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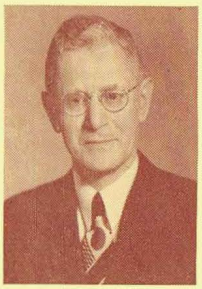

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THE TYPE 44 ROTARY SWITCH

By D. N. MacDONALD

SYNOPSIS: *Trend to miniaturization techniques — their application to single-motion stepping switches — The Type 44 Rotary Switch — driving mechanism — construction and mounting — bank and wiper assemblies — performance characteristics.*

THE trend toward miniaturization in electrical and mechanical equipment, so evident in recent years, has required an extensive study of methods for developing components which are not only compact, but also capable of outperforming and outlasting their larger predecessors. As a result, it has now become possible to produce complex devices and mechanisms which would have been impractical heretofore due to sheer physical size. The success of large scale computing machines, of automatic control of military and industrial operations, and, in communications switching, of "Director" systems for automatic call routing and toll ticketing, has been contingent in many cases upon the application of miniaturization techniques.

A number of these devices are sequential in nature, and require switching between a group of circuits to obtain successive steps of operation necessary to achieve the end result. Others require storage of information, frequently for long periods which may extend through a temporary power failure. Telephone type rotary stepping switches, with their ability to select circuits from a group, under electromagnetic control, are ideally suited to these applications, since they readily meet the requirements of simplicity, ruggedness, and reliable operation. Recently, however, the use of these switches has, in many cases, been limited by their large size in comparison with the reduced size of the other components of this type of equipment.

Now, with the introduction of Automatic Electric Company's Type 44 rotary switch, a very compact, fast, and rugged device is available for the

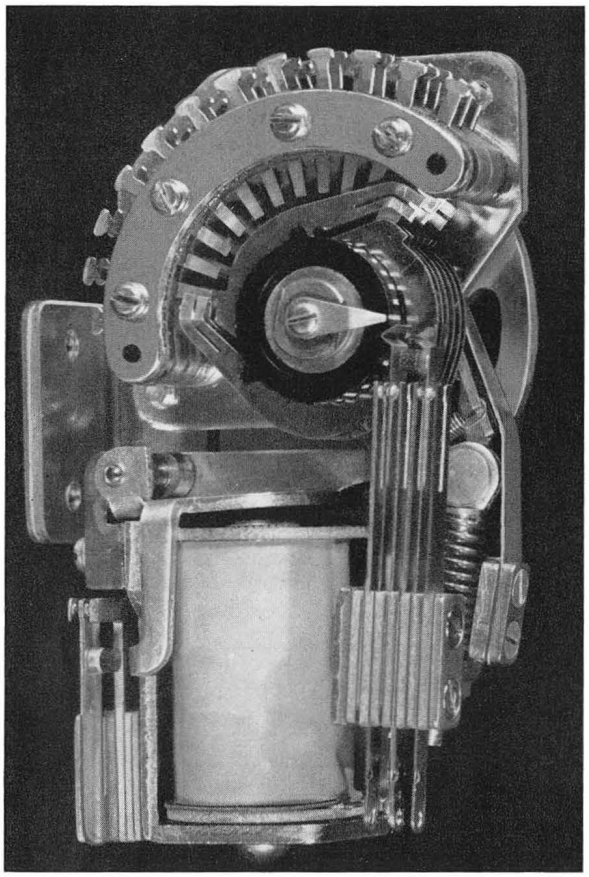


Figure 1. Automatic Electric Company's Type 44 Rotary Switch, shown approximately actual size.

first time to fill this gap. The Type 44 switch is unique in several respects. A three level switch is small enough to mount in the same panel space as a telephone type relay, yet the bank has eleven positions (ten active switching points plus a home or off-contact position). Individual parts are of ample size to insure reliability and long life. In addition to the bank and wipers for primary circuit switching, off-normal and interrupter spring assemblies are available for secondary or auxiliary circuit control.

Driving Mechanism

Operation of the switch is under the control of a single self-protecting magnet, which drives the wipers from one position to the next through a ratchet mechanism of advanced design. Energization of the magnet causes the armature to operate, compressing a driving spring and lifting the driving pawl into engagement with the proper ratchet tooth, which is held stationary by a leaf type detent spring. De-energization of the magnet initiates the step, when the armature is restored to normal under pressure of the driving spring, causing the pawl to advance the ratchet wheel and wiper assembly one step. Teeth on the armature engage the ratchet teeth at the end of the stepping stroke thereby locking the wipers in the correct position on the bank.

This type of drive, first introduced on the Type 45 rotary switch, has distinct advantages. Since the downward position of the armature is determined by the ratchet mechanism itself, no adjustable stops are necessary to set this position. Earlier drive mechanisms locked the ratchet in position and prevented it from overthrowing by wedging the pawl into the ratchet teeth through the use of a pawl stopping block, with subsequent battering of the pawl tip at each step. In the new switch, the elimination of the pawl block and armature stop, with the adjustments and wear which they entail, reduces the maintenance necessary and increases the life of the switch.

The two piece frame is arranged so that the switch parts are mounted on only one side. In this way, it is possible to equip the same basic frame with banks of various level capacities. The bank is assembled on a square bank plate, to which are fastened the motor magnet frame and the various switch mounting brackets. A slot in the bank plate receives and guides the hub of the wiper assembly (carried on the motor magnet frame) to its proper position with respect to the bank. Similar slots are provided under the mounting screws on the motor magnet frame so that the motor magnet assembly may be removed for maintenance without disturbing the mounting or bank wiring. In the same manner a motor magnet assembly may be added to an idle bank for expansion of facilities. The T-shaped mounting screw slots allow the motor magnet to be rotated after assembly, to center the wipers on the bank contacts.

Two different types of standard mounting brackets are available. Shown on the switch in Figure 1 is a "shelf-mounting" bracket, normally used for mounting the switch parallel to a panel. A relay type mounting bracket which mounts the switch at right angles is shown in Figure 2. It is slotted to allow the switch to be swung away from the panel

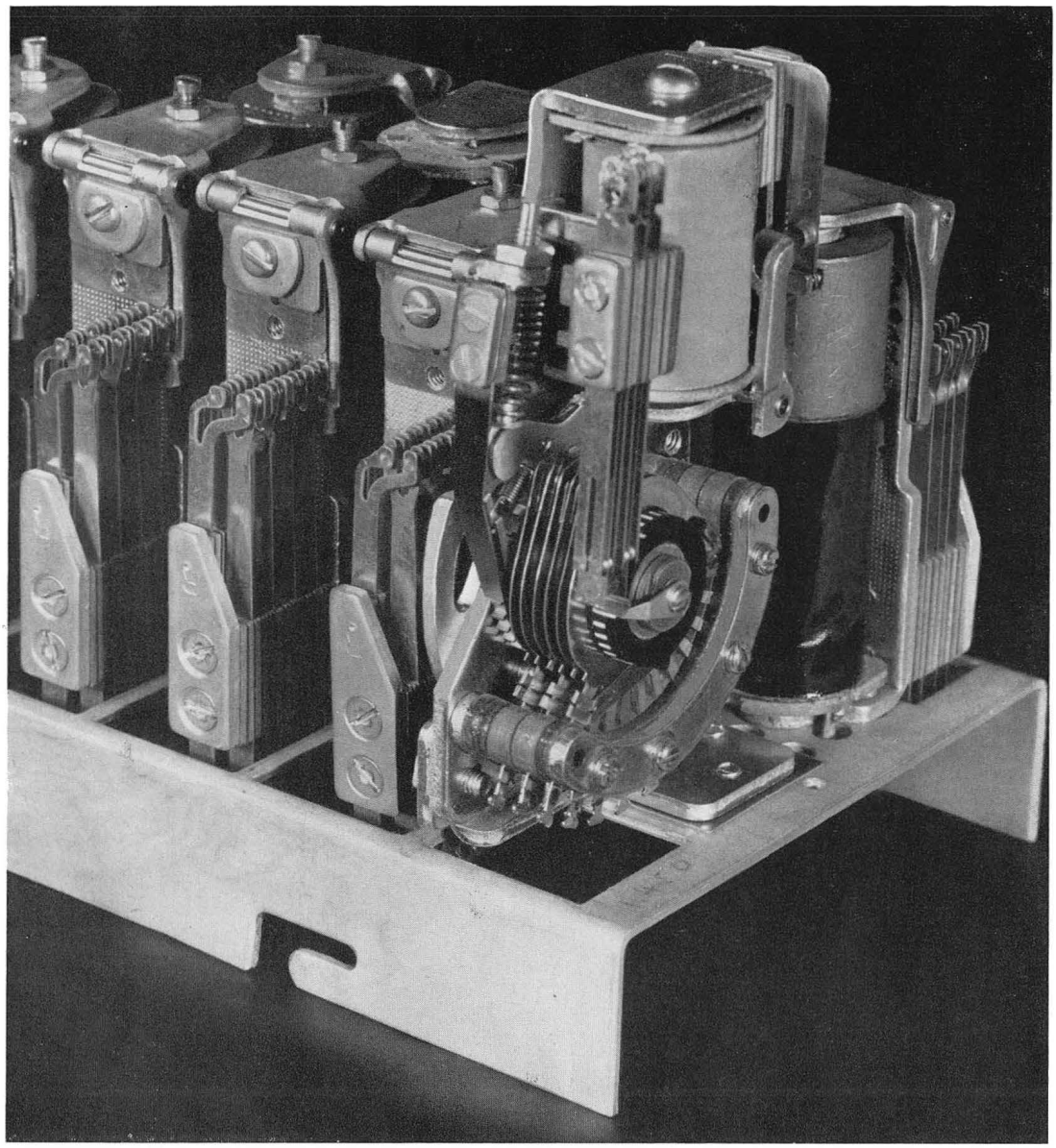


Figure 2. A three-level Type 44 switch mounted with a group of relays occupies a standard relay cut-out. Here, as in Figure 1, all units are shown approximately actual size.

to provide access to the bank terminals from the front, and to adjustment points when the switch is surrounded by other equipment. These brackets are attached to the bank plate in the same manner as the motor magnet assembly.

Design Features

The motor magnet frame (shown at the top of Figure 3) carries the complete driving mechanism of the switch—coil, armature assembly, driving spring, and the ratchet and wiper assembly—maintaining these parts in permanently correct alignment. In addition, the frame serves as a heelpiece to close the magnetic circuit between armature and coil, producing the highly efficient relay type of magnetic circuit which contributes a great deal to the high stepping speeds obtainable. A three-level switch operating automatically through its own interrupter springs will have a normal speed in excess of 80 steps per second, due to the efficient magnetic structure, the small mass of the moving

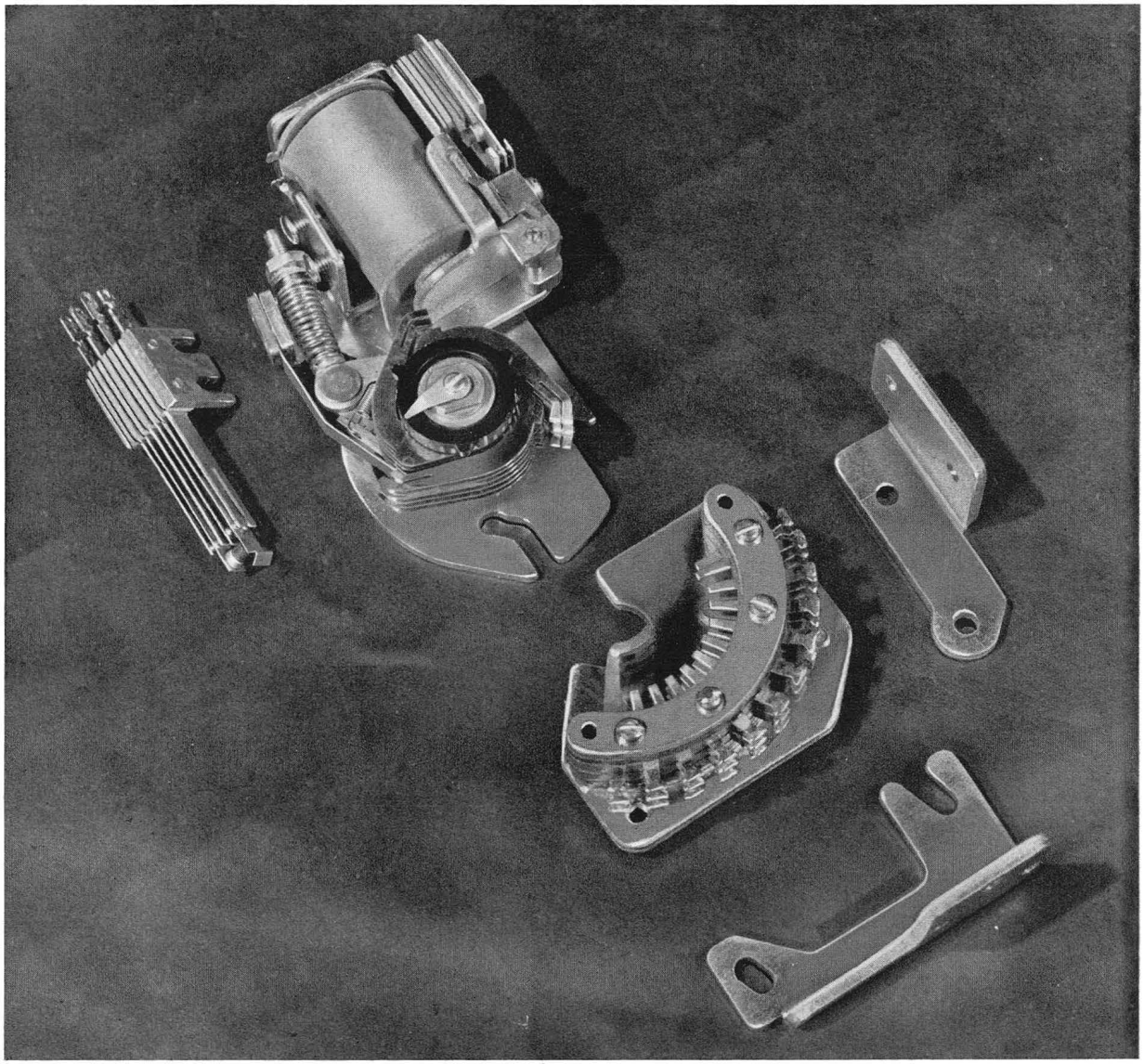


Figure 3. Component parts of the Type 44 Rotary Switch. Adjustment of the driving mechanism is not affected by this disassembly.

parts, and the careful matching of the driving spring to the motor magnet and the wiper load for efficient power transfer.

The Type 44 switch is characterized not only by high speed operation, but also by exceptionally long service life. To reduce wear to a minimum, the ratchet wheel, armature teeth, and pawl are case hardened by a special heat treatment, and the pawl is made of abrasion resisting alloy steel. The use of a bronze alloy pin as the pawl bearing, turning in a hardened bearing hole, and a hard stainless steel pin and die-cast bronze alloy yoke as the armature bearing contributes greatly to long life. The wiper assembly bearing is a case hardened steel tube rotating on a hard drawn stainless steel pin, which is undercut to provide a cavity for grease. The low temperature grease with which the bearing is filled at the factory is usually sufficient for the life of the switch. The ratchet teeth are lubricated with a graphite and oil mixture chosen for its ability to stay in place at high speeds and to withstand large unit pressures. The same light yet tenacious oil is used without graphite for the armature and pawl bearings.

This careful choice of lubricants, and the elimination of the pawl stopping block, with its ten-

dency to bind the pawl, enable switches of this type to perform normally at temperatures of —30°F and lower.

Frequently, the determining factor in the life of a rotary switch is the wear at the tips of the wipers due to mechanical friction, and erosion caused by electrical arcing which increases with the magnitude of current in the circuit being made or broken. Although the wiper assembly can be replaced if necessary, and the life of the switch extended by this means, it is obviously desirable to extend the life of the wiper assembly itself, and thus minimize the need for its replacement. To attain this end, the Type 44 switch is provided with three sets of wiper blades for each level, instead of the customary two, and the bank contacts are arranged to occupy an arc of 120°. This arrangement in itself provides 50 per cent greater life besides resulting in a more compact mechanism. As a result of careful balancing of the life of these various components, switches on test regularly operate in excess of 20 million 11-step cycles or 220 million steps, while carrying relatively heavy electrical loads.

Of equal importance is the number and frequency of adjustments required during the life of a switch. Extensive tests have shown that on both the Type 44 and Type 45 switches, the only two adjustments that normally require attention are the tension of the driving spring (margining) and gauging of the interrupter springs. The driving mechanism itself is adjusted at the factory and should require no further attention. Tension of the driving spring is controlled by a micrometer screw, while the interrupter spring adjustment is a simple gap setting to obtain smooth self-interrupted stepping. Armature stroke is held within very close limits by the use of high precision parts, and need never be adjusted in the field.

Bank and Wiper Assemblies

To meet severe service conditions, the bank and wiper assemblies are made up with spacers of a special hard moisture-resistant grade of laminated phenolic plate, coated with bakelite varnish. A baking and pressure cycle after assembly welds these parts together into a cemented unit structure. The number of components in these sandwich-type assemblies is held to an absolute minimum, and the tolerance on thickness of each held to especially close limits, so that all assemblies of the same number of levels are directly interchangeable with a minimum of misalignment.

These assemblies are designed to have a high voltage breakdown in excess of 1200 volts dc. The brush blades, which establish electrical connections with the wipers, are assembled as a part of the bank and occupy the vacant or home position. Because the brushes contact the inside of the wiper blades directly, rather than a metal washer between levels, all the space between levels can be occupied by insulating material. This prevents high voltage breakdown while retaining the advantages of a considerably more compact assembly. The disadvantage of this construction in the past has been that while one set of wiper blades passed over the brushes, another was passing over the bank contacts. This resulted in a double load on the switch, producing uneven wear and operation of the driving mechanism and limiting the number of bank levels. The provision of a vacant bank position opposite the brushes has eliminated these difficulties. Electrically, such a home or "off-contact" position is usually desirable, but in order to provide circuit continuity over this position when necessary, the first two levels have home or eleventh step contacts. The off-normal spring assembly, which operates in the eleventh position, may also be used for this purpose.

Twin contacts are provided on all auxiliary spring assemblies, while on the wiper and bank circuits a total of four contacting points are provided for each connection, since the wiper blades have split tips, and each bank brush terminates in two contacting tips. The wiper springs have long flexible trailing blades to eliminate bounce (with consequent undesirable circuit interruption) as the tips pass over the contacts at high speed.

The switch may have as many as six levels. A maximum of two bridging levels equipped with eleventh step contacts may be assembled, adjacent to the ratchet wheel. The remaining levels are nonbridging. Coils are available for operating voltages ranging from 6 volts dc. to 110 volts dc. They are self-protecting; that is, they can be energized continuously on rated voltage for any given period of time without overheating, and still operate the switch at the end of the period.

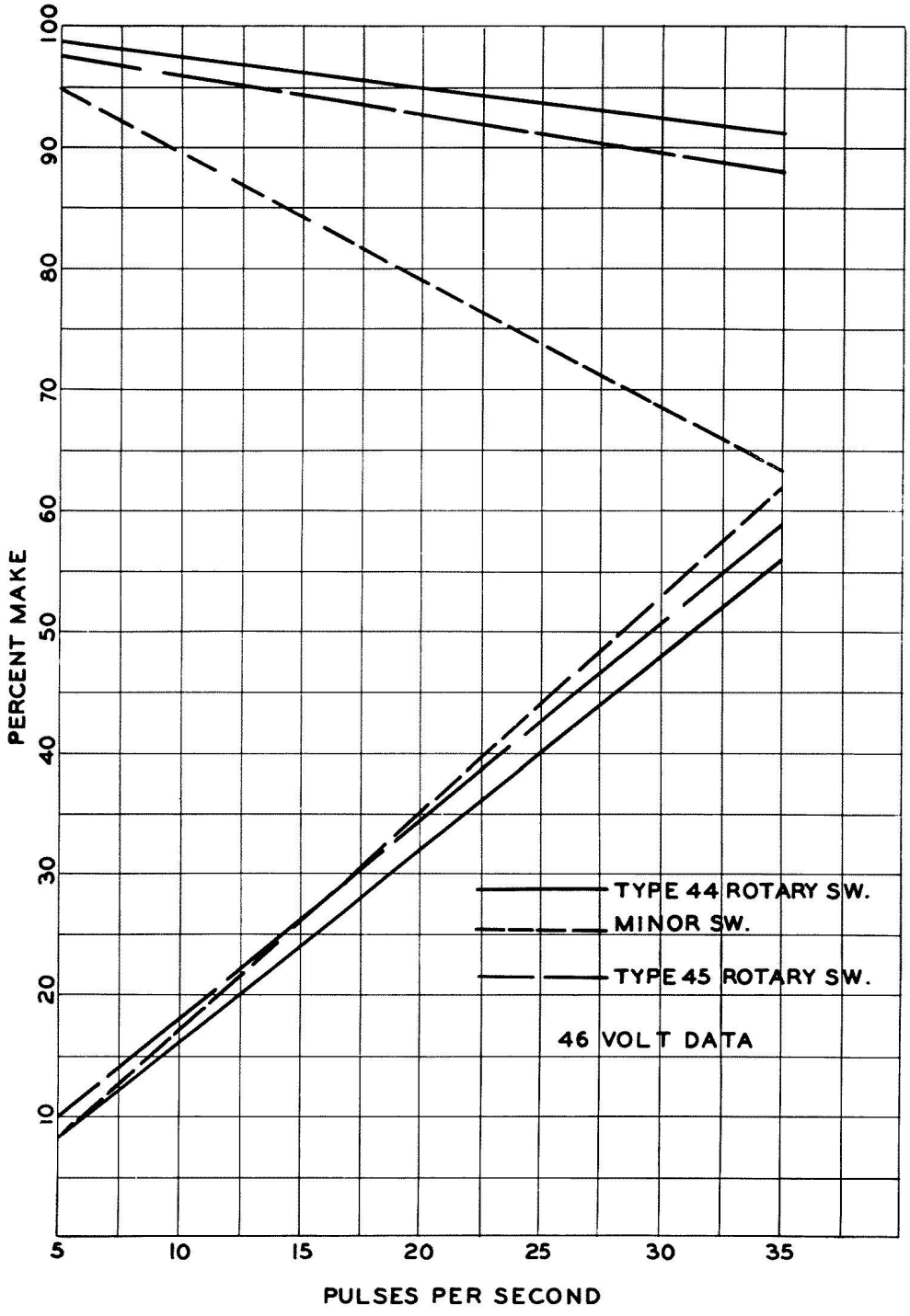


Figure 4. Operating range of a three-level Type 44 switch—external pulsing, 46 volts dc.

The high stepping speeds attainable with the Type 44 switch are evident with both self-interrupted and external pulsing operation. Figure 4 shows the operating range of a three-level switch operating on 46 volts dc. in response to external pulses. These curves correspond to an operate time

Characteristic	*Minor Switch*	*Type 44*	*Type 45*
Motor magnet operate time	16 ms.	16 ms.	18 ms.
Motor magnet release time	11 ms.	3 ms.	5 ms.
Maximum theoretical impulse speed	35.5 pps.	53 pps.	43.5 pps.
Impulse range at 10 pps. in per cent make	74% make	80.5% make	77% make
Ideal impulse ratio	60% make	84.3% make	78.3% make
Average self-interrupting speed	not applicable	80 pps.	75 pps.
Maximum time for switch to home	58 ms.	110 ms.	334 ms.
46 volt motor magnet resistance	155 ohms	140 ohms	100 ohms
Minimum expected life	3½ million ten-step cycles	20 million ⅓ revolutions (11-step cycles)	10 million ½ revolutions

Figure 5. Typical Performance Characteristics of the Type 44 Switch and other Types.

of the armature of approximately 16 milli-seconds and a release time of approximately three milli-seconds, and show that pulsing speeds up to 30-40 pulses per second are possible, depending on the accuracy with which the pulse length can be held.

Performance and Application

The Type 44 rotary switch might well supplant the telephone type minor switch and other switches with a limited number of contact points, in many telephone and industrial applications. Through the use of a uni-directional single magnet rotary switch drive, it has been possible to eliminate the release magnet and mechanism of the conventional minor switch. This reduces the mounting space for comparable facilities to one-half that formerly required, and results in a more simple and rugged switch. The bank level capacity is twice as great as that of the minor switch, which is limited to three levels, while the life expectancy is five or six times as great. Figure 5 gives comparative data on performance and life of the two switches, with some similar data for the Type 45 switch. The first five figures are obtained from the impulse range diagram of Figure 4, and are of interest in applications involving critical circuit timing. It should be noted that the maximum theoretical impulse speed is not a practical value because the pulse length cannot be held to the one critical value required, but it does provide a good performance index. This speed may be most closely aproached by pulses of the ideal impulse ratio. The figures for the maximum time to home the switch represent the time required for the Type 44 rotary switch to step self-interrupted from the first to the eleventh or home position, and for the minor switch to be released from the tenth contact to its home position. As we have pointed out, any statement of life expectancy must be considered only as a guide, since the mechanical and electrical service conditions may radically alter the switch life. Furthermore, in most cases the useful life may be doubled or tripled by minor readjustment and parts replacement after the initial point of failure has been reached.

Many mechanisms having the virtue of compactness are the result of reduction in size of component parts. For some applications such a technique may prove satisfactory. But where there are critical requirements of long life, rugged construction, and a high order of reliability, reduction of overall size must not be made at the expense of reduction in area of wearing and electrical contacting surfaces, rigidity of structural parts, or adjustment tolerances to the point where maintenance costs become excessive. This presents a much more difficult task. The Type 44 rotary switch, based on a uniquely simple design which is also the key to its exceptional performance, reconciles these apparently conflicting requirements.

SOME VARIANTS OF THE VERSATILE STROWGER SELECTOR

By N. SALVESEN

SYNOPSIS: *The standard local selector and its functions — need for variants — digit absorbing selectors — conversation timing — discrimination — time-cut-off — switching selector-repeaters — 10/20 and 20/10 selectors — toll selectors.*

IN the Strowger Automatic telephone system, whenever the capacity of an exchange exceeds that which can be accommodated in a connector system, it becomes necessary to introduce group selecting switches. The function of these switches, known as selectors, is to select trunks and extend the calling line to the next rank of switches in the switch train. This process is carried through successive ranks of switches generally referred to as first selectors, second selectors, and so on, as required by the total capacity of the whole exchange, and finally to connector groups where the final selection of the called line is made. Thus, for example, the dialing of number 26894 involves a first selector for the selection of a trunk to the 20000 group second selectors; a second selector for the selection of a trunk to a 26000 group third selector; and a third selector for the selection of a trunk to the 26800 connector group. The two last digits of the called number are dialed on a connector in this group for the selection of the called line.

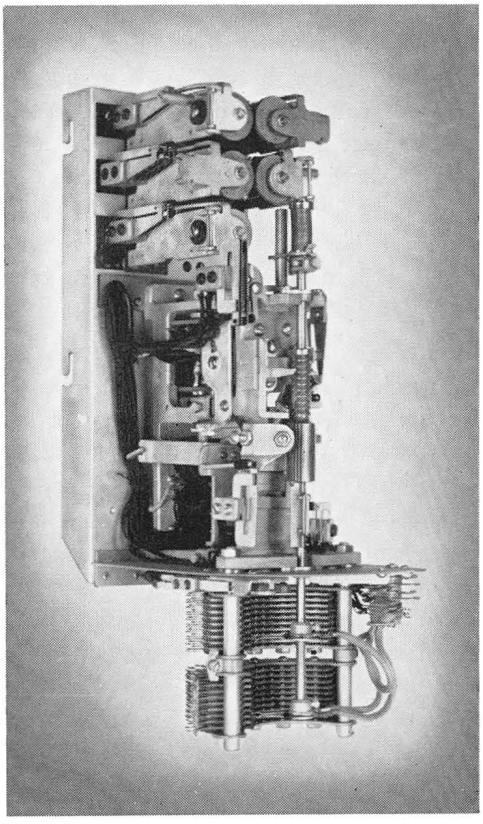


Figure 1. Standard local selector.

Figure 1 shows a typical local selector. It uses the standard Strowger two-motion mechanism, and in its most frequently used form is a one-digit switch, having ten bank levels and ten trunk outlets on each level and, as such, is generally referred to as a 10/10 selector. In response to the dialing of a digit, the shaft is stepped vertically to the bank level corresponding numerically to the digit dialed. It then automatically rotates in on the level and selects a free trunk to the next rank of switches. If all trunks on the level are busy, the selector rotates to the eleventh rotary position and returns busy tone to the calling party.

When the selector is used as a local first selector it connects dial tone to the calling line immediately after the line finder has found the line. The dial tone is an indication to the calling station that a selector is available and that the caller may proceed with dialing. The dial tone is automatically removed from the circuit when the selector steps off normal.

Immediately upon seizure by the preceding switch, the selector sets up a holding and guarding circuit over the control wire ("C" lead). This circuit holds the switches in operated position and

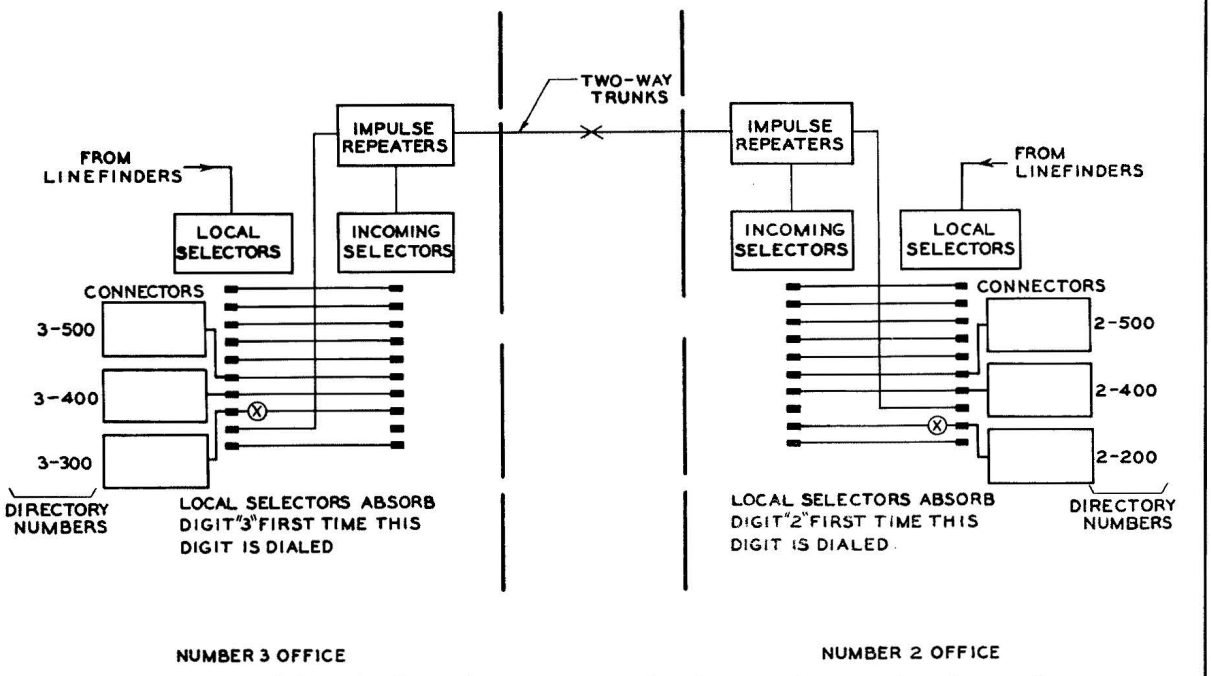


Figure 2. Use of digit absorbing selectors in two small exchanges with universal numbering plan.

guards the connection from intrusion by other calls. The release of the switches is also controlled over this holding circuit, and release is effected when the calling party restores the handset of his telephone.

The simple selector described above is probably the most commonly used switch in the Strowger system. It is employed in exchanges ranging in size from small unattended offices to large metropolitan exchanges and multi-office networks. Its principles are, of course, common knowledge among those familiar with Strowger Automatic switching, and are included here only as a necessary preliminary to an understanding of what follows.

While the conventional selector meets the majority of operating requirements it occasionally becomes desirable to supply selectors which incorporate special operating functions for which regular selectors are not suited. Some of the most frequently used of these variants will be described in this article.

The Digit Absorbing Selector

The purpose of the digit absorbing selector is, on special classes of calls, to absorb one or more digits of the dialed number. This is accomplished by arranging the circuit so that the selector will release and return to normal, either every time, or only the first time, a preassigned level is dialed. This feature, which is described more fully in the following examples, makes it possible in many cases to eliminate a rank of selectors and at the same time to meet the requirements of a desired numbering plan.

Figure 2 shows trunking diagrams for two small exchanges, designated "number 2 office" and "number 3 office", operating on a universal numbering basis. On local calls the local selectors will absorb the first digit of the called number. On inter-office calls no digit absorbing is necessary and the incoming selectors are, therefore, not equipped for this feature. It will be readily understood from the illustration that the digit absorbing feature, in this particular example, saves a rank of second selectors in each office.

Another and perhaps more striking example where a specific numbering arrangement may most economically be met by using digit absorbing selectors is shown in Figure 3. This illustration shows the general trunking arrangement of a large automatic central office comprising two units operating

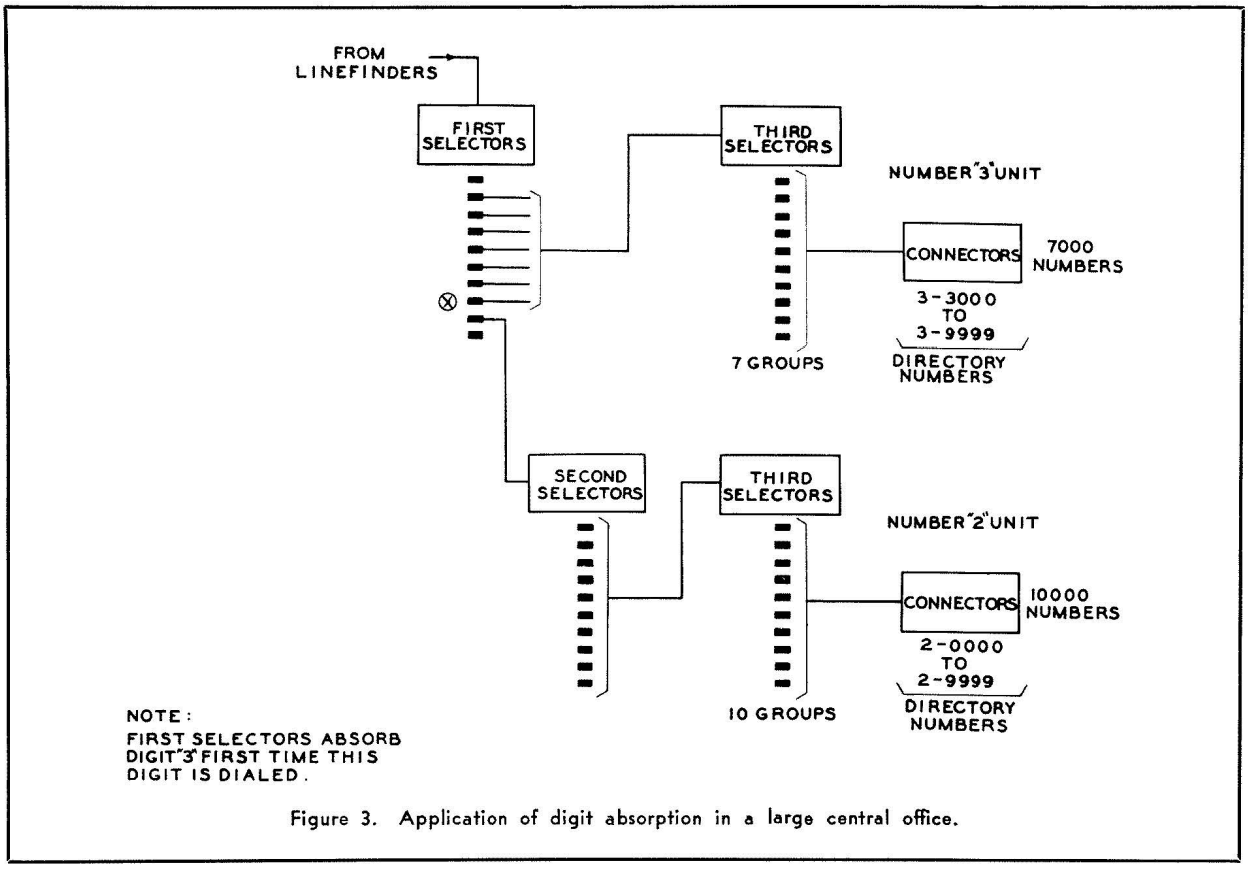


Figure 3. Application of digit absorption in a large central office.

on a terminal-per-station basis and having a five-digit numbering plan. The "2" unit serves 10,000 stations and employs first, second and third selectors and connectors. The "3" unit serves 7000 stations, but since the first digit (3) of the directory numbers for this unit is absorbed by the first selectors, one rank of second selectors is thereby saved. In this particular instance the saving effected is considerable since without the digit absorbing feature all of the terminating traffic to the 7000 connector terminals would have to be carried through a group of second selectors.

Selectors With Conversation Timing

In some exchanges it is found desirable to automatically limit the conversation time on local calls, originating either from all lines, or only from a specific class of lines such as party lines. For this purpose two slightly different types of selectors equipped with conversation timing are available.

The first type is arranged to start timing from reversal of battery which takes place when the called party answers. Conversation time is generally limited to a period of 6 to 8 minutes, after which the connection is automatically released. A warning tone is momentarily impressed on the line approximately one minute before disconnection takes place. Calls to toll, information and other special services are not timed since the trunk circuits for these services do not reverse battery and consequently timing does not start.

The second type of selectors with conversation timing is quite similar to the first type except that timing starts upon seizure of the next switch in the train. This method of operation permits the use of a simpler and less expensive circuit, but starts timing before the called subscriber answers. However, this slightly premature timing may, if desired, be compensated for by lengthening the permissible conversation period. By means of shaft springs the timing equipment may be made inoperative on designated levels, thus preventing timing of calls to toll and special services.

Exclusion of specified subscribers' lines from timing operations is controlled from the line finders by means of shaft springs which operate on des-

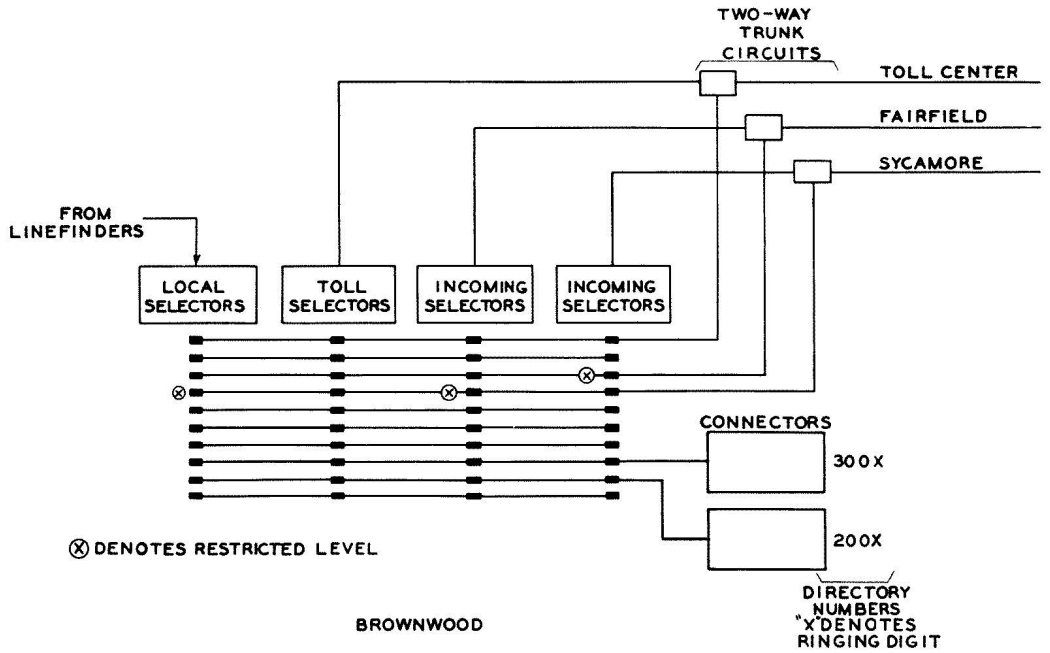


Figure 4. Applications of discriminating selectors.

ignated bank levels. The exempted lines are connected to bank terminals on these levels, and when the line finder connects with a calling line on such a level it places ground potential over a control lead to the selector, thereby preventing the timing equipment on the selector from operating.

Discriminating Selectors

The discriminating feature of these selectors provides a means for restricting access to one or more of the selector levels. These restrictions may be applied to either subscribers or operators not authorized to call such levels. In the case of subscriber restriction this is controlled from the line finder by assigning such subscribers' lines to restricted levels in the line finder bank and passing restrictive ground potential over a separate lead to the selector. Operator restriction is effected by strapping ground potential to the restrictive circuit lead of the incoming selector. If any unauthorized person dials a restricted level, the selector will rotate to the eleventh bank position and return busy tone to the person calling.

An application of discriminating selectors is shown diagrammatically in Figure 4. The unattended exchange at Brownwood has trunks to a toll center and also to the manual exchanges at Fairfield and Sycamore. There is free service to Fairfield and extended service to Sycamore. The Brownwood extended service subscribers dial Sycamore direct, and the restrictive feature of the local selectors bars non-extended service subscribers from access to the Sycamore trunks. The operators at Fairfield and Sycamore dial subscribers' numbers in Brownwood, but are restricted from calling each other through Brownwood. Operators at the toll center, however, dial Fairfield and Sycamore through Brownwood.

Selector With Permanent Time Cut-Off

Operating conditions often make it desirable to equip all or part of the subscribers' line circuits with line lock-out. The local first selectors in such exchanges are equipped with a time cut-off feature which becomes operative on seizure of the switch. If, due to a short on the line, handset off cradle, failure to dial or other similar causes, the switch is not stepped off normal within a specified time of approximately two minutes, the time cut-off circuit will operate and release the switch and its as-

sociated line finder. The line lock-out circuit will also operate and lock out the line in order to prevent another line finder from operating and hunting for the line. The line will remain locked out until the cause of the "permanent" is removed. Once the selector has received a series of dial impulses, the time cut-off circuit becomes inoperative.

It is obvious that the time cut-off feature serves a useful purpose only when used in conjunction with line lock-out; otherwise, the release of one selector and its associated line finder would merely cause another line finder to find the "permanent" line and connect it to its associated selector which in turn would release the connection and thus indefinitely repeat the cycle of finding and releasing.

The Switching Selector-Repeater

The switching selector-repeater combines the function of a discriminating selector and a repeater in such a manner that in multi-office areas it provides facilities for universal numbering without the necessity of having direct trunks to all offices. The operation and application of this switch are treated in detail in the April, 1949, issue of The Automatic Electric Technical Journal and it will, therefore, not be further discussed in this article.

The 10/20 Selector

The 10/20 selector is a switch having ten levels with twenty trunk outlets on each level. This selector is especially useful for inter-office trunking in multi-office networks, where a selector is desired having a greater traffic carrying capacity per level than the conventional 10/10 selector will provide. The 10/20 selector is generally similar to the standard Strowger 10/10 selector, except that it requires a wiper switching relay and uses 600-point banks.

For the sake of clarity, the 600-point bank should be considered as two 300-point banks, a lower and an upper bank each having ten levels. Associated with each set of banks is a lower and an upper set of wipers mounted on a standard Strowger switch shaft capable of making ten vertical steps. The wipers are located on the shaft in such a manner that when the shaft is moved vertically, as for example three steps, the lower wipers will be opposite the third level of the lower set of banks, and the upper wipers will be opposite the third level of the upper set of banks. The twenty trunks per level are so arranged on the bank contacts that the odd numbered trunks (1, 3, 5, etc., up to 19) appear on the lower banks, and the even numbered trunks (2, 4, 6, etc., up to 20) appear on the upper banks. Thus, when a switch makes its first rotary step in on a particular level, the lower wipers will rest on trunk number 1 while the upper wipers will rest on trunk number 2.

When the switch is being operated, the shaft is stepped vertically in response to the digit dialed. This raises the wipers to the level corresponding to the dialed digit, and the selector automatically rotates in on the selected level, making simultaneous contact with trunk number 1 in the lower bank and trunk number 2 in the upper bank.

If trunk 1 and trunk 2 are both idle, the selector will cut through on trunk 1 to the next succeeding switch in the switch train. If trunk 1 is busy, but trunk 2 is idle, the selector will cut through on trunk 2 to the next switch in the train. If trunks 1 and 2 are both busy, the selector will automatically rotate to the next set of bank contacts, and so on, until an idle trunk is found. If all twenty trunks are busy, the selector will automatically rotate to the eleventh horizontal position and send back to the calling party the "all paths busy" tone.

The 10/20 selector hunts over the twenty sets of bank contacts per level in approximately the same interval as the standard 10/10 selector hunts over ten sets of bank contacts per level.

It is a recognized fact that the traffic carrying capacity of a large trunk group is considerably greater than it would be if the group were divided into a number of smaller groups. From this it becomes evident that for a given traffic fewer switches will be required when the trunks to these switches are taken from twenty-trunk selector levels than if they were taken from ten-trunk levels. In the case of inter-office trunking this results in the saving of outgoing repeaters, inter-office cable pairs and incoming selectors. The larger the trunk group is the more pronounced the savings will be.

Efficient use of inter-office trunking in exchanges having 10/10 selectors may of course be obtained by the use of outgoing secondary lineswitches. However, the simplicity of 10/20 selector trunking which avoids the need for outgoing lineswitches while retaining practically the same efficiency as

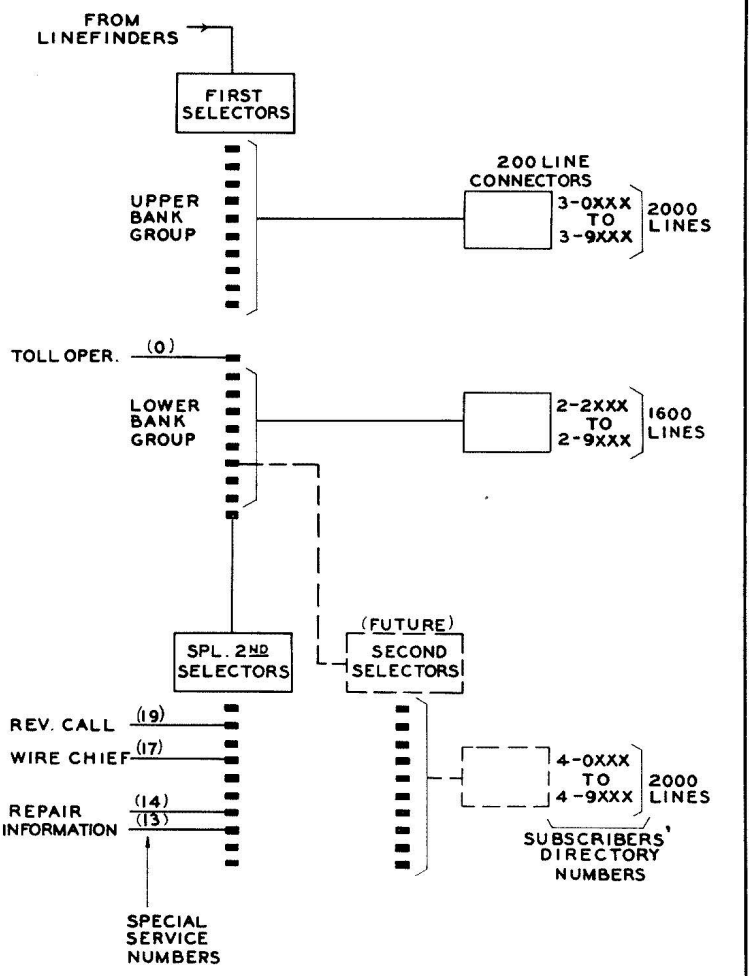


Figure 5. Application of 20/10 selectors.

obtained with secondaries, results in reduced equipment maintenance costs and makes this selector particularly suited for network operation.

The 20/10 Selector

As may be inferred from its name the 20/10 selector is a switch having twenty levels and ten trunk outlets on each level. In appearance the 20/10 selector is very similar to the 10/20 selector, but the circuit arrangement and operation are somewhat different. Like the 10/20 selector it uses 600-point banks which actually are two sets of 300 points each, forming a lower and an upper group, each group having ten levels. Group selection is controlled by shaft springs set to operate on designated levels.

The 20/10 selector is a one-digit and two-digit switch. Two-digit switch-through levels may be assigned in both the lower and upper bank groups, but one-digit switch-through levels can be assigned in the lower group only. Any digit may be the first digit of a two-digit switch-through number, except that it can not be the same digit as a one-digit switch-through number. Generally, digits of low numerical order such as "2" and "3" are preferred as the first digit of a two-digit switch-through number.

The purpose of the 20/10 selector is, within the limits of certain operating requirements, to effect economies by eliminating second selectors which otherwise would be required. Its most effective field of application is for use in conjunction with 200-line connectors and in exchanges where the ultimate capacity is not expected to exceed 3600 lines.

Such a typical application is shown in Figure 5, which shows an ultimate trunking arrangement of a 3600-line exchange using 20/10 selectors and 200-line three-digit connectors, operating on a terminal-per-line basis. Levels "0" and "1" in the lower bank group are one-digit switch-through levels for toll and special service calls respectively. All other levels in both bank groups are two-digit switch-through levels and are used for trunking to 200-line connectors. The first digits of the two-digit switch-through numbers are "2" and "3" for the lower and upper banks respectively. The circuit is so arranged that the incoming trunk to the switch is normally connected to the wipers which serve the lower bank group, but may be switched to the wipers which serve the upper bank group by the operation of shaft springs.

When calling a subscriber's number, as for example, 3-6894, the dialing of the first digit "3" steps the shaft vertically to the third level. This operates shaft springs set to function on this level,

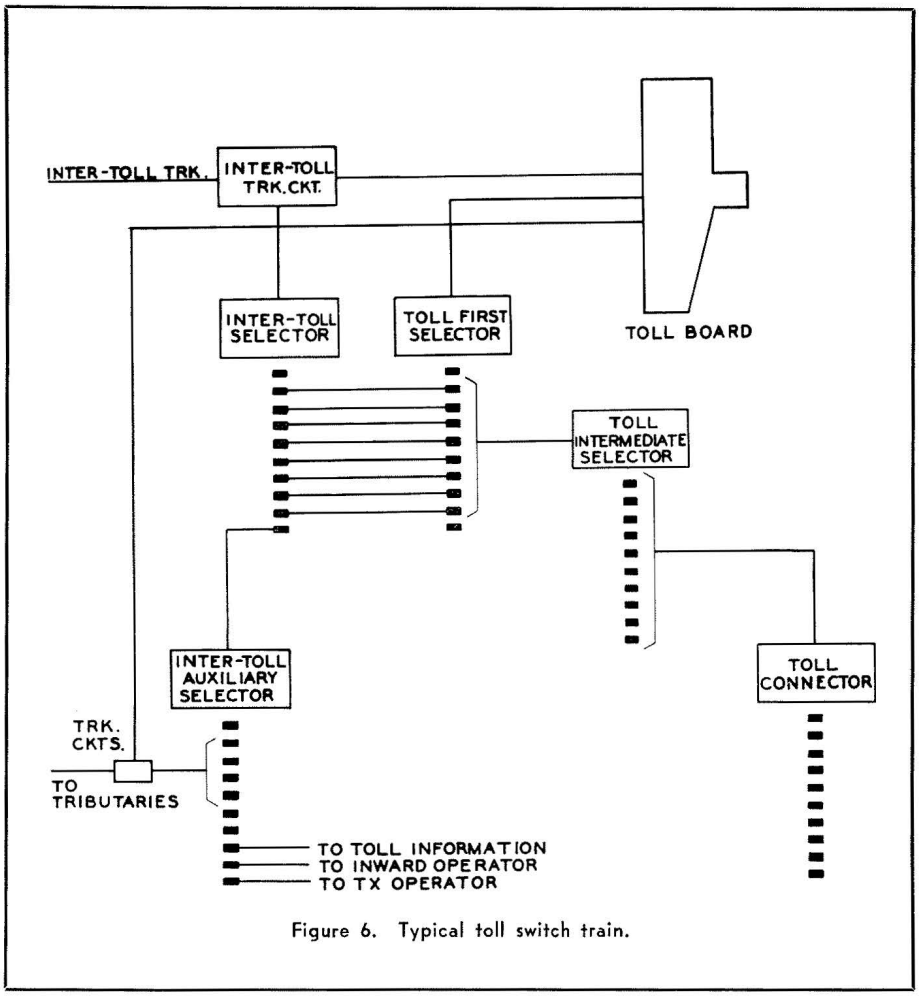


Figure 6. Typical toll switch train.

thereby switching the wipers to the upper group of banks and also closing a circuit to the release magnet, causing the selector to release and return to normal. The dialing of the next digit "6" steps the shaft vertically to the sixth level. This time the selector functions as a regular selector and automatically rotates in on the level and, in the upper bank group, selects a trunk to an idle connector. The final three digits of the dialed number operate the connector to select and ring the called line.

If the first digit of the called number had been "2" the method of operation would have been similar to that previously described, except that on level "2" a different set of shaft springs would operate to cause the selector to release and return to normal. There would be no switching of wipers, since they are normally connected to serve the lower set of banks.

When calling the toll operator ("0") or a special service number such as information ("13") there will be no shaft spring operation on either level 1 or level 0. The selector will therefore function as a regular one-digit switch and automatically rotate the wipers in on the dialed level, selecting an idle trunk either to the toll board or to a special second selector, depending upon whether level 0 or level 1 were dialed.

As previously stated the ultimate number of lines for an exchange wherein 20/10 selectors and 200-line connectors economically could be applied should be approximately 3600. This, as shown in Figure 5, is the number of lines that can be served without using second selectors. However, this must not be construed to mean that, if the estimated ultimate number of lines should be exceeded, any difficulty would be experienced in providing additional facilities. Since any level in the lower bank group may be made a one-digit level, except those corresponding to the first digit of two-digit levels ("2" and "3" in Figure 5), it is indicated by means of dotted lines in Figure 5 how facilities may be provided for 2000 additional lines by using the fourth level as a one-digit level, and trunking to a group of second selectors which in turn will trunk to ten groups of 200-line connectors.

Toll Selectors

Toll selectors are practically always of the 10/10 type and in general follow the same pattern as local selectors except that they use 400-point banks

and incorporate certain special features peculiar to toll operation.

The functions of the toll selector are to extend either incoming or delayed toll calls to subscribers' stations, and to furnish proper supervisory signals, either to the local toll operator or to a distant toll operator as in the case of inter-toll dialing. Toll selectors also supply toll grade battery feed to the called line, control ringing of the called line, control collect and refund of coins on calls to prepay paystations, and in the case of intercepted calls transmit an identifying tone to the intercepting operator so that she may flash the operator and convey to her the necessary information. The grouping of the switches in a typical toll switch train is shown diagrammatically in Figure 6.

Since it would be neither practical nor economical to incorporate all of the foregoing functions into one switch, several variations of toll selectors are available, each meeting specific operating requirements. These may, broadly speaking, be grouped into the following classes:

(a) Operator's Toll Selector — This selector, as shown in Figure 6, is the first switch in the toll train and is used by the toll operators to complete calls to subscribers. The switch provides toll grade transmission battery; "on hook" and "off hook" supervision; line seizure supervision; flash busy; toll intercepting tone and control of ringing. When used in exchanges having prepay paystations it also provides control of collect and refund of coins.

(b) Inter-toll Selector — This selector is used by a distant toll operator for completing calls into an automatic office, and, if required, also for through dialing to tributaries and other toll offices. Like the operators' toll selector it occupies the position of first selector in the toll train. Its banks are multiplied with those of the operators' toll selectors, giving the inter-toll operator access to the same groups of succeeding selectors and connectors as the operators' toll selectors. The inter-toll selector embodies, in general, the same functions as the operators' toll selector, except that it is arranged for immediate ringing of the called station in place of controlled ring, and is not equipped for coin control.

(c) The Toll Intermediate Selector — This selector is used as a numerical group selector, and in the toll train occupies the position of second selector, and, if required, also as third selector. Since its primary function is merely to select a trunk to the next switch in the toll train, it becomes a relatively simple switch, embodying practically none of the features of the previously discussed toll selectors. It uses a 400-point bank, the fourth wire (E. C. lead) being used for control and supervisory purposes.

(d) The Toll Auxiliary Selector — The toll auxiliary selector is trunked from the first level of the inter-toll selector and is used by the distant toll operator for completing calls to toll information, TX and inward operators, as well as calls to tributary offices. It is most frequently a one-digit switch, but for small toll centers it may be arranged as a one-digit switch on some levels and a two-digit switch on other levels. On the two-digit levels this arrangement permits the assignment of several small trunk groups on one level, in place of having to assign an entire level of a one-digit switch, when only a few trunks are involved.

Conclusion

The foregoing brief descriptions cover only a few of the many variants of the Strowger selector. Such features as digit absorption may equally well be applied to toll selectors as to local selectors, when economies can be effected by doing so. Such functions as digit-absorption, conversation timing and restricted service may be incorporated into one selector when special conditions most effectively can be met with such a switch. From this it will be appreciated that the Strowger selector, combined with Strowger circuit technique, can efficiently and economically meet the many problems, both simple and complex, that may arise in connection with modern local and toll switching plans.

LA LOUVIERE AUTOMATIC TELEPHONE NETWORK OF THE BELGIAN TELEPHONE SYSTEM

By R. F. STEHLIK

SYNOPSIS: *Organization of Belgian telephone system — need for automatic toll call recording — toll numbering scheme — use of the "Director"—identification of calling party—register storage for call data — ticket printer—manual connections—power equipment.*

THE telephone and telegraph services of Belgium are operated by the State through the medium of the Régie des Télégraphes et des Téléphones (R.T.T.), and the La Louvière Zone forms part of the comprehensive scheme of automatic switching for the whole of Belgium, the extent of which will be appreciated from a study of Figure 1.

Under this scheme a subscriber will be able to dial another subscriber anywhere in the country without the intervention of an operator. Thus for accounting purposes, local calls, which are not timed and for which a unit fee is charged, are recorded on call counting meters, one of which is associated with each subscriber's exchange equipment; for toll connections, full details of calls are recorded automatically. This involves the use of equipment that will record the complete history of each call.

Toll Call Recording

A great deal of original and fundamental development work on the part of the engineering and research laboratories of Automatique Electrique S. A., functioning in collaboration with Automatic Electric Company, Chicago, has resulted in the production of a highly successful system of subscriber identification and call recording which is straightforward in operation, calls for no special maintenance requirements, uses standard circuits and apparatus, and is extremely flexible.

The arrangements were first used by the Company in the Mons zone which is contiguous with the zone of La Louvière and comprises a zone centre and eight satellite offices.

The call information is automatically recorded on a ticket; an example is shown in Figure 2. The ticket, reading from left to right, gives the following information:

Upper Portion

(I) Calling subscriber's number (5-digits)
(II) Called subscriber's number (2 or 3-digit zone prefix plus 5 or 6-digit directory number)
(III) Date (day and month)

Lower Portion

(IV) Time of end of conversation
(V) Tariff rate (for 3 minute base rate)
(VI) Duration of call (in minutes)
(VII) Total cost of call (in Belgian francs)

Reference is made later to the significance of the first three digits of the called subscriber's number.

EDITOR'S NOTE: We are glad of the privilege of bringing to the readers of The Automatic Electric Technical Journal this account of a recent installation of Strowger Automatic Toll Ticketing equipment in Belgium, as supplied by Automatique Electrique, S. A., to the Belgian Régie des Télégraphes et des Téléphones. It should be noted that this installation was devised to meet the specific requirements of the Belgian network. While it differs considerably, therefore, from S.A.T.T. installations in service in the United States, it serves as a further example of the adaptability of Strowger principles to the practices and requirements of particular areas.

Where there are differences in nomenclature between U. S. and European usage, the European nomenclature is used, with the U. S. equivalent given in parentheses in the first instance only.

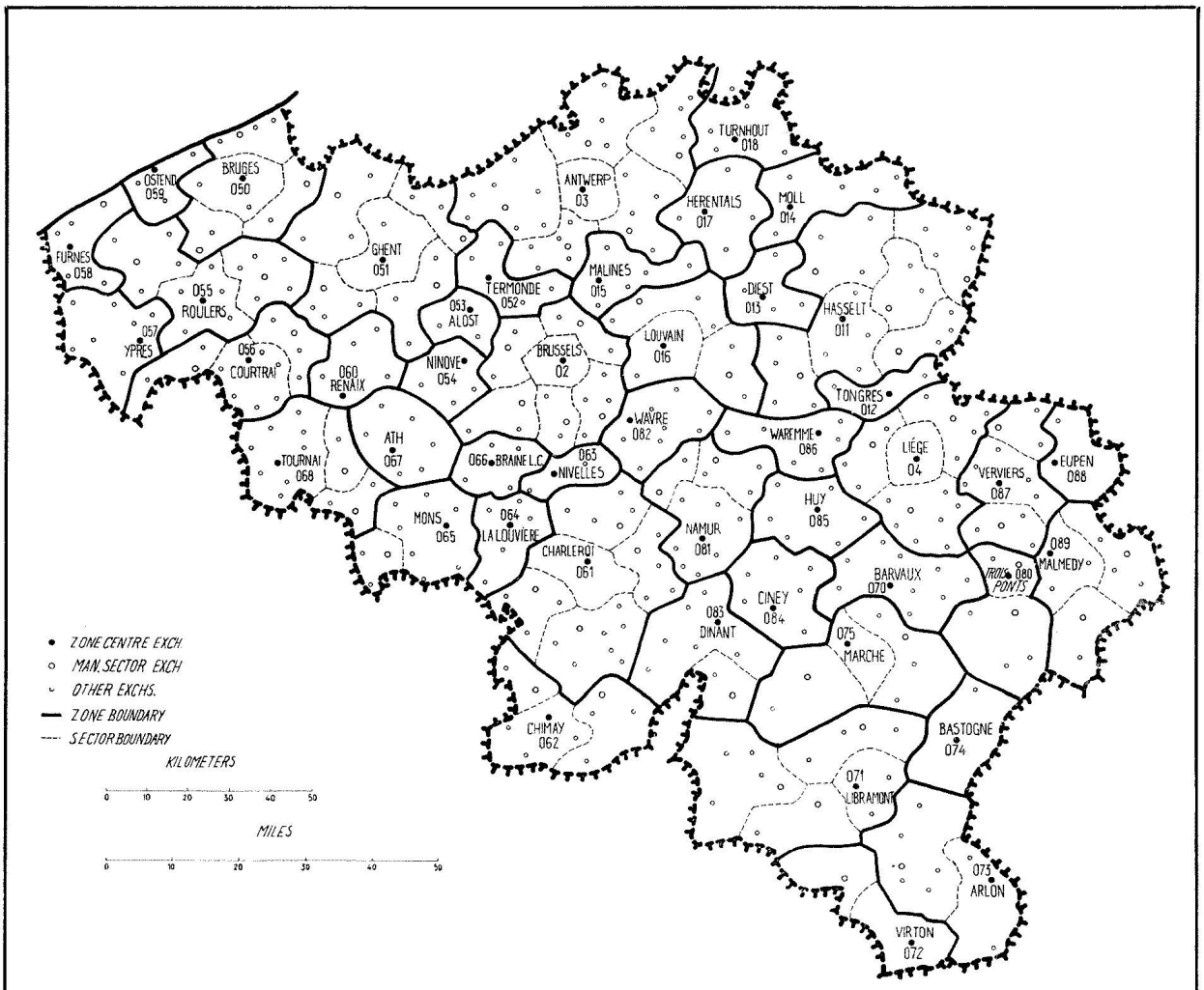


Figure 1. Map of Belgium, showing telephone zone and sector boundaries, and zone names and code numbers.

The number on the extreme lower right of the ticket indicates the machine taken into use. The ticket printing machine is a standard electrical typewriter operated by a system of electromagnets remotely controlled. Figure 3 shows a group of ticket printing machines as installed in La Louvière exchange.

The use of remotely controlled typewriters permits considerable flexibility. For example, in the La Louvière installation two groups of machines are operated in parallel from a common source; one group is located adjacent to the manual switchroom and another in the automatic apparatus room for use by the technical staff and for statistical purposes. The information is printed on tickets on the former set of machines and in roller form on the other set; in the latter case, the information relating to a call is printed in a single line.

Ineffective toll calls are recorded on a separate set of machines; i.e., if a call encounters "busy" or "no reply" the data are recorded on a printing machine with paper roller in the following sequence: calling subscriber's number, called subscriber's number, date, and time.

Normally the number of "wrong number" toll calls which reach the completed ticket stage should be insignificant, because when a subscriber answers a call, a delay of about six seconds occurs before timing commences; this is long enough for the caller to confirm that the correct number has been reached. The connection is released if the hand mi-

Demandeur	Demandé		Date				9090
23745	02446070		15/3				
Heure	Tarif	Durée	Prix Total				
12.1	6.00	15	30.00				4

Demandeur = CALLING SUBSCRIBER
Demandé = CALLED SUBSCRIBER
Date = DATE
Heure = TIME
Tarif = TARIFF
Durée = CONVERSATION TIME IN MINUTES
Prix Totale = TOTAL COST

Figure 2. Typical automatic toll ticket.

crophone (handset) is replaced within that period. Such calls are recorded as ineffective. For service observation purposes, as a check against abuse, a distinction is made in the recording of answered and unanswered ineffective calls.

Numbering Arrangement and Its Relation to Call Routing

In permitting a subscriber to set up toll connections himself, it is desirable to make the operations uniform and simple. The scheme adopted by the R.T.T. consists of adding a prefix to the subscriber's normal number. The numbers forming the prefix are dialed only when a toll call is made. Equipment in the originating exchange translates the prefix into the form necessary to route the call to the called exchange either over a direct route or via one or more tandem switching points.

The subscribers' numbering scheme is basically five digit, although there are a few zones (including the largest cities) in which six digits are used. The number of digits dialed for a toll call is al-

Figure 3. Group of toll ticket printers.

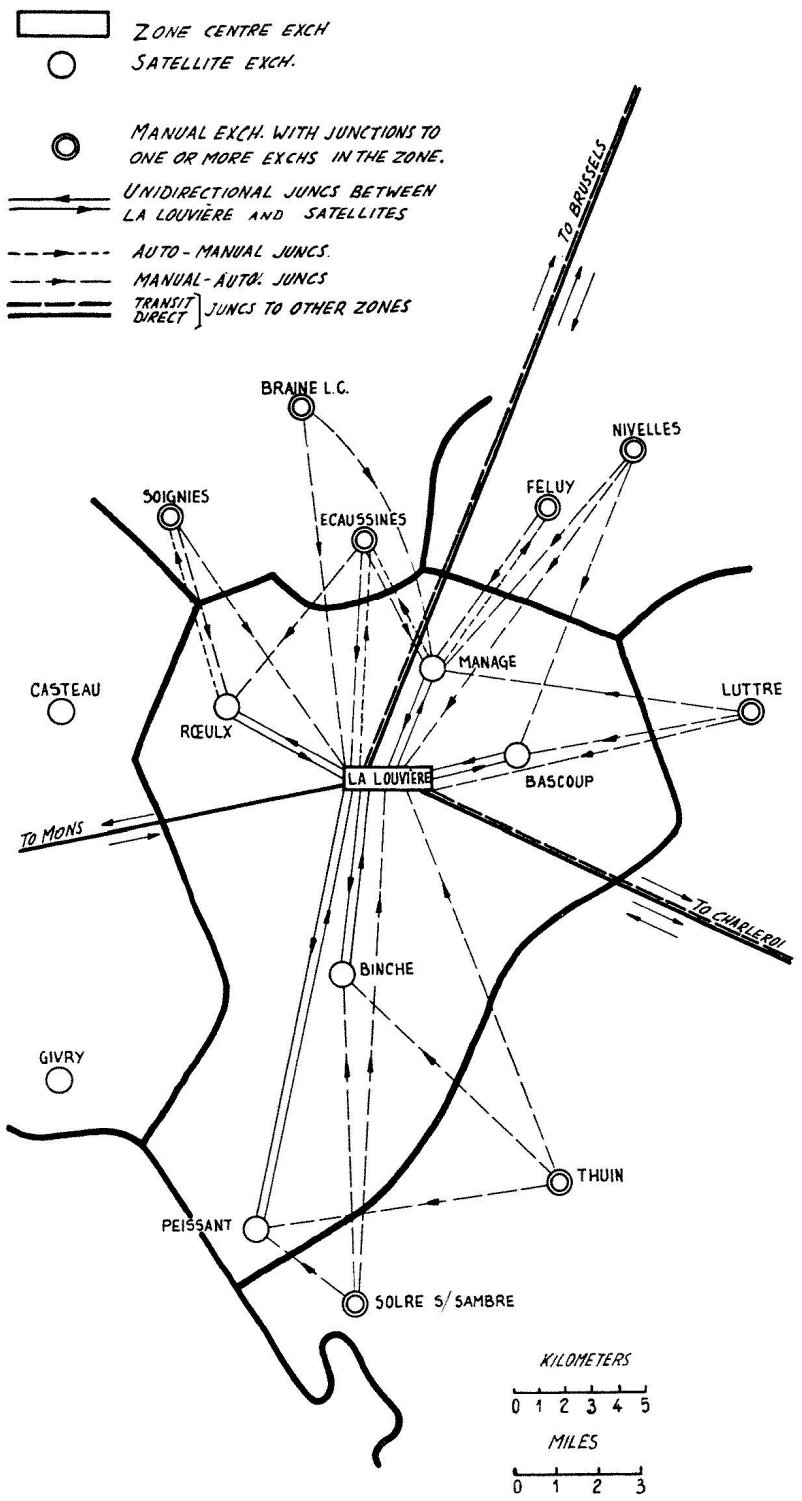


Figure 4. Junction (toll trunk) routing for the La Louvière zone.

ways eight. In cases where six digit subscribers' numbering exists, the prefix consists of two digits; where five digit numbering exists, the prefix is three digits. The toll codes allocated to the various zones are given in Figure 1.

The R.T.T. has designed the layout to provide 47 zones as shown in Figure 1. Each zone will contain a main exchange (zone centre exchange) through which all toll calls for the zone will be handled. Nine of the zone centre exchanges also serve as tandem switching points for switching indirectly routed calls.

The zones are of two general types—single sector and multi-sector. From the local call standpoint, all calls within a zone are metered on a single fee basis on subscribers' meters. In the case of toll calls, however, the Director in the originating exchange takes into account the distance between the originating and destination sectors in determining the basic tariff.

Two types of junctions (toll trunks) are provided for toll connections —direct or transit (alternate)—the use of one or the other being determined by switching requirements.

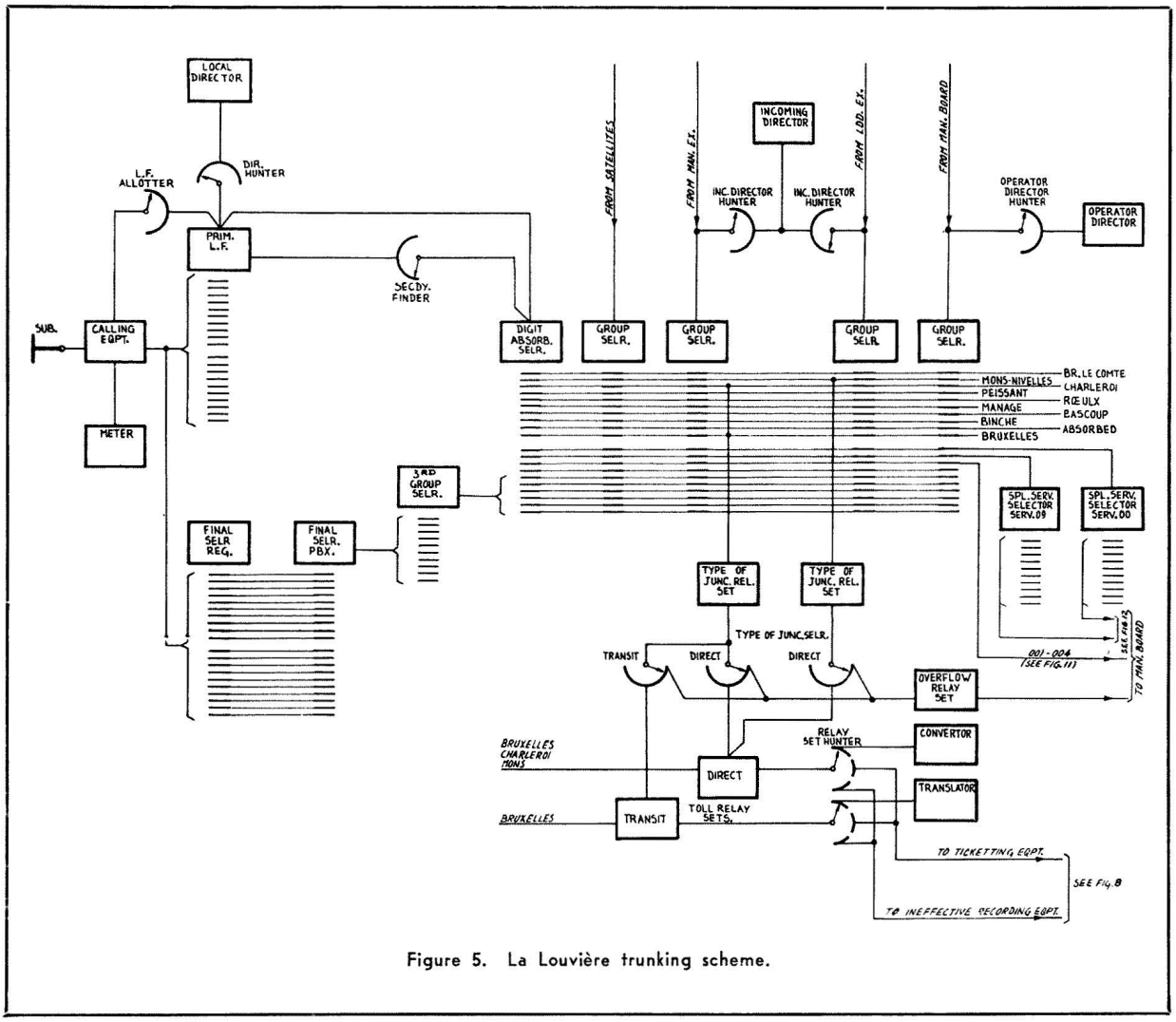


Figure 5. La Louvière trunking scheme.

In the La Louvière switching scheme it is arranged that in the event of all direct circuits being engaged, calls overflow to the transit circuits. If these are all engaged, overflow takes place to the manual board, in which event the calling subscriber's number is automatically displayed to the operator.

Figure 4 shows the junction routing for the La Louvière zone. The heavy and light lines shown radiating to Brussels and Charleroi signify the two types of circuits referred to previously.

Switching Arrangements at La Louvière

La Louvière zone contains six exchange areas sharing a common numbering scheme, and having present and ultimate lines disposed as follows:

Exchange	*No. of Lines*		*Numbering*
	Present	*Ultimate*	
La Louvière	3400	8000	21000 to 28999
Binche	2200	5000	31000 to 36999
Bascoup	1600	3400	41000 to 44999
Manage	1200	3000	51000 to 54999
La Rouelx	800	2000	61000 to 62999
Peissant	300	800	71000 to 71799

Figure 5 is a schematic diagram illustrating the essential features of the trunking arrangements.

The line finders are 200-point switches with partial secondaries working along well known lines. In the first selector stage, digit absorbing selector-repeaters of the 20-level type are provided which, in the switching train, rank as first and second selectors with the levels of the upper bank trunked

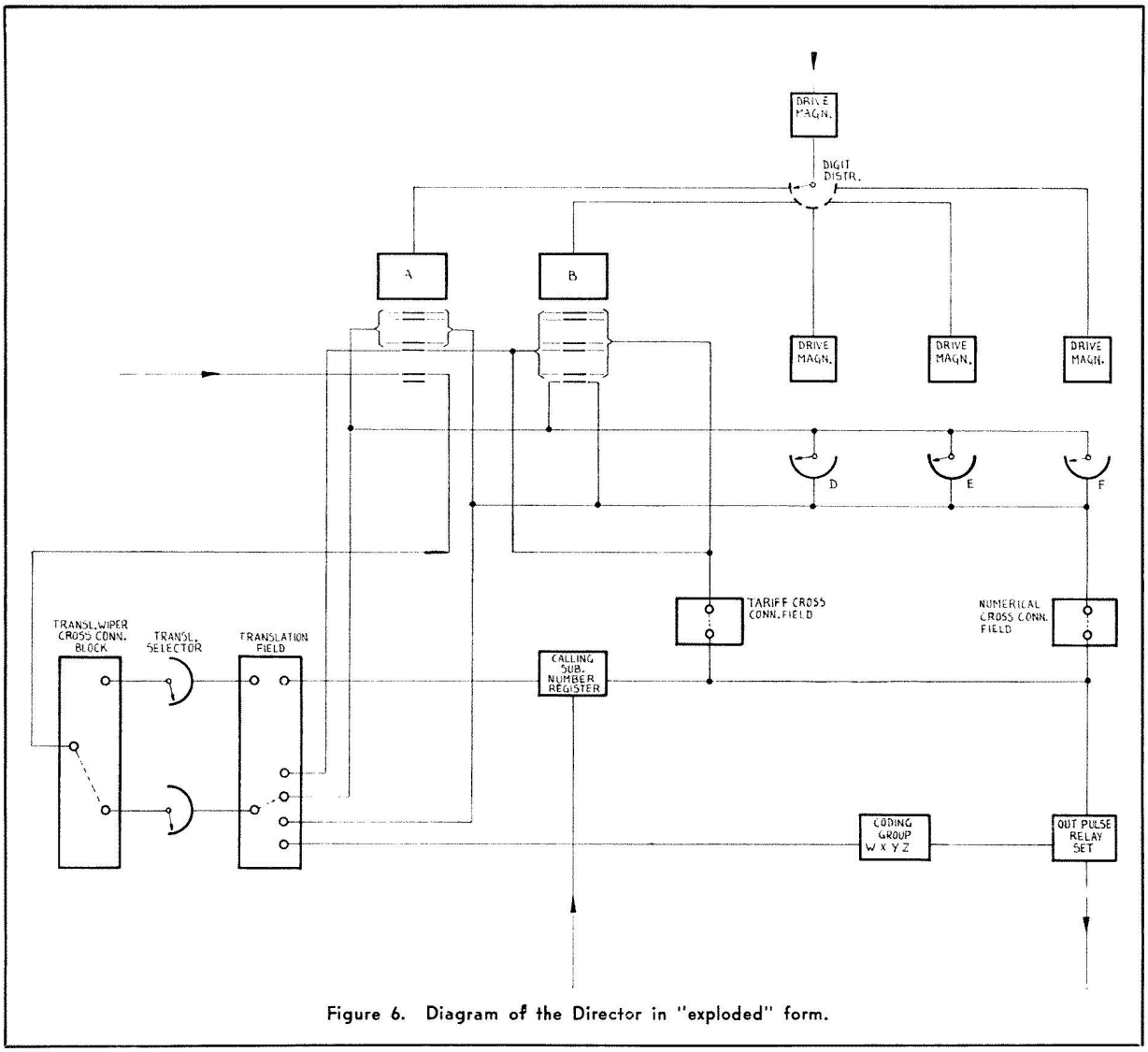


Figure 6. Diagram of the Director in "exploded" form.

out to toll centres and the zone satellite exchanges. Levels 1 to 6 of the lower bank are routed to third selectors for traffic to La Louvière subscribers and levels 9 and 0 to selectors for routing traffic to the manual board, test desk and for other services in the 00-09 number range.

Multipled with the local group of digit-absorbing selector repeaters are the groups dealing with traffic incoming to La Louvière from the sources shown in Figure 5.

The 200-point final selectors (connectors) trunked from third selector levels do not call for special comment.

50-cycle a-c dialing is used for signaling over the toll routes and, as previously stated, the routes contain two types of circuits, thus requiring discriminating facilities for routing calls.

The Director

Before attempting to describe the operations involved during the setting up of a call, it will be useful to explain the function of the Director and associated equipment, because the type designed and manufactured by ATEA for the R.T.T. differs fundamentally from the Directors used elsewhere.

The chief facilities provide normal translation from decimal pulsing to decimal pulsing; decimal pulsing to coded battery pulsing; transmission of discriminating pulses for type of junction selection;

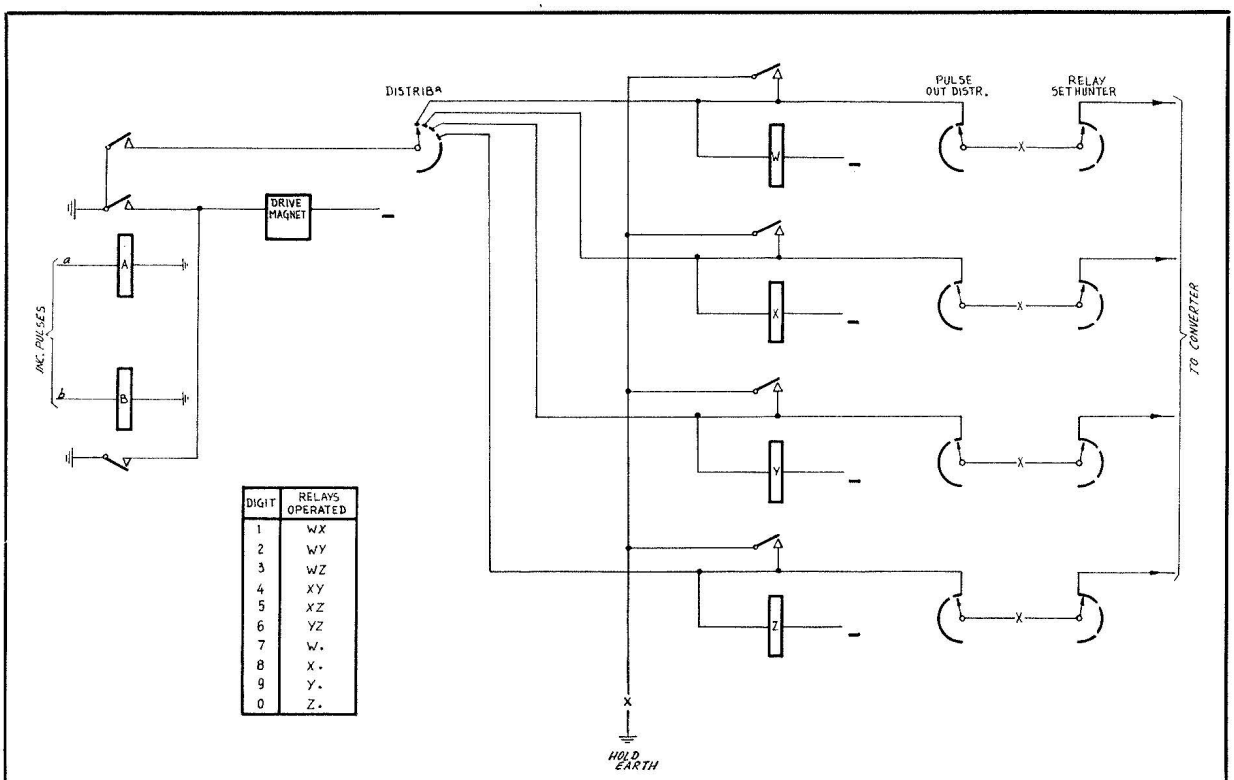


Figure 7. Principle of coding scheme.

registration of calling subscriber's number for identification purposes and toll ticketing information; discriminating for calls which are routed to the manual board and for which local rate metering is under operator control; and discriminating for stations (paystations, cafes, etc.) not authorized to initiate toll calls.

It will be apparent that a high degree of flexibility is provided on the output side of the Director to meet such a large variety of requirements. The general arrangement of the Director is shown in Figure 6, which for convenience is drawn in "exploded" form. Briefly, the operation is as follows:

The digit distributor directs the digits dialed successively to the two-motion selectors *A* and *B* and uniselectors (rotary switches) D, E and F. The five digits of a called number are stored in the subscribers' number register. The translation selector controls the number of digits to be transmitted and whether they are to be in decimal or coded form.

The pulsing out relay set operates in conjunction with the translation selector to control the transmission of pulses. The *WXYZ* coding group converts decimal pulses into coded pulses, the indication of conversion being given through the translation selector.

The principle of coding is shown schematically in Figure 7. Relays *A* and *B* are held operated when the circuit to which they are connected, e.g. a toll relay set, is seized. The Director pulsing out circuit is designed to permit relays *A* and *B* to be released independently.

When *A* is released a pulse is given to relay *W* and to the distributor drive magnet; the distributor is a uniselector of the reverse action type; thus the wipers remain on the contact until the end of the pulse, when relay *A* releases. Relay *W* remains locked and the distributor wipers step on. The operation of relay *B* transmits pulses to the distributor magnet only, thus stepping the wipers.

Each digit received consists of four pulses on *A* or *B*. Thus to register the digit "1" relays W and X are operated and locked as the result of the receipt of two pulses over the *A* wire; the two pulses over the *B* wire step the distributor wipers to the contact of the first storing relay in the next *WXYZ*

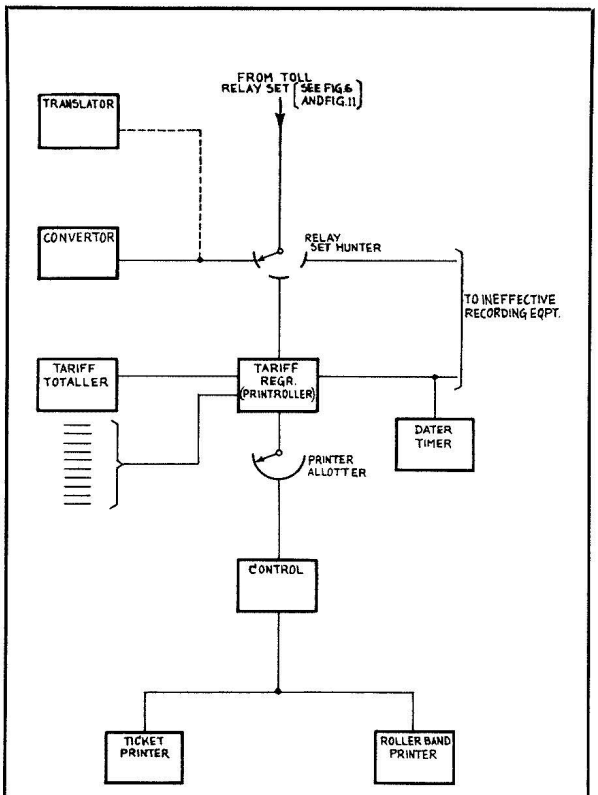


Figure 8. Principle of ticket printing scheme.

group. When sending commences, the pulsing out distributor steps and the conditions encountered on the bank contacts are transmitted.

Identifying a Calling Line

When a Director is seized by a line finder, the Director Hunter relay set (see Figure 5) transmits, over bank marking wires, the thousands digit and the hundreds indication of the 200-line group in which the calling line finder is located. The Directors are common to 3000 lines. The thousands digit will be indicated by one of three indications. For the hundreds digit, as the line finders are 200 point, one of five pairs of digits is transmitted; i.e., 1 and 2, 3 and 4, and so on. As each Director Hunter is associated with a particular 200-line group, the respective two digits can be readily indicated by a suitable strapping of the Director Hunter. The line finder does not start operating until the Director Hunter has completed these operations.

When the line finder steps up and around to reach the calling line, the pulses received by the vertical and rotary magnets during stepping are also repeated into the Director and stored on uniselectors (not shown in Figure 6). The indication

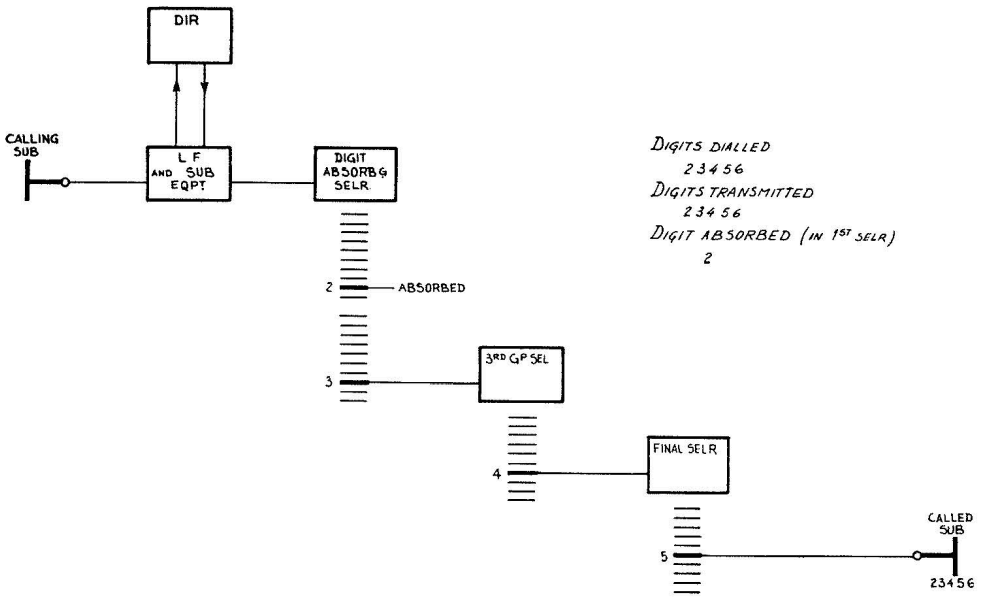


Figure 9. Routing of local call in La Louvière area.

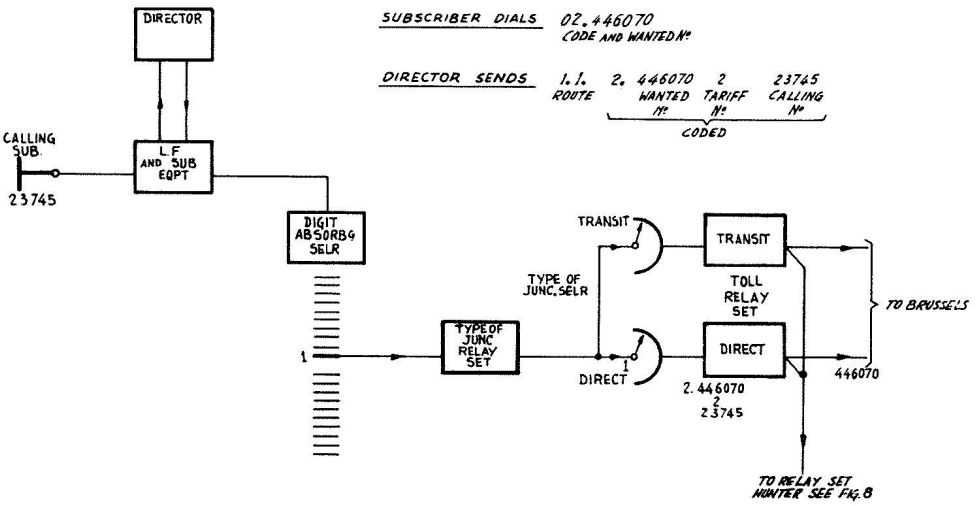


Figure 10. Routing of toll call from La Louvière to Brussels. (Since Brussels is a 6-digit area, a 2-digit prefix —02— is used.)

of the odd or even of the hundreds pair is transmitted by the operation of one of the line finder wiper switching relays.

Dial tone is transmitted to the calling subscriber from the Director. The five digits of the calling number are thus registered in the Director to be used for identification if required. The first digit, representing the exchange, is normally stored in the Director and need not be sent into it on seizure.

Recording a Toll Call

From Figure 5 it will be seen that a toll relay set is included in the toll junction. The relay set has the following functions:

1. Receives from the Director and registers in code form (see Figure 7) the called number, the tariff number and the calling subscriber's number.

2. Seizes a free converter in the case of a terminating toll exchange junction or a free translator in the case of a transit toll junction and causes 50-cycle pulses to be transmitted to the called exchange.

3. When the called subscriber answers, times the call.

4. Discharges into a free register (Figure 8) all stored information concerning the call being handled, including its duration. This is in turn transmitted via a control to the printing machine.

The toll relay set also provides the conditions for changing from day charge rates to night charge rates automatically.

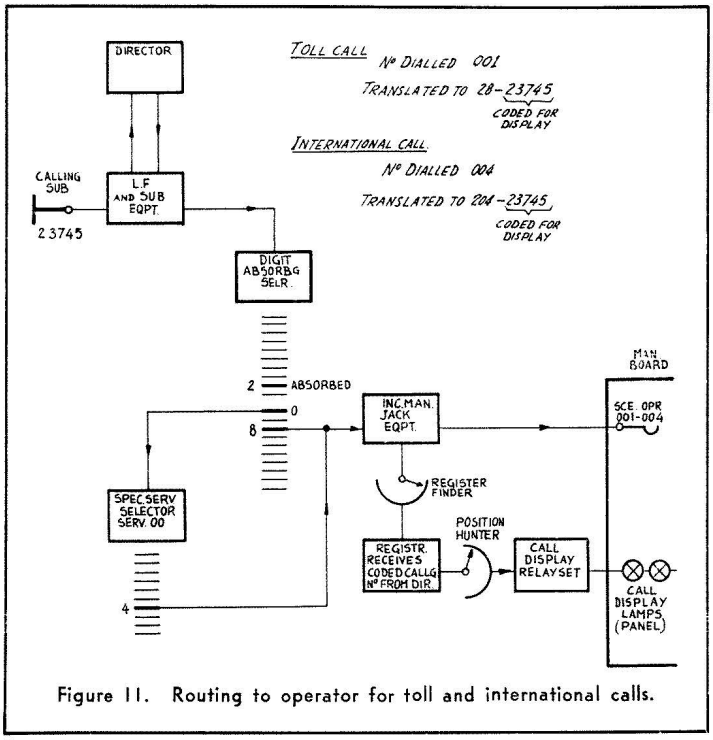


Figure 11. Routing to operator for toll and international calls.

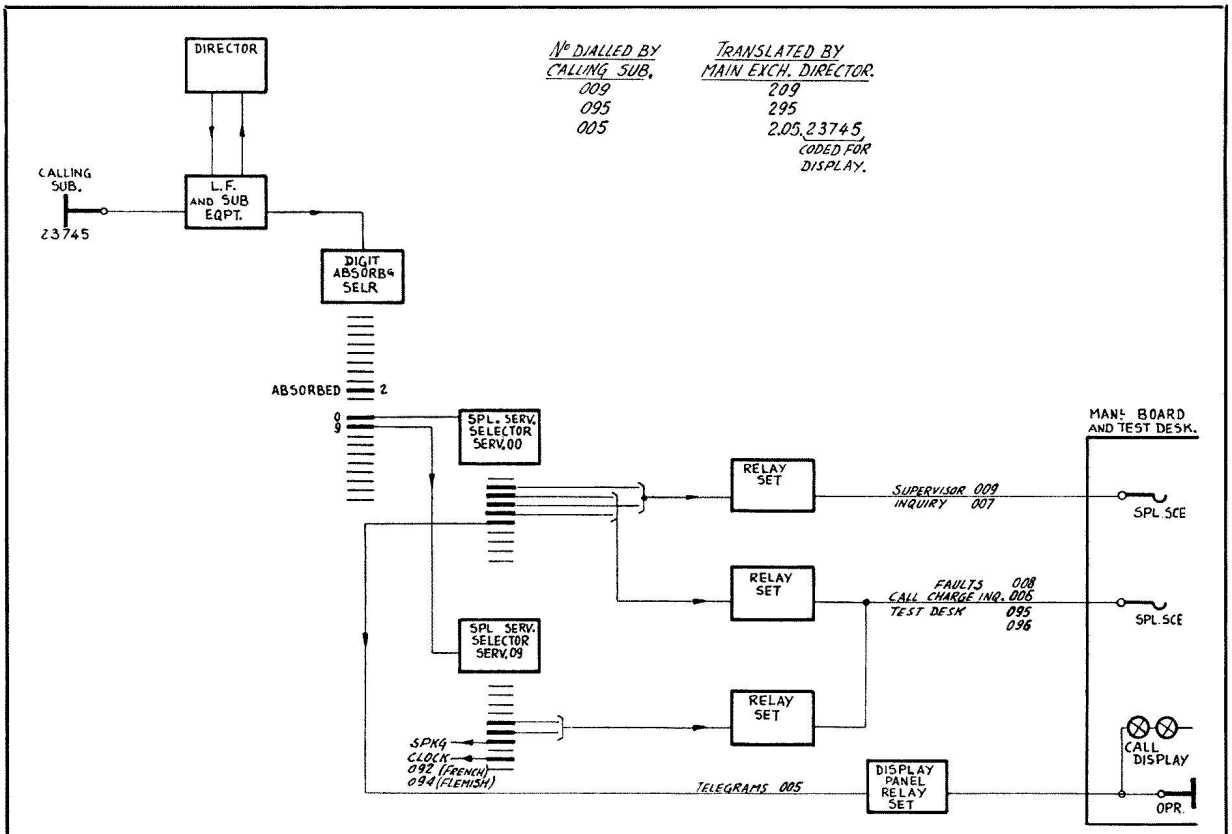


Figure 12. Routing to service positions. Calls for telegrams require number display and are coded by the Director.

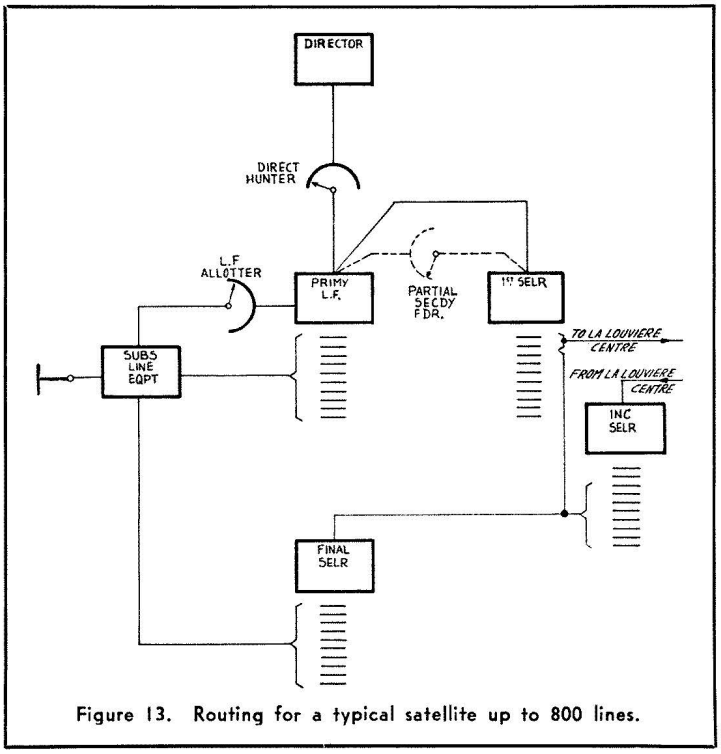


Figure 13. Routing for a typical satellite up to 800 lines.

Figure 8 is a block schematic giving in principle the disposition of the equipment involved in call recording. When the called subscriber answers, timing commences about six seconds later. The timing is derived from six-second clock pulses which step uniselectors to count, in one minute units, up to ninety-nine minutes. Toll calls routed from manual positions are not timed on the machines.

When the calling subscriber replaces the hand microphone, the set hunter associated with each toll relay set finds a free tariff register into which the toll relay set immediately discharges its stored information in this order: tariff rate, call duration, calling subscriber's number, and called subscriber's number. The toll relay set is then released.

The tariff rate indication is translated into its money equivalent and also serves to choose a set of wipers on the totalling switch, a two motion

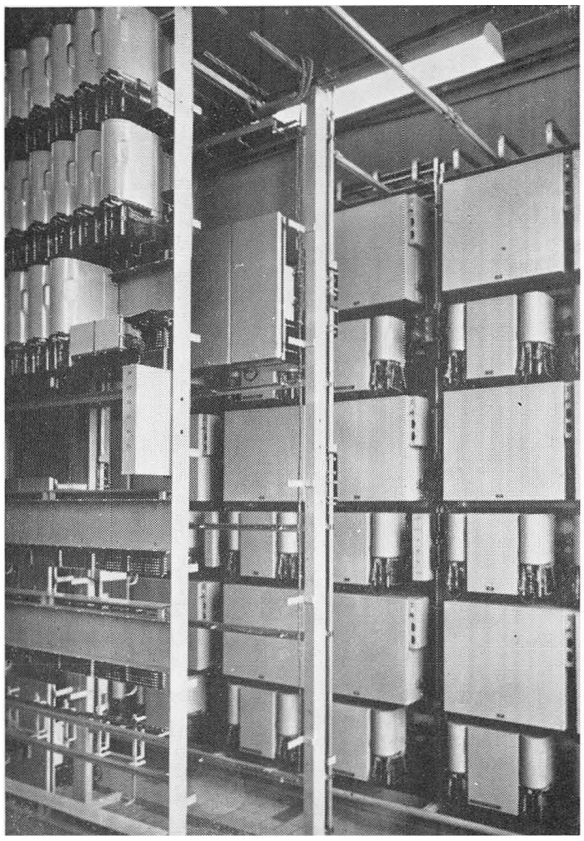


Figure 14. Corner of La Louvière switchroom, showing Directors at right.

switch whose vertical and rotary positions correspond to the tens and units of the duration time. Simultaneously the calling subscriber's number is being registered. When the first three digits are received the printer allotter connects a free printer; as sufficient information is already stored in the register, printing begins at once. While this is being done, the remainder of the information is coming in from the toll relay set. The dater-timer is momentarily connected to the register to record month, day, hour, minute.

These operations are carried out at high speed as all digits are passed along in code form:

Time for toll relay set to discharge the stored information	2.0 seconds
Register calculates total charge and converts all code registration for printer	8.0 seconds
Maximum time during which printer is held to complete printing	10.0 seconds

Calls to Toll Board

Subscribers may, if they so desire, obtain toll calls via an operator. The dialing of the special three-digit code for this service causes the Director to send out the necessary pulses to reach a manual position. When a manual jack equipment is seized, its associated finder seizes a free register into which the coded calling subscriber's number is discharged. The calling lamp associated with the jack glows. The registers are common to all positions, but the jack equipments are distributed between the positions. Hence, when an operator answers a call, the operation of plugging in causes the register position hunter to find the position; the register discharges the calling number into the visual display panel of that particular position and is then released. The calling number remains displayed until released by the operator.

International calls are always obtained via an operator in the manner just described. The routing is shown in schematic form in Figure 11.

Figures 9, 10 and 12 show other typical call routings from La Louvière.

Calls Incoming from Manual and L.D.D. Exchanges

When calls from manual and L.D.D. exchanges are to be extended to local subscribers and toll and special service operators of the zone, an incoming Director (which is a simplified version of the subscriber's Director) is momentarily associated with the incoming junction relay set to control the setting up of the call (see Figure 5). If the call is destined to an operator's position which is equipped with a display panel, a single digit "0" is displayed to indicate that the call is from another manual operator.

Satellite Exchanges

At the time of compiling these notes La Louvière is the only exchange in the zone converted to automatic working. Plans are, however, well advanced for converting the remaining exchanges as satellites. The features and method of routing will be basically the same as those described for La Louvière. Figure 13 shows the trunking for a typical 1000-line satellite.

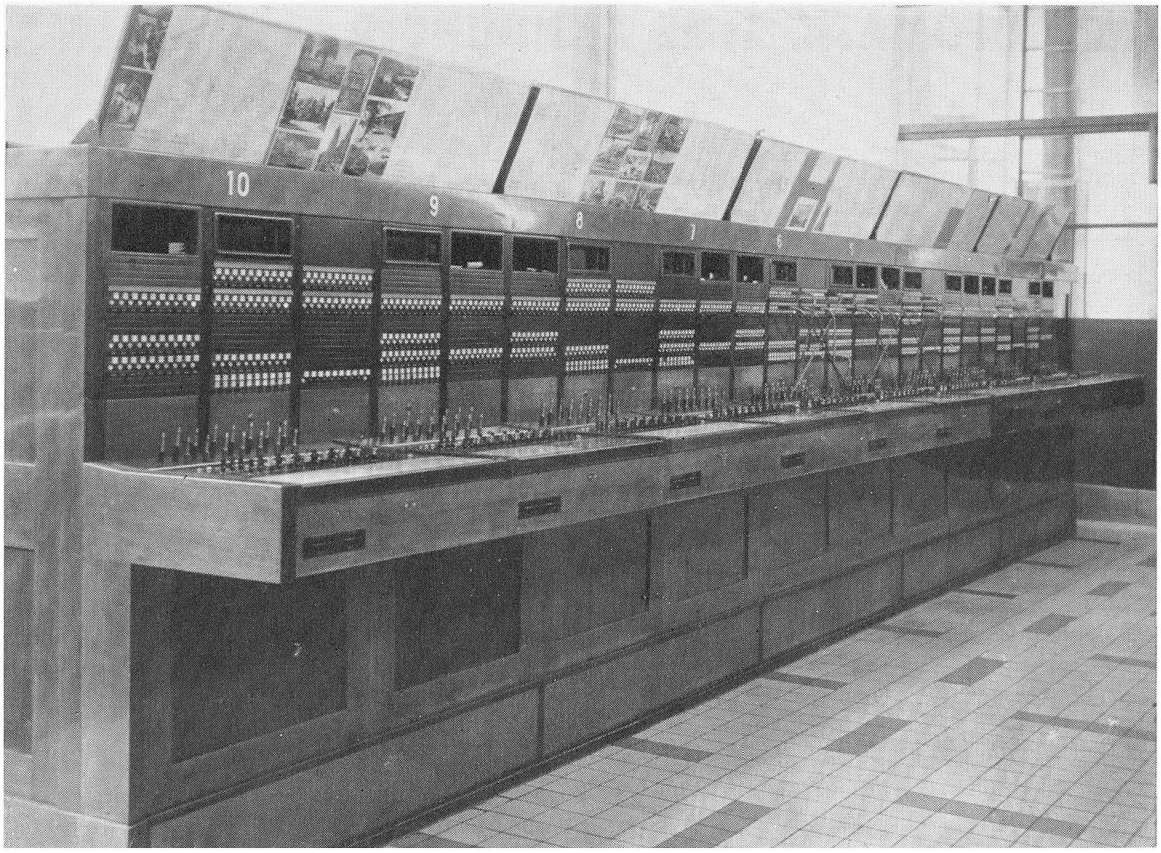


Figure 15. View of manual switchboard, showing number display panels at top of jack fields.

Power Plant

The power arrangements consist of a full float scheme with automatic voltage control on the output side.

The main 48-volt battery is floated across the mains via a 150-ampere dry disc rectifier. If the load increases beyond the capacity of the rectifier a motor generator is automatically switched in parallel with the rectifier. Should the rectifier fail or in the event of an abnormal load a second motor generator is automatically brought in parallel. The switching is controlled from contact voltmeters.

In the event of a mains failure, a reserve diesel engine generator set is automatically switched into service. Thus all contingencies are fully covered.

Ringing and Tone Supplies

Two rack-mounted inductor type machines, together with a ringing and tone distribution panel and tone observation equipment, are provided in the apparatus room. Fitted on the same rack is a 50-cycle generator, provided for toll dialing as a reserve against mains failure.

It is probable that for future installations a 50-cycle output will be included in the ringing and tone machines, thus making it unnecessary to use the mains directly and also providing an alternative supply source.

The La Louvière installation is yet another example of the flexibility of Strowger switching and of the ability of the circuit designers to meet unusual and onerous requirements without departing from basic principles and without recourse to "freak" circuit design.

AUTHOR'S NOTE: *Automatique Electrique, S.A. gratefully acknowledges the kind permission of the Régie des Télégraphes et des Téléphones to publish this article. There is every indication that automatic ticketing, in one form or another, will one day find universal adoption. The fact that this development found its first application in Belgium is directly attributable to the inspiration, imagination, enterprise and courage of the Régie.*

THE AUTOMATIC TIME ANNOUNCER

By E. S. PETERSON

SYNOPSIS: *Previous time-announcing techniques—requirements to be met by an automatic time announcer—commercial advertising feature—functions and operation of master clock — alarms — mounting and enclosure.*

THE supplying of time announcements over telephone lines is not a new service among telephone companies; in fact it has been the custom from the very earliest days in many manually operated exchanges for the operator to give the correct time whenever requested by a subscriber. Many telephone men feel that this little personal service is a highly worthwhile source of goodwill—and in exchanges equipped to provide measured service, "time-of-day" calls often contribute substantially to revenues.

When an exchange is converted to automatic operation, time service must to some extent become impersonal. It must be provided either by an automatic time-announcing machine or by operators who simply announce the correct time at regular intervals. The second method, because of its extreme monotony from the operator's standpoint, usually requires the services of several operators, working on short shifts. Time announcing by machine avoids this difficulty, and in cases where time service has not heretofore been provided at all, it offers a means of improving goodwill among subscribers.

Several methods have been devised to place time service on a mechanical basis. Some of these employ film with sound tracks (photoelectric-cell type), with the time announcements recorded on several drums or discs. In most of these cases, the recording of each complete time announcement has been divided between a number of individual drums or discs; the combination of words representing the introductory phrase, the minutes, and the seconds, is obtained from separate drums or discs which are successively switched into the circuit. This, however, often results in a "disconnected" announcement lacking smoothness and uniformity. In other cases, disc records have been employed, requiring the use of a bank of records with several phonograph pick-up arms operating on them and controlled by mechanical cams and levers.

Still another device, introduced by Automatic Electric Company some years ago, employed chimes of different pitches to count out the hours and minutes whenever a subscriber dialed the time code. This equipment is still in use in several exchanges, and has proved to be satisfactory, though subject to the criticism that the time announcement is non-verbal and requires that the calling party be familiar with the meaning of the signals. It also shares with most of the other machines described above the disadvantage of being "impersonal"; even the verbal types using film or disc records reveal the drawbacks of mechanical operation when the time signals are broken by pauses, or by changes in pitch that indicate that the announcement is not being spoken.

The Automatic Time Announcer described in this article was designed with the disadvantages of existing methods constantly in view. It was felt also that any recording means used for time announcements might also prove useful for other types of announcements, which the telephone company might wish to make on its own behalf, or which could be offered as a commercial service to business organizations in the community. Such commercial announcements might be expected to reimburse the telephone company, in whole or in part, for the cost of time service in those cases where telephone service is on a "flat-rate" basis.

Design Factors

Consideration of the requirements outlined above led to the following conclusions: (1) the announcements should be verbal, not merely signaled; (2) the recording medium should be continuous with no interruptions due to switching between drums or discs; (3) the service must be

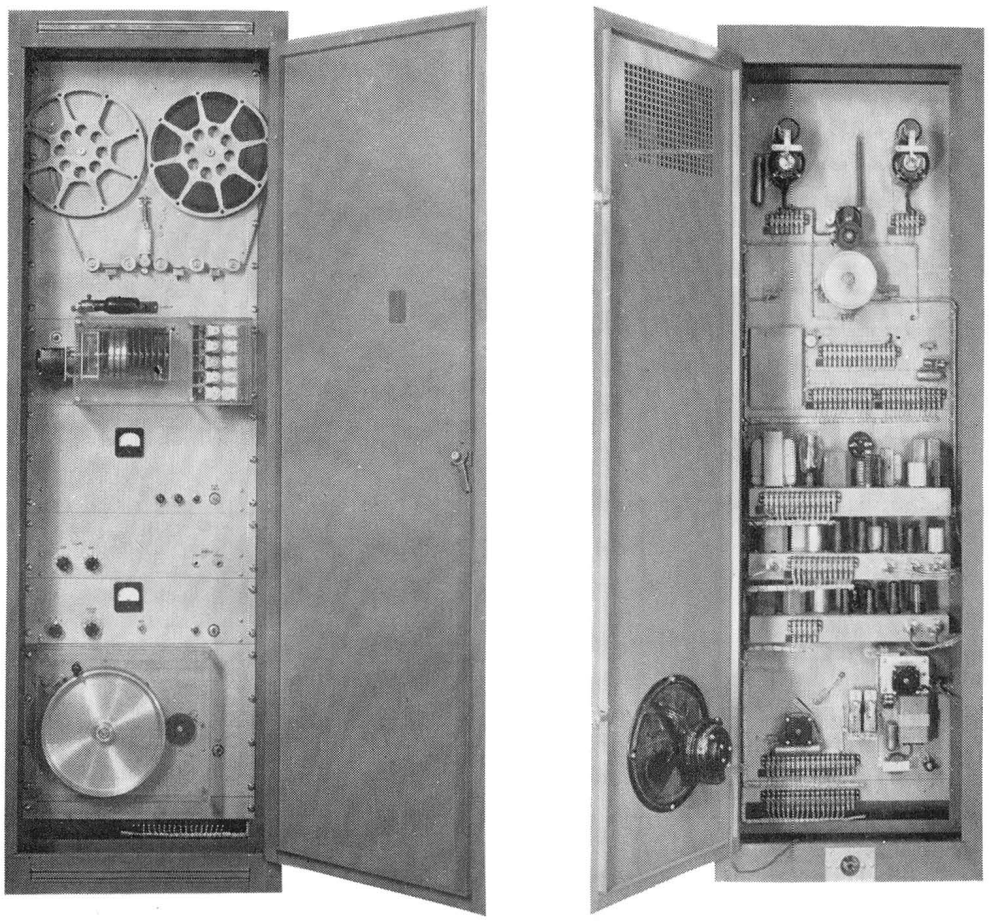


Figure 1. Automatic Time Announcer (cabinet doors open). Front view at left, rear view at right. Panels shown are as follows (from top): time-announcing tape drive; master clock cams and relays; power supply; time announcing and stopping amplifier; commercial announcing amplifier; commercial tape drive; terminal strip for connection to external equipment.

easy to use and the equipment simple to operate so that commercial and other announcements could be readily and inexpensively recorded without the need for trained personnel.

These requirements were met through the use of a continuous recording on magnetic tape — a cellulose acetate tape which has an iron oxide coating. This magnetic recording tape is similar in principle to the wire used in magnetic wire recorders.

In the new Automatic Time Announcer shown in Figure 1, a 2700-foot length of magnetic tape passes between two standard 16 mm. film reels, 10½ inches in diameter. Recorded on the tape are three separate sound channels—two for the time announcements, and the third for synchronizing purposes. Time announcements for six hours are provided by one channel, using the entire 2700 feet of tape; at the end of this period, the tape direction is reversed, and the pick-up circuit is switched to the second channel, which is recorded in the reverse direction, providing time announcements for the next six hours.

The time tape supplied for the Automatic Time Announcer is reproduced from a master tape on which the time announcements are recorded by an especially selected trained voice. From this master tape, any number of copies may be made as required.

The wording of each time announcement follows the typical pattern: "At the tone, the time

will be twelve, one, and one-quarter." The tone signal is then heard after an interval of approximately three seconds. Similar announcements are made every fifteen seconds, one-quarter minute being added on each succeeding announcement. Each announcement is continuous, so that it appears to the subscribers that they are hearing the voice of an operator rather than a recorded message. The time announcement itself requires only 3½ to 4½ seconds out of each 15-second interval; to make full use of the tape, however, the announcements are recorded in continuous succession, and the tape is stopped after each announcement, under control of a 1000-cycle "stopping" signal on the third channel of the tape.

The tape passes from one reel to the other over a series of roller guides; the "take-up" reel automatically winds the tape, maintaining constant tension upon it as it is fed between two rollers—one metal and one rubber—under control of a small motor with friction-drive reduction wheels. This so-called "capstan" drive mechanism is quite simple, since it employs no belts or gears. The pay-out and take-up reels are mounted directly on the shafts of their respective drive motors, which are of a special slow-speed "constant-torque" type, capable of operating at the required slow speed without overheating. The travel of the tape is timed by a master clock which also controls the reversal of the drive motor at the end of each six-hour period.

Provision for Commercial Announcements

The commercial announcements are delivered during the interval between successive time announcements by a separate "loop recorder" which transmits from a length of magnetic tape mounted on the rim of a drum approximately 10 inches in diameter. This recorder starts on the first second of each 15-second interval, and the speed of the drum is such that a period of five seconds is available for the commercial announcement. One complete revolution of the drum completes the announcement, and the drum then stops, ready to repeat the message immediately after the next time signal tone.

The loop tape provides for a maximum of six "commercials" which are recorded side by side; these are transmitted in succession by a device which automatically moves the loop pick-up head from one channel to the next a moment before the commercial is to be transmitted. (Optionally, the loop recorder may be connected to a program-selecting clock, to control the sequence of commercials in any way desired.)

Recording on the tape is very simple and convenient, and no special training is required to operate the machine. Commercials can be erased and replaced at will, or any number of them can be recorded and stored for future use as desired.

Functions and Operation of Master Clock

The master clock, which controls the entire operation of the Time Announcer, employs eleven cams to perform all the functions required, as shown in chart form in Figure 2. The sequence of operation is as follows: At the exact quarter-minute, cam 5 causes the time announcing tone (1400 cycles) to be sounded, and starts the commercial announcement (which is approximately 5 seconds in length). At six and one-half seconds, cam 6 closes the circuit to a power relay, which in turn actuates the capstan motor, causing the time tape to begin moving over the pick-up head. Approximately one second later, the verbal time announcement is heard, continuing for 3½ to 4½ seconds. Movement of the time tape is stopped, not by the master clock, but by the "stopping" signal on the third channel of the tape itself. (It will be noted that cam 6 maintains the circuit to the capstan motor throughout the entire period covered by the time announcement; this prevents accidental stopping of the tape before the "stopping" signal is received.) The "stopping" signal causes a relay to place direct current on the field of the capstan motor, stopping it quickly without "coasting."

The time announcement is completed at approximately the twelfth second of the period; approximately three seconds later (exactly at the quarter-minute) the time-announcing tone sounds again, completing the 15-second cycle.

Cams 1-4 control reversal of the time tape at the end of each six-hour period. Through cams 1, 3 and 4, a chain circuit is closed at exactly 6 o'clock, to prepare the capstan motor for reversing the time tape for the next announcement. At 12

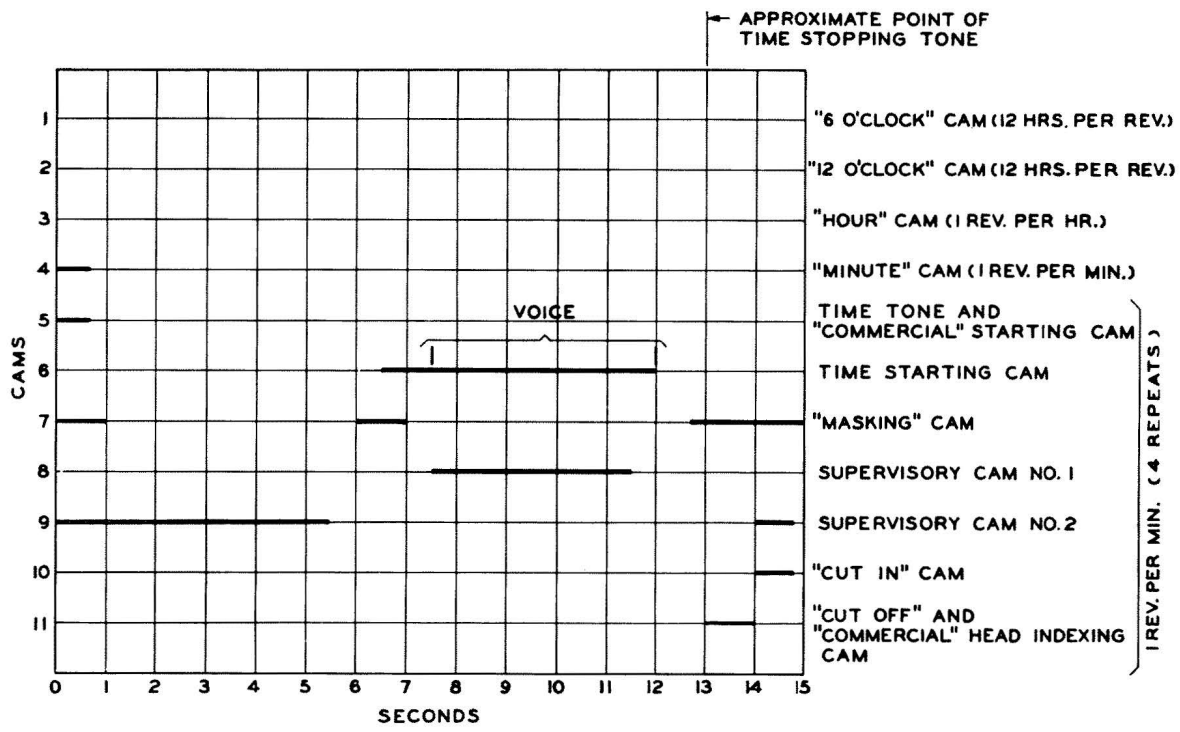


Figure 2. Arrangement and functions of master-clock cams, showing sequence of operations in each 15-second period.

o'clock, a similar chain circuit is closed through cams 2, 3 and 4, again reversing the tape direction.

Cam 7 is a "masking" cam, which places a short-circuit across the audio output to the line, to prevent clicks caused by the closing and opening of relay and motor circuits (note that this cam "masks out" the starting and stopping of the commercial and time tapes, and the operation of the other cams).

Cams 8 and 9 are "supervisory" cams, which cause an alarm to be sounded if the time-tape driving motor circuit is not closed throughout the time-tape moving period, or if it is closed improperly at any other time.

Cam 10 is employed only if the telephone company desires to insure that subscribers will be "cut in" to the time-announcing circuit only at the beginning—and never in the middle—of a time-announcing period, though many companies prefer to connect calling subscribers immediately into the time-announcing circuit, to avoid the period of silence during completion of the current announcement. Similarly, cam 11 is employed if it is desired to limit the number of announcements received on each time call; this cam operates in conjunction with suitable trunk equipment to give the calling party a busy signal after one or two repetitions of the announcement. Cam 11 also controls the indexing mechanism of the commercial pick-up head, to place the head over the proper channel slightly before the announcement is to begin.

Alarms

Alarm equipment is provided to give instant notification of power failure or any abnormal operation of the Time Announcer. In case of power failure (even for only a fraction of a second), or breakage of the tape, the Announcer stops instantly and closes a circuit to exchange alarm equipment. Abnormal operation of the tape—that is, moving at the wrong part of the cycle, or standing still when it should be moving—will also bring in an alarm, as described above.

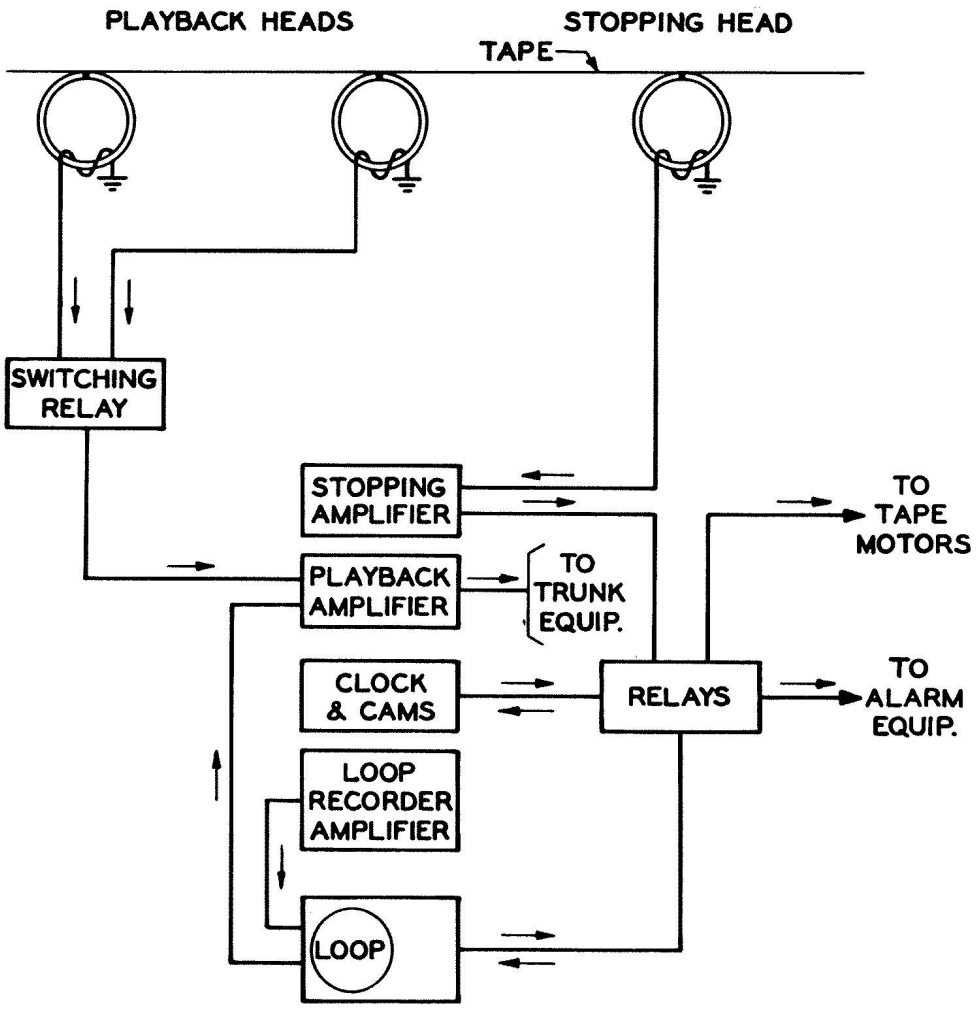


Figure 3. Schematic diagram of circuit elements.

When a spare machine is desired, the two machines are arranged to run simultaneously, and the audio circuit of the spare unit is automatically switched into service in case of failure of the first machine.

Power Supply and Controls

The Automatic Time Announcer operates on commercial alternating current, and is self-contained, providing high- and low-voltage a-c for its amplifiers, and 24 volts d-c for control purposes. The clock motor is of the synchronous type, assuring accurate timing so long as the frequency of the input is accurately controlled (as is usually the case in most communities today). Where the frequency of commercial current is not accurately controlled, a crystal-controlled oscillator and amplifier can be provided to drive the clock motor (which requires about seven and one-half watts for operation); this provides timing which is even more accurate than that provided by most commercial current sources. The "capstan" motors (used for winding the tape) are non-synchronous, and may be operated from the commercial power, even though it is not controlled.

The Automatic Time Announcer is so designed that if it is stopped by power interruption, it must

be manually restarted; it cannot restart itself and thus give incorrect time announcements.

Both the master clock and the tape are easily reset in case of such interruptions. Means are provided for a fast rewind in either direction to approach the proper point on the tape; then, by monitoring the time announcements, the correct setting can quickly be found. Through a de-clutching arrangement, the cams of the master clock can be rapidly turned and set at the proper point. The machine is usually started a few minutes ahead of time, so that the clock motor may be turned off and on to set the cams to exact time within a fraction of a second. Three dials are provided on the cams, and from these the time setting can be read directly. As explained above, the time announcement is reproduced from the tape, but the actual time signal is impressed on the line by one of the master clock cams.

The output circuit of the Automatic Time Announcer has an impedance of only one-half ohm; the time service trunks are connected across this audio output, with a 300-ohm resistor in each side of each trunk producing a total loading of 600 ohms. Thus when two or more trunks are bridged across the Time Announcer the possibility of talking between connections is negligible. The audio output of the Time Announcer is approximately 10 watts; this is sufficient to take care of at least 50 time-service trunks simultaneously without an appreciable drop in volume.

The arrangement of all circuit elements is shown schematically in Figure 3.

Mounting and Enclosure

The components of the Time Announcer are mounted on standard panels, assembled on a 19-inch relay rack, and housed in a steel cabinet approximately five feet high and two feet square. Audio connections between the panels are made through shielded cords and plugs and multi-conductor fanning strips, so that any panel can be removed individually for replacement if required. A fan and air filter are provided near the bottom of the housing, to force filtered air into the cabinet for ventilation; this also slightly "pressurizes" the cabinet and prevents dust from entering.

Summary

The Automatic Time Announcer herein described provides verbal time announcements, and facilities for commercials that may easily be recorded, and changed at will. It uses a standard type of recording medium and standard electronic tubes and other components. The time and commercial tapes, and any other parts, may be readily replaced at any time. Thus it appears that the Automatic Time Announcer meets all requirements for a machine of this type.

PREFABRICATED BUILDINGS FOR SMALL UNATTENDED AUTOMATIC EXCHANGES

By BRUCE B. SHIER

SYNOPSIS: *Small exchange networks of the Manitoba Telephone System—building requirements for small unattended exchanges—advantages of prefabricated buildings and preinstallation of equipment — building design and equipment layout—construction and transportation of buildings — completion on site.*

TELEPHONE service throughout the Province of Manitoba, Canada, is provided by the Manitoba Telephone System, with headquarters at Winnipeg, the capital and largest city of the province. One of the earliest users of automatic telephone equipment in Canada for its larger exchanges, the Manitoba Telephone System has now embarked on a program of installing groups of small unattended automatic exchanges to serve rural communities. Three such exchanges were installed in 1949 in the Stonewall area, six were installed in 1950 in the Melita area, and three will be installed in 1951 in the Hamiota area. The locations of these exchanges and their control offices are shown in Figure 1.

Type 11 Strowger M.A.X. equipment, supplied by Automatic Electric (Canada) Limited, is being used for these exchanges. Each group has an universal numbering scheme and the following services are provided:

(a) Flat rate individual lines,

(b) Flat rate ten-party lines with divided code semi-selective ringing,

(c) Paystation lines, post-payment type.

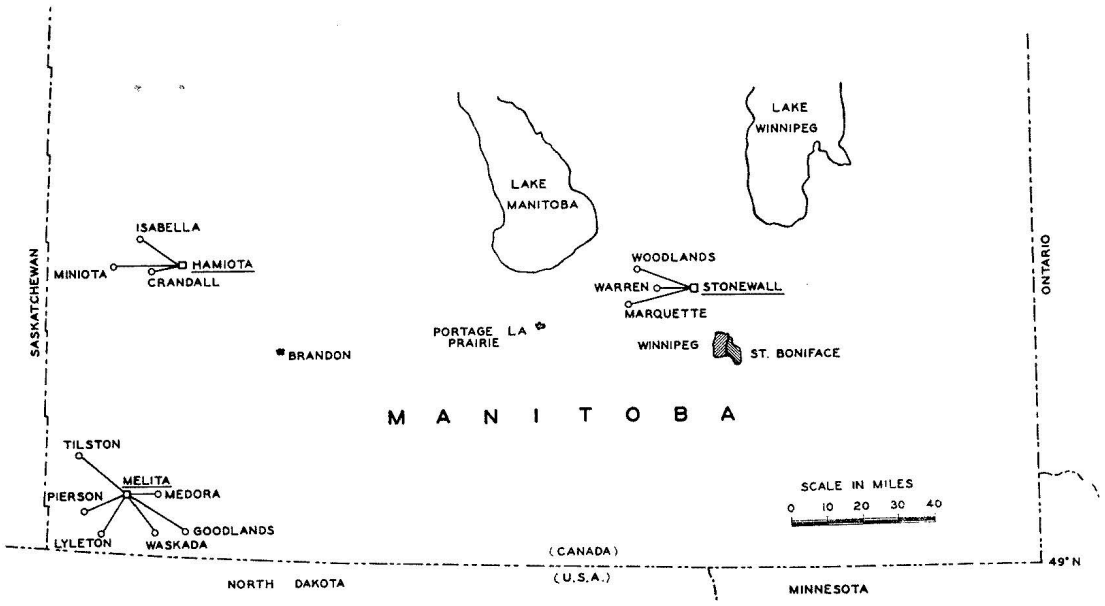


Figure 1. Map of the southern portion of the Province of Manitoba, showing locations of prefabricated unattended exchanges and of associated toll and control offices.

Since these exchanges are unattended, toll, emergency, information and similar calls are handled by operators at a larger exchange in each area, which acts as the toll and control centre for the group.

There are no unusual features of the automatic telephone equipment involved, with the exceptions of some modifications to suit local operating requirements. The methods used by the Manitoba Telephone System in the construction of the buildings for housing these exchanges and in the installation of the equipment are unique, however, and this article is concerned with these aspects of the project.

Building Requirements

Although elaborate structures are not essential for housing small, unattended automatic exchanges, it was necessary to give careful consideration to the following important factors:

(a) The equipment would have to be protected against climatic conditions, the winters being particularly severe, with temperatures frequently at —40° F. or lower. By contrast, summer temperatures are quite high, exceeding 100° F. during heat waves, and the atmosphere is likely to be dry and dusty.

(b) The buildings should be reasonably permanent, fireproof and damp-proof, and should require a minimum of maintenance and upkeep.

(c) There should be adequate heating, lighting and ventilating facilities to provide comfortable working conditions for personnel maintaining the equipment.

(d) Regardless of surrounding structures, it was desired that the buildings be neat and attractive in appearance.

Provision of the foregoing features are a matter of proper design and do not involve any complicated building techniques. It was felt, however, that few local contractors in the communities involved would be capable of erecting the buildings exactly in accordance with plans and specifications without almost constant supervision and without considerable assistance in obtaining the required materials and fittings. Workmanship and finish would be likely to vary and the costs of construction of these small buildings on an individual basis would be high.

The alternative arrangement of having these buildings constructed at each site by a large firm of contractors would undoubtedly result in more uniform and satisfactory structures, but the traveling and living expenses of the workmen and supervisors would greatly increase the cost.

Advantages of Prefabricated Buildings

The comparatively small size of the buildings required, and the drawbacks of constructing them on site, led to the consideration of prefabricating the buildings at a convenient point and transporting the completed structures to their final locations. The chief advantages of prefabrication are outlined in the following paragraphs.

(a) The construction of a group of buildings of uniform design at the same time in one location would provide the most efficient utilization of labor and material and would result in uniform standards of workmanship and finish.

(b) Power tools and shop equipment could be used and constant supervision provided. Workmen of various trades would be available on short notice as required, so that there would be a minimum of lost time.

(c) Architectural and engineering advice would be available as required to settle any difficulties or misunderstandings on the spot.

(d) There would be no traveling or living expenses for labor and supervision.

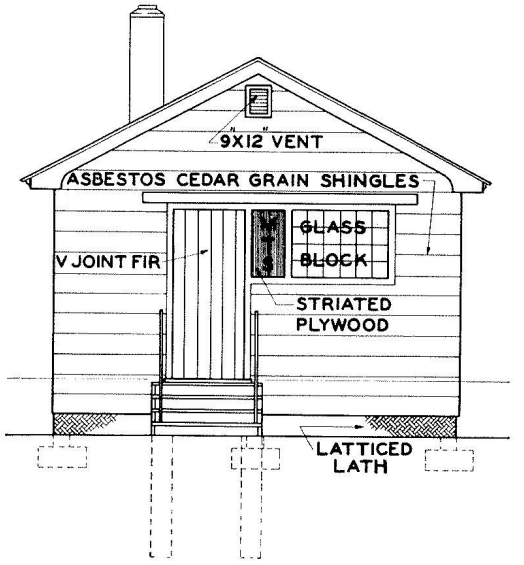
(e) All of the materials for the complete group of buildings could be purchased at the same time and delivered to the same location.

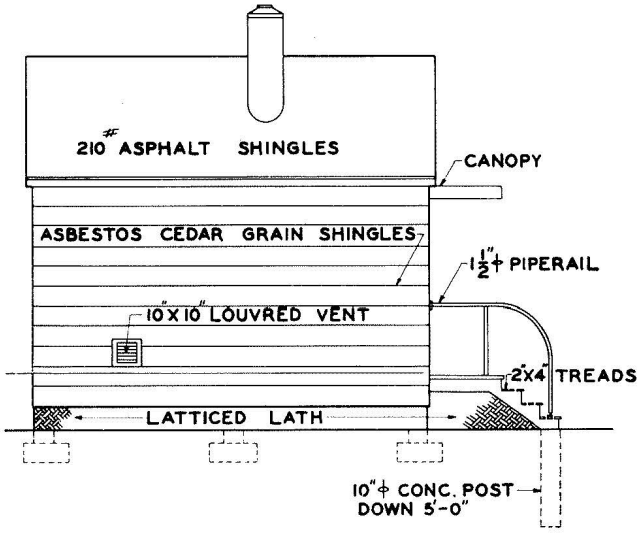
It was ascertained from moving contractors that there would be no unusual difficulties in transporting the completed buildings to their final locations and that the expense involved would be more than offset by the savings in construction costs.

Preinstallation of Equipment

The same advantages resulting from the prefabrication of the buildings at a central point also applied to the installation of the telephone and electrical equipment. Experience has indicated that

Figure 2. Exterior view of Warren office, showing original design of prefabricated building and aerial cable entrance.





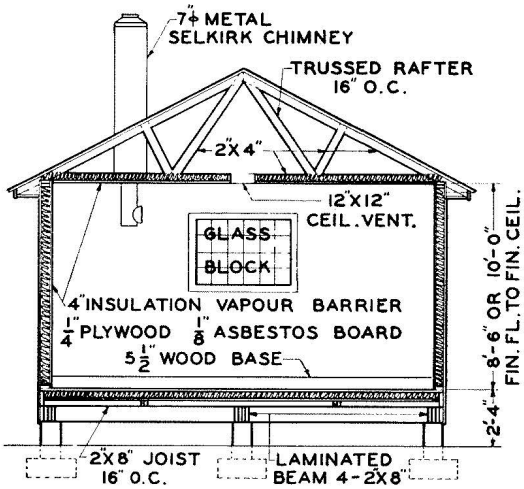


Figure 3. Elevations and section of final design of prefabricated buildings.

the traveling and living expenses of installation personnel will add from 40 to 60 percent to installation labor costs, quite apart from the traveling expenses of supervisors and engineers. Furthermore, arrangements have to be made to receive and store shipments of material at the exchange location.

By installing and testing all of the equipment in the completed buildings before moving them to their final locations, there would be no additional transportation expense and it would be certain that all items would be complete and in good working order.

Initial Exchange Group

It was decided to install, in 1949, a group of three small automatic exchanges in an area approximately 30 miles north-west of Winnipeg, on the

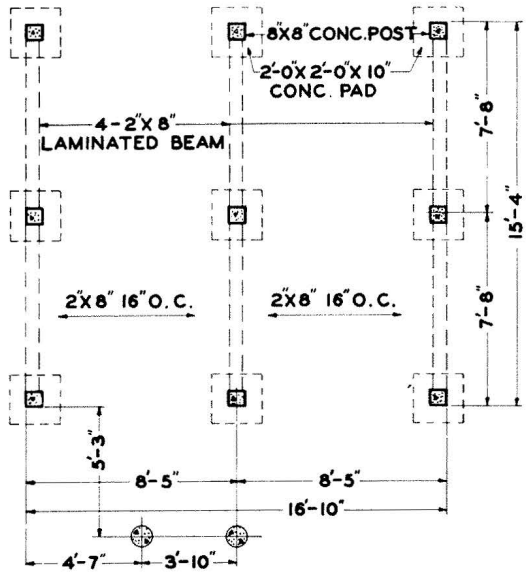


Figure 4. Plan of foundation posts and beams.

basis of prefabricating the buildings and preinstalling the equipment at the System's shops in Winnipeg. The exchange locations were at the villages of Woodlands, Warren and Marquette, with the existing exchange at the town of Stonewall serving as the toll and control centre (Figure 1).

The locations of these initial exchanges in an area close to the System's headquarters at Winnipeg provided an opportunity of observing all details of the project and of establishing procedures to be followed on future projects at more distant points.

Building Design

The building design adopted was a square wood-frame structure, with a peaked roof, as shown by the accompanying photograph (Figure 2). This photograph shows the original building design for the initial three exchanges; after their completion some modifications were introduced and the final design for all subsequent buildings is shown by Figure 3. This design covers buildings of the same floor area but with two different ceiling heights — 8 feet, 6 inches, and 10 feet — for equipment mounted on 7-foot 6-inch and 9-foot high frameworks respectively.

The wooden framework consists of 2 by 4 inch wall, ceiling and roof members at 16 inch centres, with 2 by 8 inch floor beams. The exterior walls consist of 1-inch wood sheathing, a layer of tarred paper and grained asbestos shingles; the roof is of similar construction except that heavy asphalt shingles are used. The interior walls and ceiling consist of ¼-inch plywood covered by ⅛-inch hard asbestos sheets. The floor is made up of 1-inch wood sheathing, a layer of tarred paper and ¼-inch plywood. In the first buildings, this was covered with ⅛-inch hard asbestos sheets, but this had an uncomfortable and "gritty" feel and heavy linoleum is being used for subsequent buildings. The spaces between the wall studs, ceiling joists and floor joists are filled with fireproof heat-insulating material.

This type of construction is light yet strong, provides good insulation against the extreme climatic conditions previously mentioned, and the exposed surfaces are durable, mostly fireproof and do not require painting.

Each building is supported by nine concrete posts, on which rest three parallel wood beams (which are at right angles to the floor joists), as shown by Figure 4. These foundation posts and beams were installed in advance at the building sites by regular line construction crews.

The buildings are heated by means of two 2000-watt space heaters, thermostatically controlled to maintain a minimum temperature of 45°F. When the buildings are occupied by maintenance personnel, the electric heaters can be stepped up to full power by means of a manual control to attain a comfortable working temperature. It has been found that a remarkably small amount of electric power is required to keep these buildings heated, even in extremely low winter temperatures, in view of their insulated construction and the fact that the doors are seldom opened. Each building is provided with a metal chimney so that, in case of a power failure, a portable oil-fired heater can be installed. Pressurized fire extinguishers are supplied for each building.

Ventilation is provided by wall and ceiling vents, as shown in Figure 3. These vents have fixed wooden louvres and spun-glass air filters. The two low vents in the side walls are equipped with in-

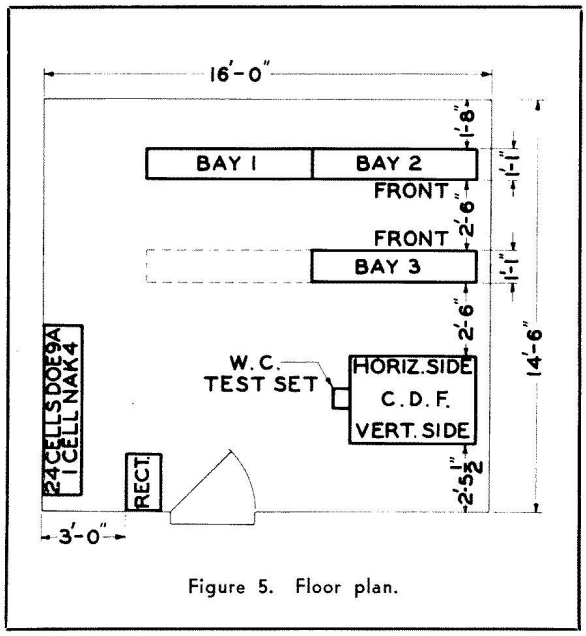


Figure 5. Floor plan.

sulated inside doors, to control humidity in the buildings.

Equipment Layout

A uniform layout of equipment is followed and this is shown by Figure 5. It will be seen that there is ample space for access to the equipment and for future growth.

The floor-type combined distributing frame provides, on the vertical sides, outside cable terminals, bunching blocks and code concentration blocks. On the horizontal sides are the terminal blocks for the subscribers' line circuits, connector multiple, connector multiple code leads and long line adapters (when used). A length of entrance cable is connected to the vertical side of the frame.

A small wire chief's test set and a test telephone set are mounted on the end of the combined distributing frame.

Three equipment bays are provided and there is space for an additional bay for mounting equipment up to a maximum of 400 lines. The trunk equipment, long line adapters and power control equipment are mounted on Bay 1; the incoming and local selectors are mounted on Bay 2; and the linefinders and connectors are mounted on Bay 3.

The charging rectifier is supported on a metal floor stand and the storage battery is mounted on a two-tier rack of wood and metal construction. A small wooden cabinet provides storage space for maintenance drawings and specifications, spare parts, etc., also a writing surface for records and reports.

Light metal runways support the cables connecting the various equipment units.

The accompanying photographs (Figures 6, 7 and 8) show the appearance of the equipment as installed.

Construction and Installation

The initial three buildings were constructed simultaneously in the yard of the System's shops in Winnipeg. With all shop facilities and personnel available, this work proceeded rapidly and without difficulty. The buildings were completely finished, including the installation of electrical wiring, lights and heaters, and all painting.

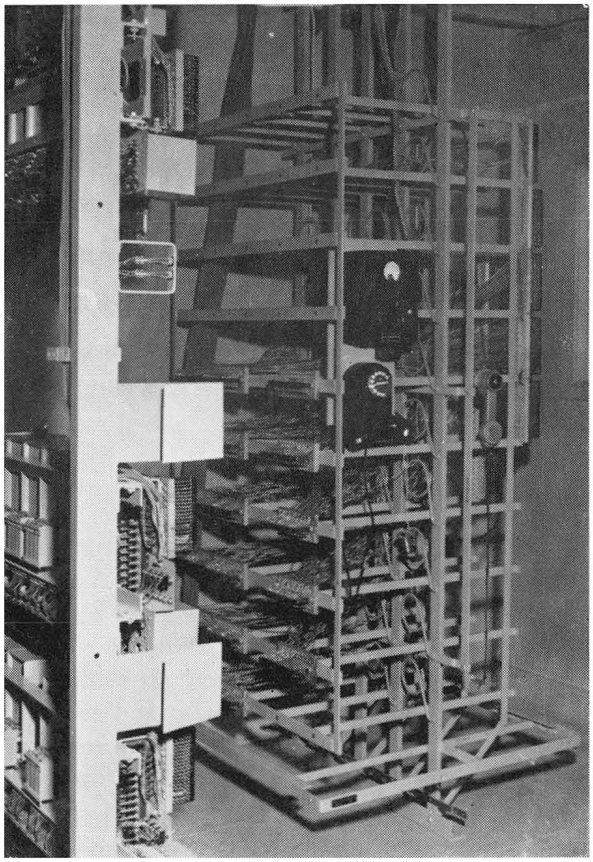


Figure 6. Interior view showing end of Bay 3 (linefinders and connectors) and combined distributing frame.

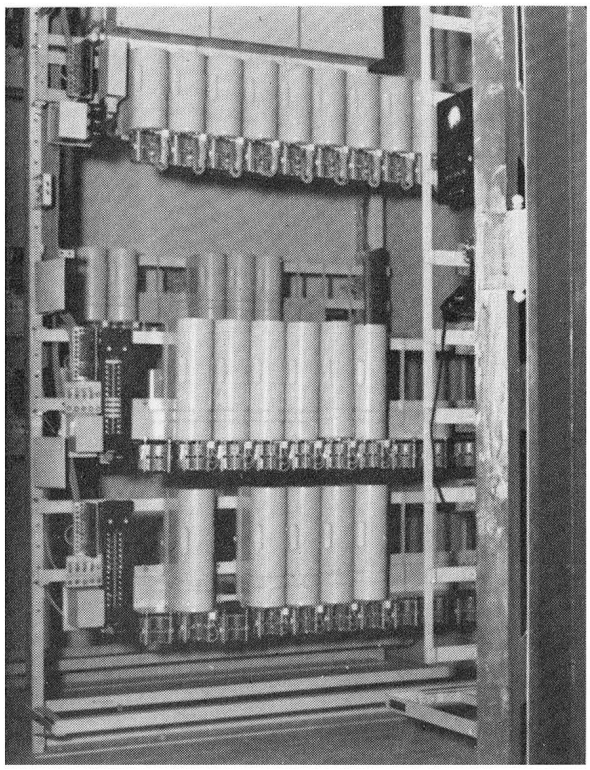


Figure 7. View from doorway, showing Bay 3 (linefinders and connectors).

As soon as each building was completed, the automatic switchboard equipment was installed and wired. Temporary electric power and storage battery connections were made and all circuits and functions of the equipment were thoroughly tested.

Preparations for Transportation

The usual precautions in connection with moving large loads over public thoroughfares were observed. The routes were surveyed to ascertain if any obstructions existed, but nothing of a permanent nature was found. Only a few low branches of trees and some drop wires had to be lifted as the buildings passed. Permission for the movement of the buildings was obtained from the city and highway police.

The only major item of equipment not installed in the buildings was the storage battery, this being transported separately. All of the two-motion switches were securely clamped in place. Any loose items were either tied in place or placed in cartons on the floor.

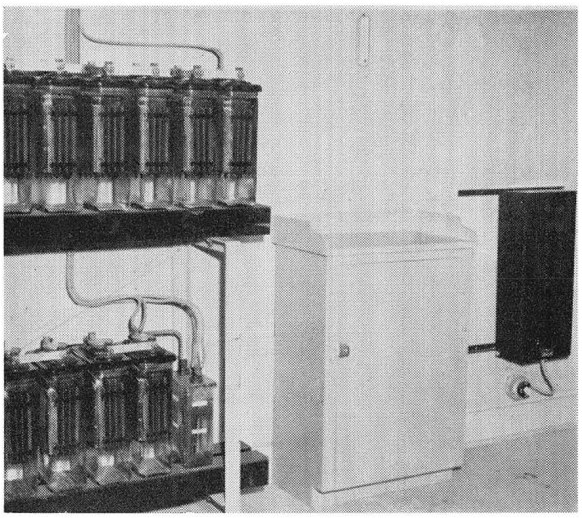


Figure 8. View showing battery rack, wooden cabinet and one of the electric heaters.

Transporting and Placing the Buildings

The first building to be moved was hauled on a low, flat semi-trailer, but transferring the building from the trailer to the foundation beams proved to be an awkward procedure. On the advice of the moving contractor, subsequent buildings were moved on a cradle formed of two large wooden beams. A group of four rubber-tired wheels was lashed to one end of each beam and the other ends of the beams were supported by a crane mounted on a heavy truck, as shown by Figure 9.

This seemingly cumbersome arrangement functioned perfectly and the buildings were moved

Figure 9. Prefabricated building on dolly being towed by crane truck.

Figure 10. Building being hauled on to foundation beams by power winch.

from the shops to their final locations without incident. A maximum speed of 15 miles per hour, on straight level roads, was attained.

Upon arrival at the building site, the cradle was drawn up to the foundation beams, the wheels were detached and the two cradle beams were jacked up to form a sloping ramp. The building was then hauled into position on the foundation beams by means of a power winch on a separate truck, as shown by Figure 10.

By making an early morning start, the moving contractor was able to haul a building from the shops in Winnipeg to the exchange location, place the building on the foundation, and return the moving equipment to Winnipeg in a single day.

Completion on Site

With the building in place on foundation beams, all that remains to complete it is to install the door steps and the lattice wood frames around the bottom of the building. These items, of course, were made up previously at the shops and had only to be nailed into place. The electric power wiring was connected and the outdoor-type meter installed.

The storage battery was unpacked and installed on its rack and connected. The entrance cables, already connected to the combined distributing frame, was brought out of the building and spliced to the aerial cable. As may be seen from Figure 2, the entrance cable was brought out to an adjacent pole in the case of the initial exchanges, but a buried cable is being employed for subsequent installations. It was found that the equipment stood up very well to moving by road and but few adjustments were required before cutting into service.

To improve the appearance of the site and to reduce the fire hazard, the entire area is cleared of vegetation and covered with gravel. A woven wire fence prevents rubbish from being blown against the building. Nearby residents tend to discourage trespassing, since it is in their own interests that no damage be done to the exchange.

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