Section 4

DIAL IMPULSE-SENDERS ON SUBSCRIBERS' INSTRUMENTS

The automatic switching apparatus of an exchange responds to impulses sent from the subscribers' offices.

In the early installations, which were worked on what was known as the three-wire

FIG. 6.—A. T. M. Co. (A. E. Co.) DIAL SWITCH.

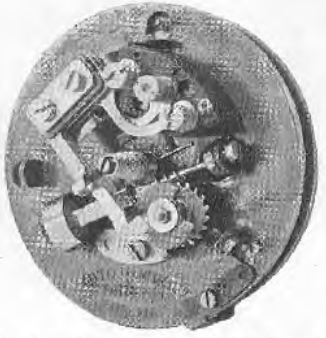


FIG. 7.—INTERIOR OF A. T. M. Co. IMPULSE DIAL.

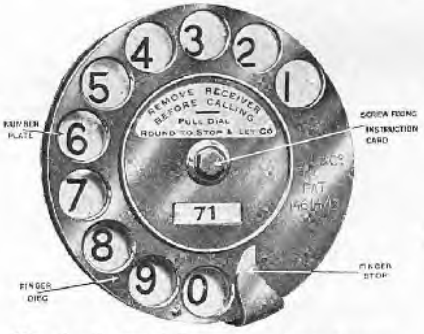


FIG. 8.—SIEMENS' TELEPHONE DIAL SWITCH (FRONT VIEW).

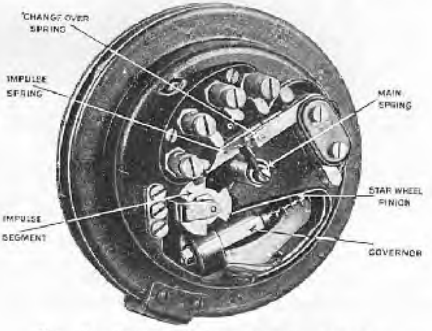


FIG. 9.—SIEMENS' DIAL SWITCH (REAR VIEW).

system, the impulses were sent from the sub-station by a succession of short earthings of one wire of the metallic circuit line, to step a switch either vertically or in a rotary direction. Each train of impulses was followed by an earthing of the opposite wire for circuit-changing purposes, to bring into circuit the magnets necessary for the succeeding train of impulses.

In all modern systems the earth is eliminated and the impulses are now sent by interrupting, or momentarily opening, the metallic circuit, completed when the receiver is lifted.

In the Strowger system, the duration of an impulse is from the beginning of a break in the circuit, over the re-make, to the beginning of the next break. Until recently the duration of make and break were about equal, but in the later dials of the A. T. M. Co., the break is now ·61 of the impulse instead of ·5. The Siemens' break is about ·33 and the W. E. Co. about ·12.

FIG. 10.—W. E. Co.'s DIAL.

The circuit-changing is now effected by special relays, which energise in the local circuit of the line or impulse relay, when the receiver is lifted. Such relays are made slow to de-energise, usually by having a mass of copper surrounding the end of the core, which acts as a single turn to prevent the rapid demagnetisation of the core. These relays energise immediately after the impulse relay, and remain energised whilst the former is de-energising and re-energising in response to the impulses, but de-energise when the interruption is longer than an impulse break, or opening of the circuit.

This is not the invariable method of changing over. In the Western Electric Co.'s system, a long interruption of the circuit at the end of a train of impulses allows a relay, made slow to energise, to energise and bring about the change-over to another register. Other variations will be pointed out later.

In the early installations, the impulses were sent by keys or push buttons, a plurality of keys being provided, one for each digit of the hundreds, tens and units. These proved unreliable, as the subscriber could not be depended on to depress a key the correct number of times, according to the digit.

To the Strowger Co. of Chicago belongs all the credit for evolving the dial impulse-sender, which is now universally adopted. It is practically fool-proof, and eminently suitable for use by the general public. Externally it is a rotatable disc with a series of holes near the outer edge through which figures which represent the digits appear. At a point on the path of rotation is a fixed stop. A finger is to be placed in the hole corresponding to the digit to be called, and the dial-plate rotated clockwise until the finger comes against the fixed stop. The dial cannot be rotated counter-clockwise. The rate of pull is of no moment, as the impulses are sent out as the dial returns to normal under spring control.

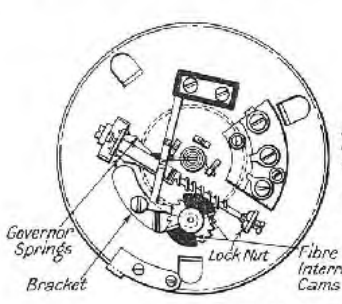
Illustrations of several dials are given as used by different companies, but all have the same fundamental features.

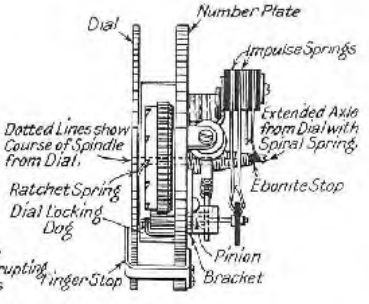
Figs. 6 and 7 show the dial as made by the Automatic Telephone Manufacturing Co., of Liverpool, Figs. 8 and 9 the dial as made by Siemens Brothers & Co., of Woolwich, and Fig. 10 three views of the dial made by the Western Electric Co., of Woolwich. In the two former, the figures are arranged 0, 9 . . . 1 clockwise, the second having a greater interval between 1 and the fixed stop for reasons to be explained. The W. E. Co.'s dial is arranged 0, 1 . . . 9 clockwise, for reasons also to be explained.

Section 5

DIAL ADJUSTMENTS

Automatic Telephone Manufacturing Co.'s dial. Figs. 11 and 12 give a better idea of the mechanical arrangements and the relationship of parts, the more important parts being named on the drawing.





A. T. M. Co. (Strowger) Dial.

Fig. 11.—Rear View with Connecting Strips removed.

Fig. 12.—Side View with Terminals removed.

The following details of the adjustments and construction will be of interest :—

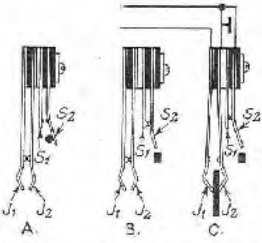
When the dial plate is rotated the ratchet spring should fall into the second ratchet tooth just as the front of the finger stop passes through the centre of the first finger hole.

The conical main spring should have between one and a half and two turns counter-clockwise. The main spring bushing should raise the front shunt about $\frac{1}{32}$ of an in. from its opposing contact on the impulse spring. The shunt spring should be so adjusted that it does not cut into the main spring bushing, and should follow the impulse spring $\frac{1}{32}$ of an in. when in contact with it. When the dial is operated the main spring must not bulge out and touch the governor hub and cause slow return.

The impulse springs should break contact at the instant the fibre cam passes through

the tips of the springs. The tips of the springs should not be opened in order to reduce the friction, but at the same time they should not be so close as to short circuit the contact points. Daylight should just be visible between the tips.

The tension of the springs should be such that the inner spring will follow the outer one until its end lines up with the upper side of the fibre cam. The mate spring should



A. Normal Position.	B. Dial pulled away from Normal Position.	C. Dial Free to Return.
"J_1" and "J_2" in Contact, "S_2" open.	"J_1","J_2" and "S_1","S_2" in Contact.	Interrupter Springs "J_1" & "J_2" open circuit. "S_1","S_2" in Contact.

Note.—"J_2" & "S_1" are assembled in contact.

FIG. 13.—A. T. M. CO. DIAL IMPULSE SPRINGS. POSITION OF IMPULSE SPRINGS DURING OPERATION, &c.

behave similarly. The outer spring should follow the inner one when it is deflected until its end lines up with the lower side of the fibre cam.

The impulse springs should be deflected equally when the cam is rotated by the finger plate. They should be free of the cam centre and only touched by the cam wings.

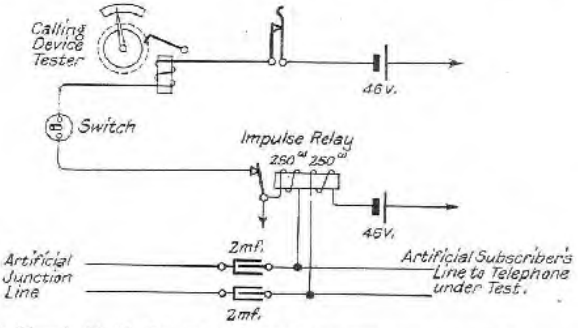


FIG. 14.—A. T. M. CO. DIAL TESTING CIRCUIT FOR USE IN WORKSHOP.

The contacts are to be operated as shown in **Fig. 13** at A, B, C. The shunt spring (to short circuit the telephone) should not break prematurely. It should break just after the impulse springs have closed at the end of the digit.

The most efficient operating speed is 10 impulses per second with a maximum of 12 and a minimum of eight. The speed of dials should be checked on the *dial speed tester* fitted on the test desk. Such testers should be fitted also where dials are to be adjusted. A suitable circuit, as used by the British Post Office, is shown at Fig. 14.

The dial speed tester can be tested at intervals against a telegraph inker as follows :—

An ink mark to correspond in length with four seconds is made on a tape. A fourth of this is to be taken as a standard. A record should be taken, from a dial of 10 impulses from the digit 0, on a slip. The length from the beginning of the first break to the end of the last break, when compared with the standard length of tape, will give the speed of the dial. The dial should be adjusted until the two lengths are equal. The dial will then be running at a speed slightly slower than 10 impulses per second. The dial should then be tried on the dial speed tester and, if the latter is not correct, the length of the pendulum should be adjusted accordingly.

To adjust the speed of a dial the governor wings should be slightly bent with a special tool close to the governor balls, so that the adjustment will bring each ball to exactly the same distance from the inside rim of the governor cup. The governor wing must be adjusted so that the governor balls do not rub on the sides of the aluminium hub notches. There should be about $\frac{1}{64}$ of an in. play between the governor shaft ends and the agate bearings, with which each bearing screw is provided. Care should be taken in turning the bearing screw into the lug at the worm end of the governor not to crush the agate thrust bearing. The screw should be held tightly in the lug by the clamping nut. The bearing screw holding the governor cup should be in exact line with the governor shaft. The aluminium hub should not be rotated about the governor shaft as a slight pull is the proper test for loose aluminium hubs. To examine the governor generally, pressure should be taken off it by rotating the finger plate and holding it. Attention should be given to end play, correct shape and tension of the wings, and clearance between the governor and main spring.

The fibre cam should be set so that its mid line is approximately at right angles with the line of the governor shaft. If the fibre cam is not set correctly, the pinion will have to be remeshed with the ratchet gear. This can be done as follows :—

Remove screw from the bracket which holds the pinion, turn the dial so that the dial locking dog is free from the pinion, and unmesh both the ratchet and governor gears. Turn the fibre cam to the proper angle, remesh the gears and replace the screw. Care must be taken not to rotate the ratchet wheel while the gears are unmeshed.

The fibre cam should be rigidly locked when in the normal position, but if there is looseness between the worm wheel and the pinion, or if the locking dog is not properly adjusted, this will not be the case, and the fibre cam will slip out of its normal position when tested by hand and remain between the impulse springs. A test should be made to see if the cam is fixed as it should be, but as it is set permanently into a rectangular base, only a slight pressure should be applied to it in order to avoid injury.

One slightly bent worm gear tooth may cause the dial to stick. The pinion should be placed so that the tooth of its worm gear will engage about four-fifths of the depth of the governor shaft gear. The dial locking dog should strike exactly in the notches of the pinion.

The ratchet spring should drop into the ratchet gear notches when the dial is lightly forced back from 1 as rapidly as possible.

Section 6

DIAL. SPECIAL FEATURES

The Siemens' Dial (Figs. 8 and 9).—A definite minimum interval between trains of impulses is secured. Where this is not provided short trains of impulses, such as 1 . 1 . 1, may arrive before a free selecting switch has been found. To effect this interval the dial switch is provided with two trains of gears, the governor train and the impulse train. The ratchet wheel driving the governor train is fixed to the finger plate and driven thereby. The impulse train is driven by a pawl mounted on a disc, the disc being located between the driving wheels of the respective trains. The pawl referred to engages the internal teeth of the ratchet wheel, thus transmitting the drive to the disc, and subsequently to the impulse train in one direction only. The disc is further provided with a slot, the ends of which engage a pin on the toothed wheel of the impulse train so that the governor comes into action some time before the impulse train. When the dial is released the governor starts at once, but it is only after the pin has passed to the other end of the slot that the impulse train is operated and impulses begin. No matter how quickly the dial is operated, this interval must occur between successive trains of impulses.

The governor and the main spring have been made the subjects of special study and design, to give great regularity in the timing of the impulses. The impulse springs are normally held closed by the fibre, opening under their own tension. This assists greatly in securing exact impulses.

W. E. Co.'s Dial (Fig. 10).—The finger disc is mounted on a shaft and held against a stop by a spiral spring. When displaced from normal the disc returns under the tension of the spiral spring, but does so at a predetermined and constant speed under the influence of a governor. A special loose disc at the centre is so fitted that the finger disc may be moved forward as quickly as desired, the governor being disconnected.

The finger disc carries a series of small teeth and one large tooth, which operate in passing a contact lever ; the contact lever opens a contact, included in the line circuit, but only on the return movement of the finger disc. The short interruptions of a train of impulses are always followed by a long one to mark the change over.

Section 7

INTERCHANGEABLE DIAL

New Dial Impulse-sender with Interchangeable Impulse Wheel.—The joint property of A. T. M. Co., Siemens Brothers and W. E. Co. (Fig. 15).

The different systems in use require different ratios between the times of making and interrupting the current impulses, and also a variable amount of lost motion in the impulse transmitting device at the beginning of each train of impulses.

This dial is constructed so that the cam or impulse wheel is interchangeable, and can be readily removed and replaced by one adapted to meet the particular requirements of the system in use, this interchange being made without affecting any other part of the apparatus.

The teeth of the cam wheel and the pawl operating the contact springs are formed so as to provide the required ratio between the times of making and breaking the circuits, and the design also ensures that the pawl leaves the teeth of the wheel without causing any vibration of the contact springs.

The cam wheel is provided with long teeth adapted to provide a considerable amount of lost motion at the beginning of the transmission of each train of impulses. Normally, the pawl is held radially to the wheel; when the cam wheel is rotated by the operation of the finger dial the pawl is rotated through a considerable angle before it rides over the end of the tooth with which it has been in engagement. If the teeth are close together the pawl cannot slide far down into the space between the teeth during the continued rotation of the cam wheel by the finger dial; when, however, the hand is removed and the dial rotates in the reverse direction, the pawl will be displaced so as to extend more deeply into the space in which it happens to lie. When the pawl has regained its radial position, the continuation of the rotary motion causes it to move upwards out of the space which it has entered until it reaches the level of the top of the teeth, when the first current impulse will be transmitted. The considerable extent of the motion of the pawl from the release of the finger until the beginning of the first impulse corresponds to a comparatively long interval of time.

The shape of the teeth of the cam wheel determines the character of the impulses transmitted by the apparatus. For instance, if the end of a tooth is broad, the current will be interrupted for a longer time than if the tooth is narrow. All the teeth need not have the same form; for instance, a very broad tooth will cause a longer interruption at the beginning or end of a train of impulses.

Fig. 15 A is a view of the dial as seen from the back, B is a central section, C and D show a modified construction of the pawl.

Schedule of parts with reference to the drawings:—

1. Base plate.
2. Spindle, free to rotate in 1.
2'. Collar to prevent axial play, even when 3 and 4 are removed.
3. Number plate.
4. Finger dial, fitted at one end of 2.
5. Clamping ring fitted in recess of base plate. Holds number plate in position against 1.
6. Cam wheel with long teeth, fitted to rear end of 2 and made readily removable.
7. Pawl operated by 6. Normally held radially to the teeth and enters deeply between the teeth.

8. Screw fixed to 1, about which 7 rotates.
9. Spring.
10. Stud secured to 7, on which 9 presses.
11. Clock spring to counter rotate 2.
12. Casing to which one end of 11 is fixed (other end to spindle).
13. Ebonite stud on pawl.
14. Spring contact with which 13 engages as the pawl rides over the end of each tooth during the return movement of cam wheel 6. Thirteen momentarily lifts 14 from 15 without springs vibrating.

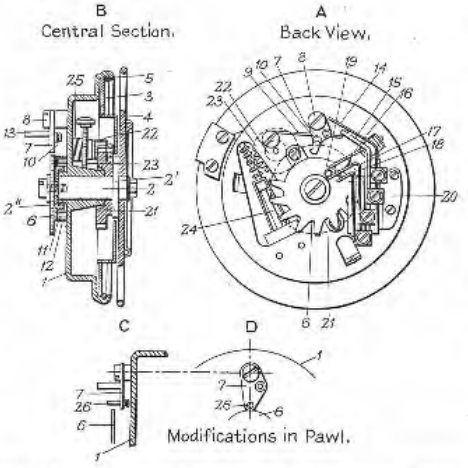


Fig. 15.—Dial with Interchangeable Crown Wheel.

15. Mate contact spring.
16, 17, 18. Contact springs to short circuit receiver.
19. Stud in cam wheel 6 to operate above.

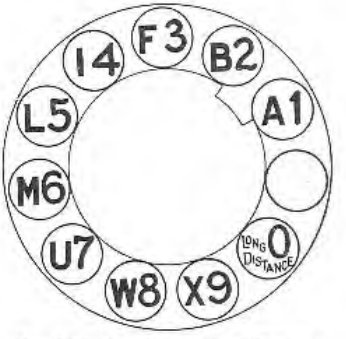


Fig. 16.—Dial Plate with Figures and Letters.

20. Bracket on plate 1 carrying above 16 to 19.
21. Toothed wheel on spindle 2.
22. Pinion with which 20 engages.
23. Governor wheel on spindle of 22.
24. Governor to control rate of interruptions.
25. Spindle spring attached at one end to wheel 23 and wound round spindle of pinion 22. This spindle can rotate freely inside the spring 25 when the dial is pulled round, but on the return movement of the dial the spring tightens on the spindle and forms an effective clutch between the spindle and the governor wheel 23.

In the modification according to C and D the pawl 7 does not engage directly with the cam wheel 6, but by means of a projection 26 carried by the pawl.

Fig. 16 shows how a dial may be arranged with figures and letters in the finger holes so that a number may be prefixed by a letter. (See also Fig. 139.)

Section 62

BRITISH POST OFFICE STANDARD DIAL, NO. 8

In connection with this device the Department has made a very important departure from the usual practice and, from their point of view, a very desirable result is obtained.

Hitherto it has been the practice to accept dials of different designs from various manufacturers, but in an endeavour to obtain uniformity of practice, simplification of stocks and maintenance, one design has been adopted as a standard, which is known as "Dial Automatic No. 8."

The dial is illustrated in Figs. 125 130.

FIG. 125. P.O. STANDARD DIAL, NO. 8. FRONT.

FIG. 126.—P.O. STANDARD DIAL, NO. 8. INTERIOR.

The present standard 3-point fixing has been retained. As will be seen from Fig. 125, there is a considerable gap between the finger hole 1 and the stop, to allow of an interval of time between the completion of the pull to the stop and the sending of the first impulse.

A rotating impulse cam, with teeth controlling the impulse springs, is used, instead of a geared rotating fibre segment opening the impulse springs. The impulse cam is readily removable, so that another cam with differently spaced teeth, to suit a particular system, can be inserted.

From the illustration of the rear, Fig. 127, it will be seen that the springs are assembled as a unit, so that they can be removed without the adjustments being disturbed. The clock-like driving spring is housed in a spring box situated underneath the impulse cam.

Impulsing.—The impulses are produced by the impulse cam which, operating in conjunction with the impulse lever, causes the impulse springs to open and close. These impulses are positive and clean, and of uniform duration. In other dials the impulses are produced by the contact springs being forced apart for the break, and then allowed to fall together for the make. The latter operation results in vibration, the main break being

followed by a series of minute breaks, as shown on an oscillogram, Fig. 130A. In a circuit in which there is considerable inductance, the vibration tends to shorten the period of make, but where there is considerable capacity, such as that due to a telephone condenser, the make period is not shortened. In the new dial the contact springs are normally held together, and permitted to fall apart for the break period. In this way vibration is eliminated, as shown in Fig. 130B. The lengths of the periods of make and break depend upon the width of the teeth of the cam. No ratchet and ratchet wheel are now necessary.

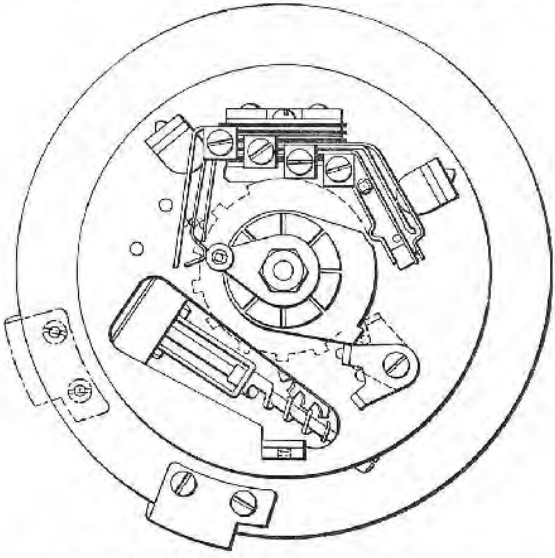


FIG. 127.—P.O. DIAL, AUTOMATIC, NO. 8. INTERIOR. HORIZONTAL SECTION.

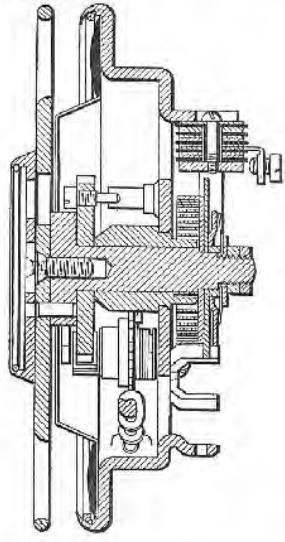


FIG. 128.—P.O. DIAL, AUTOMATIC, NO. 8. TRANSVERSE SECTION.

A dial fitted with a standard cam sends ten impulses per second, the length of each break being 63 milliseconds (·063 second), and of each make 37 milliseconds (·037 second). Cams to give other ratios of break to make can be fitted.

Minimum Pause.—This is an arrangement by which a certain minimum time (about 300 milliseconds) must elapse after the release of the dial plate and the sending of the first impulse, to ensure that selectors have time to perform their hunting operation. Without this facility it is possible when dialling numbers, such as 1–1–1, for the impulses to arrive before a free selecting switch has been found.

This minimum pause is provided for by the slipping cam fitted above the impulse cam, as shown in Fig. 127.

The function of the slipping cam is to screen two of the gaps in the impulse cam, so that when the dial is actuated and released, a pause, equivalent to two complete impulses,

is made before an impulse is sent, thus definitely providing the time required by the exchange apparatus to find an idle line in all circumstances.

The action of the slipping cam is dependent upon the phosphor-bronze spring washer, which provides sufficient friction to ensure satisfactory action without causing the cam to wear.

Provision is made for the retention or elimination of this feature as required. Such

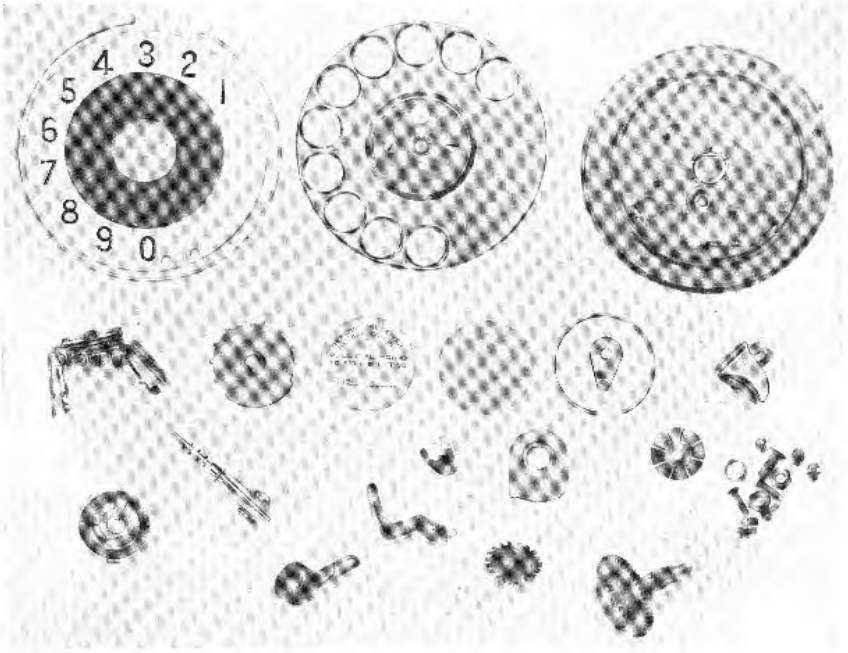


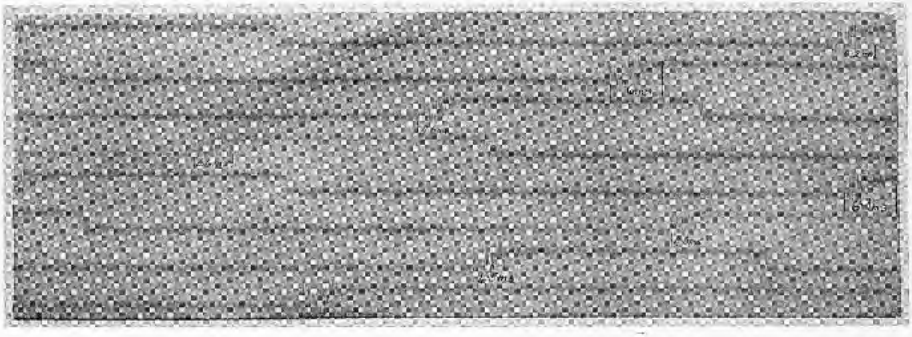
FIG. 129. P.O. STANDARD DIAL, NO. 8. PARTS.

changes are easily effected by altering the position of the finger-stop and the stop for the slipping cam. No additional parts are required, and extra holes are provided for the purpose of making the change.

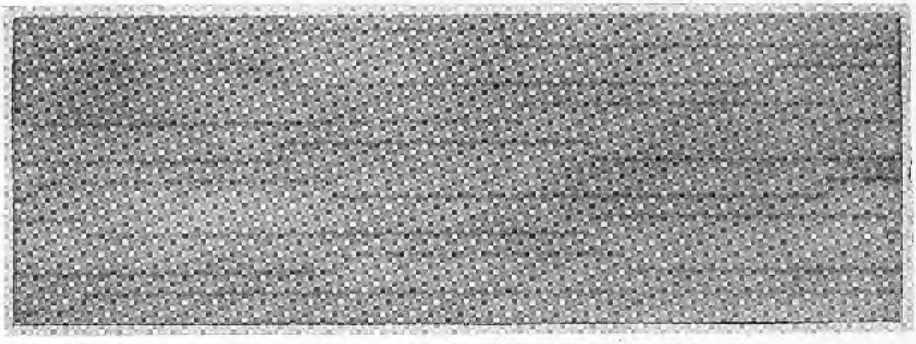
Speed Control.—The governor is of the worm and worm-wheel type, so proportioned as to give uniform control over a considerable range of speeds—from 7 to 14 impulses per second. It is difficult to accelerate or retard the dial seriously.

Accessibility.—Certain replacements and adjustments can be made without removing the dial from the telephone, or interfering with the running and adjustments.

Upon removal of the wire ring and instruction label, two screw-heads are exposed. The centre screw secures the finger-plate, the other is the spring tension and stop screw. To allow the dial to run down, or to alter the spring tension, the stop screw is slightly withdrawn out of engagement with the fixed stop (the screw may be moved back only a few turns), when any required alterations may be made.



A



B

FIG. 130.—IMPULSE OSCILLOGRAMS.

To change the enamelled number ring, the centre screw is taken out and the finger-plate lifted off. The number ring is held in position by a circular spring wire, on removal of which the former can be lifted out.

To change the impulse cam, main spring, or spring unit, or to make governor adjustments, the dial must be removed from the telephone. After the removal of the finger-plate and number ring, the whole of the interior is open for inspection, including the gearing, which consists simply of a wheel and pinion, and the governor.

The adjustment of the contact springs is as follows :—

Contact pressure at normal	20 to 30 grams.
Tension to lift lower impulse spring only from ebonite pip on lever	5 to 10 grams.
Contact opening	14 mils.
Follow of upper impulse spring when contacts close, *i.e.* the distance between the end of the buffer and the impulse spring	6 mils.

Section 63

A NEW DESIGN OF WALL AND TABLE INSTRUMENTS (A. E. CO., A. T. M. CO.)

These are shown in Figs. 131 to 134. The transmitter and cup assemblies of the two instruments are interchangeable. The mounting neck is of solid aluminium bronze, finished in black enamel. The hinge, permitting of vertical movement only, is concealed in the transmitter cup.

The pillar of the table set is now placed out of centre to give greater stability, and protection to the dial.

The receiver hook and spring assembly are also interchangeable on both types of instruments, and in the table set may be lifted 4 inches clear, as shown in Fig. 134, to allow of examination. In the wall instrument and bell-box for the desk set the bell gongs are placed in a lower chamber slotted to the outside, as shown in Fig. 132. All parts are readily detachable for examination and replacement.

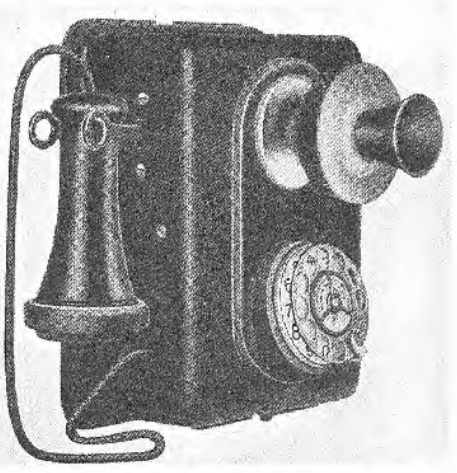


FIG. 131.—WALL TELEPHONE (A. T. M. CO.). LATEST DESIGN.

All margins of safety are maintained with any potential between 44 and 52 volts. A failure will not occur, in most cases, between limits of 40 volts and 55 volts.

Apparatus is self-adjusting, that is, unavoidable wear will not throw the apparatus out of adjustment.

Service and Traffic.—Affords full and complete supervision of all semi-automatic connections.

Permits every stage of a call to be investigated.

Provides for various systems of automatic metering.

Permits distribution of junction traffic to be accurately recorded.

Permits the operators' handling time and subscribers' drag to be analysed.

Permits the average holding time to be determined at any junction point.

Permits simple re-distribution of junctions to meet the variations in traffic.

Reduces the effect of false calls, and subscribers' drag, to a minimum.

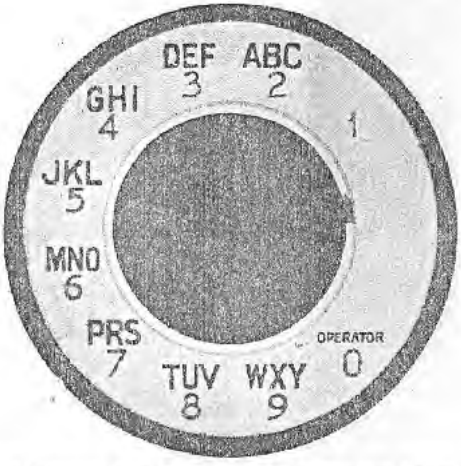


FIG. 139.—DIAL WITH LETTERS AND FIGURES AS PROPOSED FOR PANEL SYSTEM, LONDON.

Full Automatic Dialling.—The subscriber's dial does not require close adjustment.

Any speed between 9 and 13 steps per second is permissible. A dial, when once adjusted to normal speed, will remain between these limits for a long time.

No special dial speed adjusting apparatus is required at the central office.

With a little practice, it is possible to judge the speed of a dial by eye with sufficient accuracy for all practical purposes.

A dial adjusted on a telephone in the store room before installation will not require re-adjustment when the set is installed.

From numerous observations it may be said that the dialling tone is heard on 99 per cent. of the calls in 1·5 second or less; in other words, about as soon as the receiver is placed against the ear. After the dialling tone has been heard, it is impossible to dial too rapidly.

Section 2

STROWGER DIRECTOR SYSTEM

(Automatic Electric Company, Chicago ; Automatic Telephone Manufacturing Company, Liverpool.)

The Strowger System, as illustrated and described in Vol. I., pp. 27 to 74, is a system in which the selecting and connecting switches are controlled directly from the subscriber's dial, an arrangement which is only feasible if the exchange names and the numbering can be made to fit the trunking scheme. This system has been used in many networks both large and small throughout the world, but is not well adapted to the needs of the largest metropolitan areas

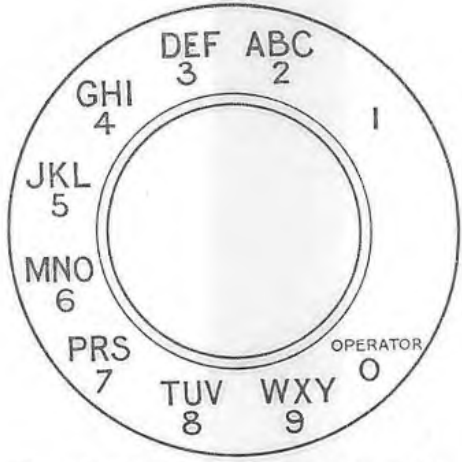


FIG. 1.—DIAL WITH LETTERS AND FIGURES (W. E. Co.). PANEL SYSTEM.

such as London, where the conversion from Manual to Automatic working must, of necessity, be gradual.

After very careful consideration of all automatic systems suitable for such an important area as London, and realising the necessity and responsibility of providing a system that would stand the test of time, and provide a service that would meet all the requirements of modern business and social life, the British Post Office have decided to instal the Strowger Director System. Although this is new as a combination, it is built up of apparatus that operates in known ways and has stood the test of many years in all parts of the world.

Introductory.—For economic and engineering reasons, the application of automatic operation to large metropolitan areas invariably involves a transition period, which may extend

over several years. During this period it is necessary to provide means for handling four classes of calls, *i.e.* manual-to-manual, manual-to-automatic, automatic-to-manual, and automatic-to-automatic.

The director unit has distinct spheres of usefulness in increasing the flexibility and efficiency of operation in all four of these classes, but a brief description of its application in the last-named class (full automatic) will give an adequate idea of its adaptability.

In large metropolitan areas it seems desirable to identify each subscriber's station by means of an office name and four digits. To dial the desired station it is the plan to "spell" the first two or three letters of the office name by successive turns of the dial, which "spelling" would be followed by the four significant digits of the called station's designation. It is apparent, therefore, that the dial must be marked with letters in addition to the digits.

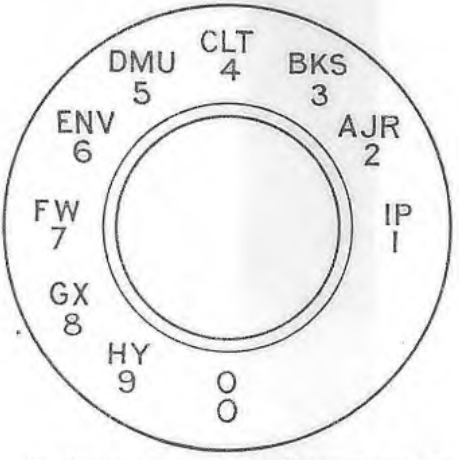


FIG. 2.—DIAL WITH LETTERS AND FIGURES (A. T. M. Co.). DIRECTOR SYSTEM.

Two arrangements of dial lettering are shown in Figs. 1 and 2. Fig. 1 shows an arrangement that has been in use for some little time. See Vol. I., p. 202. With either plan, it takes the subscriber somewhat longer to locate letters than to locate numerals, but there seems to be no such difference in finding time between the two forms of lettering.

So far, the use of the plan in Fig. 1 has demonstrated that while the spelling scheme is feasible, great care must be exercised in the selection of office names to avoid the possibility of confusion resulting from the subscriber's lack of familiarity with the spelling of any of the office names chosen.

It has also been demonstrated that many subscribers do not differentiate between the letters "I" (corresponding to the numeral 4 in Fig. 1) and the numeral 1; or between the letter "O"