell circuit to obviate "tinkling". The additional contact of RI, the buzzer and the small switch for breaking the buzzer circuit, shown by broken lines in Fig. 7, comprise the circuit of the audible signal indicating the completion of an extension-to-exchange call.

As a safeguard against the simultaneous depression of more than one button, preference is given to No. 4 so that, unless this is actually released, the operation of additional buttons will be without effect; also, with button No. 4 operated, there can be no interference with an extension-to-exchange conversion by the manipulation of the dial or generator at the intermediate point. No mis-operation of the buttons will prevent exchange signals from being received if the hand-set is on the cradle.

The diagram of the extension instrument is shown in Fig. 8. The generator of this otherwise standard CB/auto circuit is in series with a condenser when the micro-telephone is on the cradle, in order to avoid

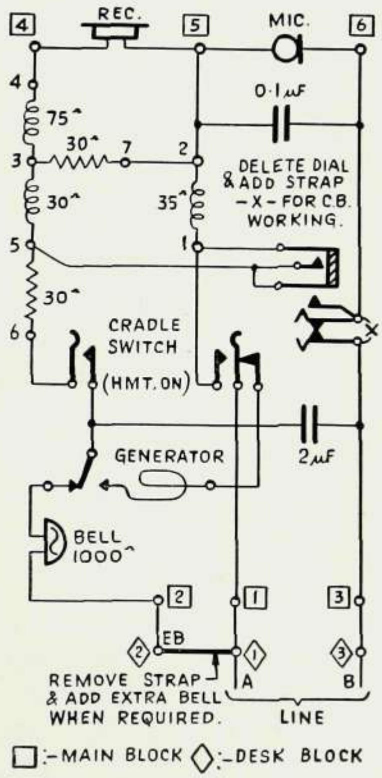


Fig. 8—Circuit of Extension Instrument (External System)

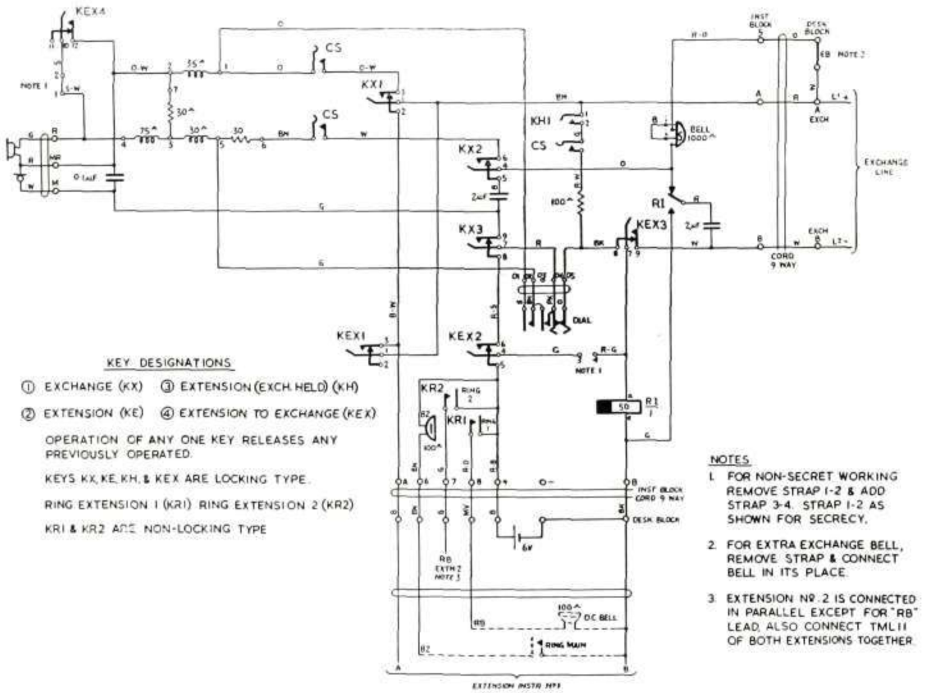


Fig. 9—Circuit of Intermediate Instrument (Internal System)

placing a calling condition on the exchange line when extension calls the intermediate and button No. 4 is operated.

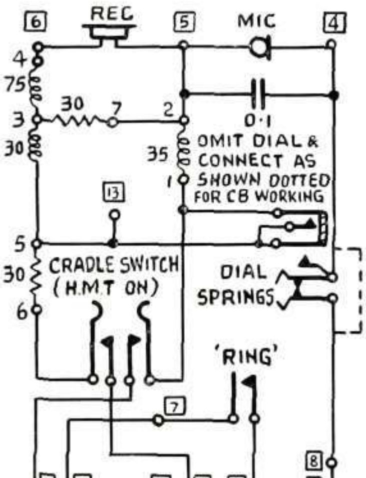


Fig. 10—Circuit of Extension Instrument (Internal System)

INTERNAL WORKING SYSTEM.

The relative circuits for internal working sets are shown in Figs. 9 and 10 and it will be observed that the intermediate telephone is provided with twin ringing buttons, enabling two extensions to be connected in parallel. It is recommended that when two extensions are working, the bell for the reception of exchange ringing should be connected in only one of the extension telephones.

The intermediate telephone contains the A.C. bell for exchange signals and also a DC buzzer operated from the first extension station. For the second extension, a 100-ohm DC bell is mounted away from the intermediate instrument so that there can be no confusion in determining which party is calling.

The extension telephone has a push button for calling and a magneto bell. The battery bell or buzzer for signals from the intermediate is fitted externally near by.