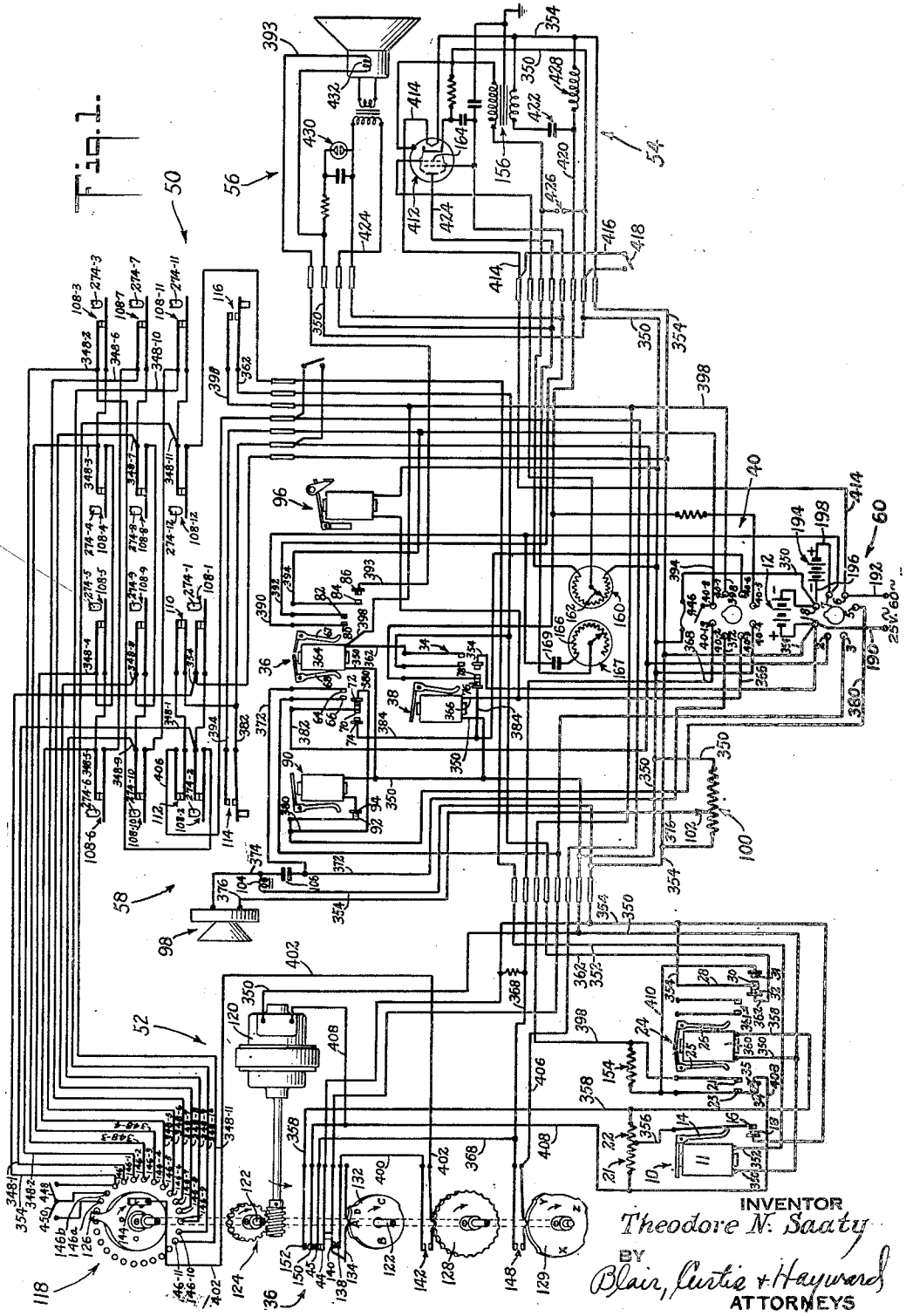
July 8, 1941. T. N. SAATY 2,248,899

TELEPHONE SYSTEM

Filed Aug. 3, 1940 4 Sheets-Sheet 1

Fig. 1.



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TELEPHONE SYSTEM

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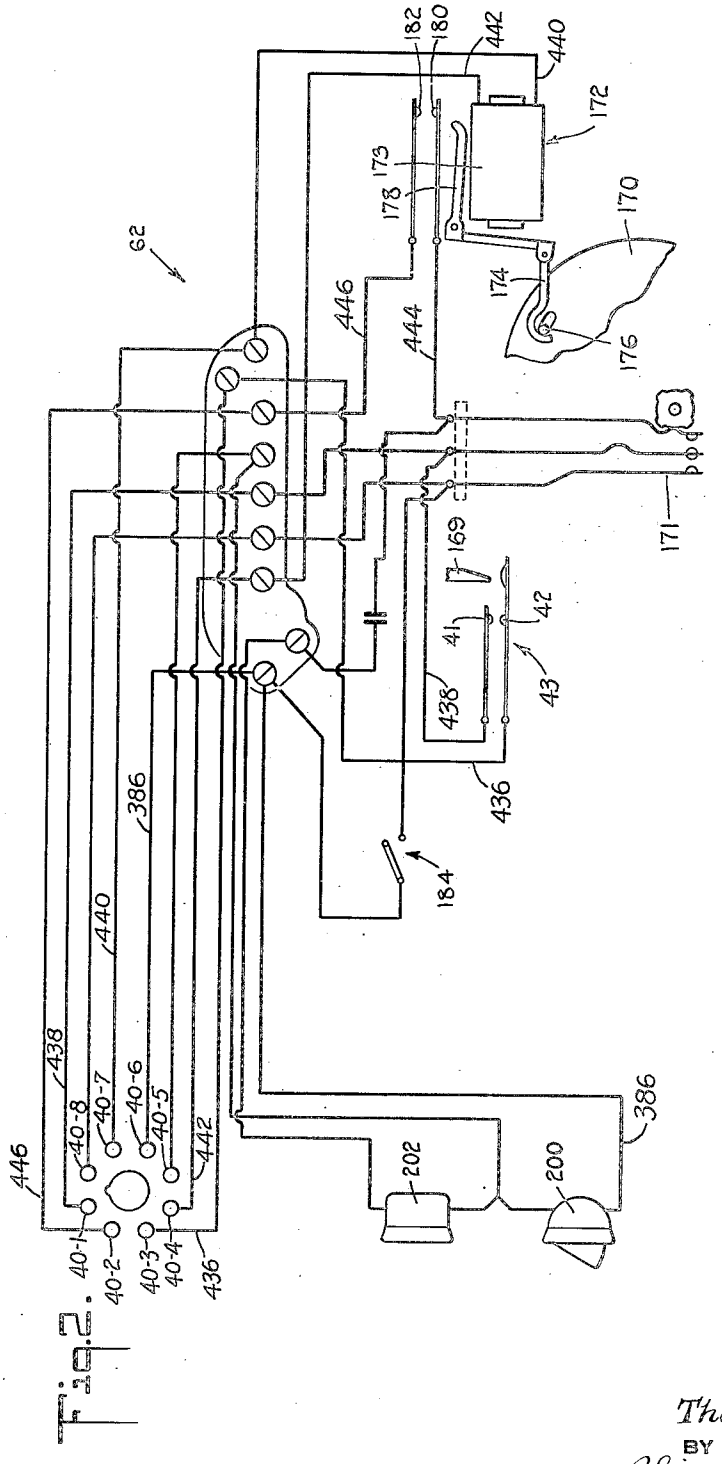

Fig. 2.

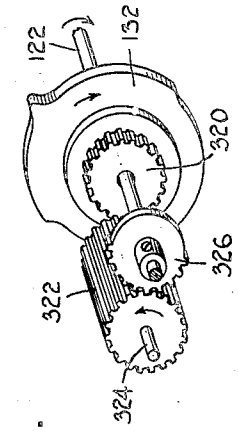

Fig. 3.

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TELEPHONE SYSTEM

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Fig. 4.

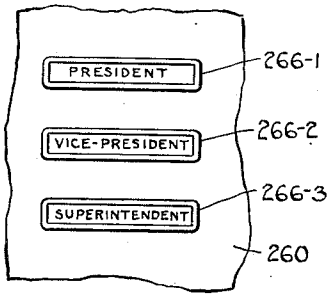

Fig. 5.

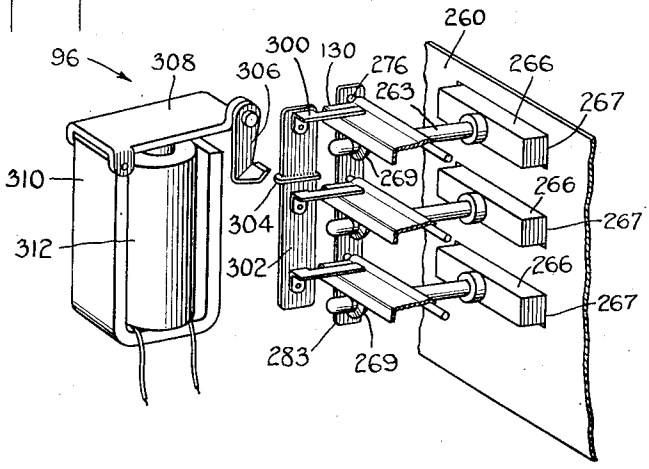

Fig. 6.

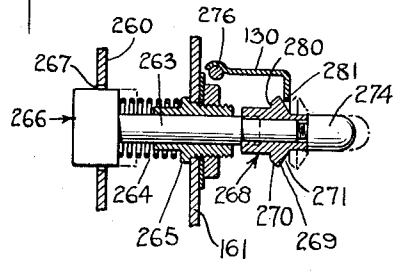

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Fig. 7.

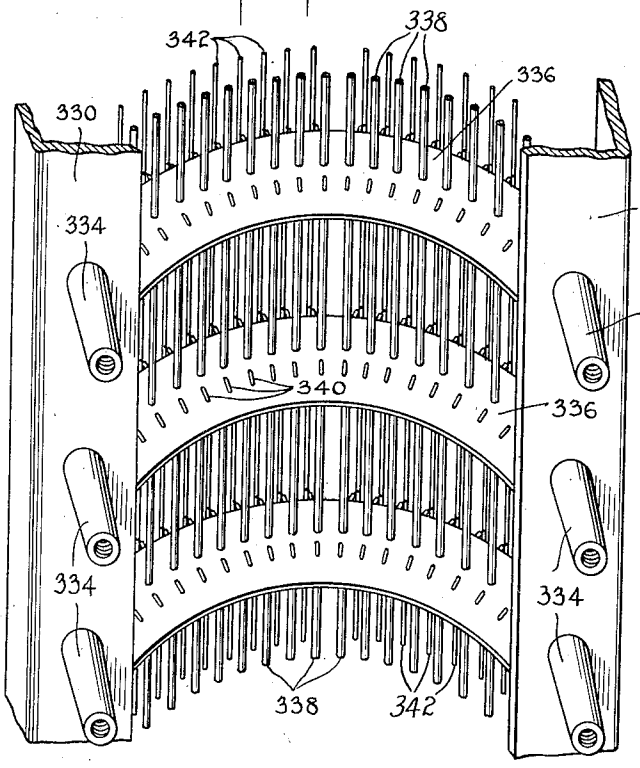


Fig. 8.

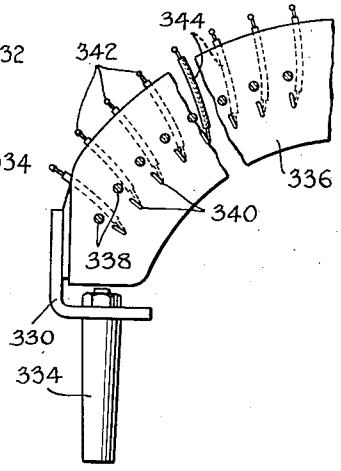


Fig. 9.

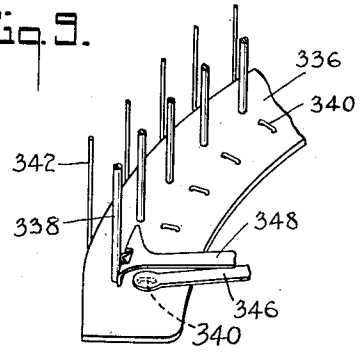
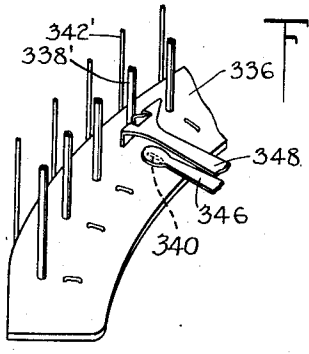


Fig. 10.



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Patented July 8, 1941

2,248,899

UNITED STATES PATENT OFFICE

2,248,899

TELEPHONE SYSTEM

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Application August 3, 1940, Serial No. 350,843

9 Claims. (Cl. 179—40)

This invention relates to communication and more particularly to an automatic telephone system and apparatus used in conjunction therewith.

An object of this invention is to provide an automatic telephone system wherein the calling station is connected through a central station to the called station in an efficient and dependable manner with a minimum amount of equipment and a minimum number of lines between the various stations of the system. Another object is to provide an automatic telephone system which performs its various operations with maximum efficiency in a minimum of time, and which is flexible in use so that it is adaptable for efficient operation under a wide variety of conditions. Another object is to provide equipment of the above character which is sturdy and durable in construction and which is light in weight and can be constructed with a minimum of materials.

A further object is to provide a system of communication for use in an establishment such as one having a large number of offices where it is desirable for each office to have communication with each of the other offices, and where the number of stations in the system may be increased without disturbing the original equipment. A further object is to provide a system of communication wherein one of a number of stations may carry on telephone conversation with the other stations and wherein one or more of these stations has auxiliary talking and receiving equipment. Another object is to provide a system of two-way communication between any number of stations by means of a circuit having a minimum number of wires. Another object is to provide a telephone station wherein the dialing is automatic and the equipment is so arranged that errors in dialing are reduced to a minimum. A further object is to provide a telephone system which is dependable in its operation even though part or all of the stations are called infrequently. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combination of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described and the scope of the application of which will be indicated in the following claims.

In the drawings:

Figure 1 is a diagrammatic representation of the main portion of a telephone station of a system constituting one embodiment of the invention;

Figure 2 is a diagrammatic representation of a telephone handset which is used in conjunction with the apparatus of Figure 1;

Figure 3 is a perspective view of a gear assembly which drives the timing cam at the left-hand side of Figure 1;

Figure 4 is a front elevation of a portion of the keyboard of the apparatus of Figure 1;

Figure 5 is a perspective view, with certain associated parts omitted, of a latch release mechanism shown diagrammatically in the central portion of Figure 1;

Figure 6 is a sectional view of one of the keys of the key assembly shown at the top of Figure 1;

Figure 7 is a multiple-unit contact assembly which is used in conjunction with the embodiment of Figure 1;

Figure 8 is a view on the line 8—8 of Figure 7; and

Figures 9 and 10 are perspective views of a portion of the apparatus of Figures 6 and 7 showing contactor arms which are associated therewith.

This application is a continuation-in-part of my copending application Serial No. 148,075 filed June 14, 1937, and reference may be had to that application for a more detailed discussion of certain phases of the embodiment of the present application. The embodiment of my copending application is hereby incorporated into the present application and the embodiment of the present application differs from the prior embodiment as herein pointed out.

In telephone systems, and particularly automatic systems where a party at one station automatically calls another station, it is important that the equipment be adaptable for use under a wide variety of conditions. Furthermore, the equipment should be dependable in operation even though parts of the equipment remain unused over a long period of time. The various automatic operations of such equipment should be carried on quickly and efficiently as a delay in completing a call is often a serious matter. In addition to avoiding tying up the equipment, the feature of saving time in completing calls may be a vital point in favor of installing automatic equipment.

Under some circumstances of use, it is important that the party being called be informed as to the calling party as this permits the called party to select calls which must be answered. In the past there have been frequent occasions when an organization having automatic equipment has gradually expanded so that the original equip-

ment can no longer handle the large number of stations. It is important under these circumstances that the equipment be easily adaptable for expansion without disturbing the original installation. Furthermore, it is desirable that equipment be standardized so that it may be manufactured, installed and serviced efficiently, and at the same time, the initial cost of a small installation must be small.

At times, one particular station of a system must be provided with auxiliary equipment, and this auxiliary equipment must not interfere with the normal operation of the system. For example, under some circumstances, it is desirable that the user be permitted to talk and listen through either a handset or a microphone and loud speaker.

It is an object of this invention to provide a system which attains these ends by providing a number of cooperating units wherein each unit of the system performs its functions in a dependable and efficient manner. In the illustrative embodiment, the major portion of one station is shown in Figure 1, and the mechanical details of certain operating units of the system are shown in the other figures. As indicated above, this system is related to that of my copending application, and reference may be had to that application for certain details of the system which have been omitted from the present detailed description for the sake of brevity. In this embodiment, the term "dialing" has been used in the sense of producing a set of impulses or a signal which identifies a station which is being called, even though in the present embodiment this operation is carried on by a motor-driven mechanism which differs from the normal telephone dial. The term "selecting" is used in the sense of connecting the calling station with the station being called, in the present embodiment this being done by means of the central selector relay which has a pair of wipers which are moved along an arcuate path. The term "ringing" has been used in the sense of being a signal at the station being called, and in the present embodiment, this signal notifies the called station of the particular party calling.

Referring particularly to Figure 1, the station consists of a group of units, the major ones of which are the keyboard assembly **50**, the motor assembly unit **52**, the amplifier unit **54**, the loud speaker unit **56**, and the chassis assembly **58**. External circuits enter the chassis assembly through receptacles **40** and **60**; these external circuits are the main line circuits which are connected through receptacle **60** and a privacy handset unit **62** (see Figure 2) which is connected through receptacle **40**. The privacy handset unit is used to dial beyond the capacity of the keyboard, and to carry on conversations without the use of the loud speaker unit.

The main circuit in this embodiment comprises three wires which are not shown but which extend from receptacle **60** to the switchboard at the central station. These three wires have been designated the C-circuit, the L-circuit and the S-circuit, and they are connected in receptacle **60** to terminals **1**, **2** and **3**, respectively. The C-circuit is common to all stations of the system and is connected at all times to all of the stations. The L-circuit connects its particular station to the central selector relay, and accordingly, each station is provided with its own L-circuit. The S-circuit is similar to the L-circuit in that it extends from its station to the central selector relay, the L-circuit and the S-circuit being used to carry the "dialing" signal for the selecting operation and for carrying on subsequent signaling and conversations. Terminal **1** is connected to the positive side of a thirty-volt battery **12** which has its other side connected to a terminal **8**. Terminal **1** is also connected through a lead **190** to one side of a twenty-five-volt, sixty-cycle, alternating current source, the other side of which is connected through a lead **192** to a terminal **6**. A one-hundred-and-twenty-five-volt battery **194** has its negative side connected through a lead **196** to terminal **8** and has its other side connected through a lead **198** to a terminal **7**. The uses of these various voltage sources is more fully discussed below.

As indicated above, this apparatus is easily adaptable for use under a wide variety of conditions, and under some circumstances, certain of its parts perform functions which are other than their normal functions. However, certain of the normal functions of the various units will be briefly outlined at this time. The central portion of the apparatus is the chassis assembly **58**, and this chassis assembly connects the other units together and coordinates their actions. The chassis assembly in itself includes a number of operating units which are more fully explained below, and among these are the following: a potentiometer unit **160** which is used to control the volume of the output of the loud speaker unit **56**; a resistance unit **166** which is regulated to control the tone of the output of the loud speaker unit **56**; a privacy relay **38** which is effective when energized to disconnect the loud speaker and microphone circuits when the privacy handset unit **62** (Figure 2) is being used; a keyboard release relay **96** which is shown with its associated mechanism in Figure 5, and which, after being energized and then deenergized, automatically releases all of the key latches on the keyboard; a control relay **36** which is energized to condition the station for talking; a buzzer relay **90** which is energized when there is an incoming call to perform the "buzzer" or "ringing" operation; a microphone unit **98** which is used to transmit voice from the station when the privacy handset unit is not being used; and a voltage divider **100** which has an adjustable voltage pick-up **102**.

The amplifier unit **54** receives the voice signals from the incoming circuits and transmits these signals, suitably amplified, to the loud speaker unit **56**. As indicated above, the volume and tone of the output of the loud speaker unit **56** are controlled respectively by units **160** and **166**, and this control is exerted through the amplifier unit **54**. The loud speaker unit **56** receives the amplified voice signals and translates them into sound. The keyboard assembly **50** includes the various control keys with one key for each station which may be called, and with additional keys to permit manual control of the talking and ringing operations.

The keyboard assembly **50** is connected by means of a number of leads to the terminals of a commutator assembly **118**, which is part of the motor assembly unit **52**. The motor assembly unit is connected to the chassis assembly **58**, and is effective to connect and disconnect the various circuits at the proper times depending upon the control exerted by the units of the chassis assembly. The motor assembly unit **52** is provided with a constant speed motor **120**

which drives a shaft 122 (shown partly in broken lines) through a worm gear unit 124. When a station is to be called, motor 120 rotates shaft 122 two complete revolutions, and during the first of these revolutions a "dialing" signal, or a set of "dialing" impulses, is transmitted to the central selector relay, which "dialing" impulses correspond to the station being called. The central selector relay thereupon connects the calling station to the called station and during the second revolution of shaft 122, a "ringing" signal is transmitted over the circuit set up to the called station, and this "ringing" signal identifies the calling station so that the party being called knows who is calling.

The "dialing" signal is produced by the combined action of the commutator assembly 118 and a cam 128 with its associated switch 142, and the "ringing" signal is initiated by a cam 129 and its associated switch 148. A control cam 132 controls the completing of the "dialing" and "ringing" circuits so that the circuit of switch 142 is first closed and the circuit of switch 148 is held open so that the "dialing" operation is performed; and then the circuit of switch 148 is closed and the circuit of switch 142 is opened so that the "ringing" operation is performed. Control cam 132 also stops the operation of motor 120 when the "ringing" signal has been completed. Cams 128 and 129 are keyed directly to shaft 122, and cam 132 is rotatably mounted on the shaft and is mechanically connected thereto through the gear assembly shown in Figure 3. This gear assembly drives cam 132 with an intermittent motion, and cam 132 completes one revolution at the time shaft 122 completes its two revolutions.

Motor assembly unit 52 is provided with a normally energized relay 10 which is deenergized to permit the carrying on of the "dialing" and "ringing" operations when one of the keys is pressed. A control relay 24 is also provided which performs a number of control functions including the control of the starting and the continued operation of motor 120.

As indicated above, shaft 122 rotates two complete revolutions during the "signaling" operation, there being one revolution during which the calling station is being connected to the called station, and there being one revolution during which a "ringing" signal is being transmitted to the called station. The mechanical connection for driving cam 132 is shown in Figure 3 with cam 132 loosely mounted on the shaft, and with a gear unit to transmit intermittent movement to the cam.

Accordingly, rigidly attached to cam 132 is a gear 320 which meshes with an intermediate gear 322 which is mounted to rotate freely on its shaft 324 which is parallel to shaft 122. Keyed to shaft 122 and adapted to mesh with intermediate gear 322 is a segment gear 326 which has teeth around one-half of its periphery. Thus, when shaft 122 rotates one revolution, gear 326 is engaging and rotating gear 322 during one-half of the revolution, or 180°, and during the other half of the revolution gear 322 remains stationary. Accordingly, cam 132 is rotated through 180° during each 360° movement of shaft 122, and at the end of each two revolutions of shaft 122, the elements return to the position of Figure 1. As previously pointed out, cam 132 operates a number of switches, and by using this type of drive for cam 132, the switches are opened and closed at a rapid rate and in the proper timed relationship. At the same time, the operating mechanism is compact and sturdy.

In this embodiment, the stopping of motor 120 is controlled by cam 132 so that the motor is stopped only when the cam reaches a predetermined position. Thus, each "dialing" and "ringing" cycle is started with cam 132 in the proper position, and any error which might appear in one cycle of operations is not carried into the next cycle of operations.

As indicated above, the keyboard assembly 50 is provided with a number of keys which are independently operable, and there is a separate key for each station to be called. Certain details of the construction of the keyboard assembly are shown in Figures 4, 5 and 6, though in Figure 5, certain of the elements are omitted to show the operating relationship between the other elements. A panel 260 is provided with a number of rectangular holes 267, and through each hole extends the front of a key 266 with the keys in alignment both vertically and horizontally. Each key bears a notation upon its face corresponding to the station which is called when the key is pressed, keys 266—1, 266—2 and 266—3 being marked "President," "Vice President" and "Superintendent" respectively. When the operator desires to talk to a particular person, he merely presses the name of that person, and the mechanism is automatically operated to provide the proper connection. It has been found that by providing this construction, the operator does not make errors in calling the wrong station, and at the same time, the call is completed in a minimum of time and without effort.

When one of the station keys is pressed to connect a station, the key is latched in its inner position by means of a latch mechanism, the details of which are shown best in Figures 5 and 6. Referring to Figure 6, at the right of panel 260 is a false front 261, and rigidly mounted in a hole in the false front is a sleeve-bearing assembly 265 through which the key shaft 263 extends. A coil spring 264 bears at the left against the head of the key and at the right against a flange on the sleeve-bearing assembly 265, and the key is therefore urged to the left, or outwardly, by the spring. Upon the right-hand end of shaft 263 is a cam collar 268 which has a cam flange 269 with beveled surfaces 270 and 271. Cam collar 268 is held in place by a plunger 274 which is threaded onto the end of shaft 263 and the right-hand end of which operates the key switch.

The left-hand side of beveled flange 269 is provided with an annular latch surface 280. Extending above each latch cam is a latch bar 130 which is rockably supported by a rockable bar 276. Latch bar 130 has a downwardly extending flange with a lower edge 281, and when the key is pushed to the right to the position shown in broken lines, the latch edge 281 rides up over cam surface 271 and down over surface 270 to the side of surface 280. When in this position, the key is securely latched, and the key is held in its depressed position until released. As shown in Figure 5, the rockable bars 276 are supported at their ends by brackets 283 (only one of which is shown).

Under some circumstances, a key remains in the depressed position after a call has been completed, and it is important that the pressing of a particular key release all of the other keys which are depressed. Accordingly, the latching mechanism is constructed so that the pressing of

a key releases all of the latches, and then the latching mechanism is effective to hold only the one key in the depressed position. Accordingly, all of the latch bars 130 are mechanically linked together by a latch release bar 302 which is pivoted to the left end of a latch release arm 300 extending from each of the latch bars. Thus, when any one of the keys is pushed inwardly, raising its latch bar, all of the latch bars are raised, and as a result, any key which has been held inwardly by its latch is released. When released in this manner, the initial movement of the latch lifts edge 281 (Figure 6) upwardly along surface 280, and when the edge 281 rides onto cam surface 270, the spring 264 urging the key to the left, assists in raising the latch bar.

As indicated above, Figure 5 shows a latch release mechanism which is operated by the keyboard release relay 96. Accordingly, latch release bar 302 is provided with a transverse ridge 304, and movably mounted in cooperating relationship with respect to ridge 304 is a dog 306. Dog 306 hangs from the right-hand end of an armature 308 which is pivoted at its left-hand end to a base 310. A spring (not shown) normally holds the armature and the dog in the raised position, but when the solenoid 312 is energized, armature 308 is drawn downwardly, and the lower end of dog 306 swings in below ridge 304. Later when the solenoid is deenergized, armature 308 moves upwardly, lifting dog 306 and raising latch release bar 302. The raising of latch release bar 302 lifts all of the latch bars 130, and any keys which have been latched in their depressed positions are moved outwardly by their respective springs.

The privacy handset unit shown in Figure 2 is provided with a number of independently operating units which are as follows: a transmitter 200 and an associated earpiece 202; a manual ringing button 184 which is used to signal the called station; a dial 170 which is provided with a dial latch 176 which normally permits the winding of the dial but prevents the return of the dial; a dial spring (not shown) which tends to turn the dial clockwise toward a stop (not shown); a make-and-break contactor unit 171 which is operated by the rotation of dial 170; and a latch relay unit 172 which has a latch hook 174 engaging dial latch 176 and carried by an armature 178. Latch hook 174 is pulled to the right by the energization of a solenoid 173, and this movement releases dial latch 176 so that the dial may rotate freely.

In use, the dial latch is in the position shown, and the dial is manually rotated to a position corresponding to the particular station to be called, and the dial is held in this position by the dial latch. Solenoid 173 is then energized so that latch hook 174 is pulled to the right and dial latch 176 is thereby released. Dial 170 is automatically returned to its normal position by the dial spring, and during this return movement, the contactor unit 171 transmits the dialing signal to the central selector relay.

The connecting of the handset into the circuit is controlled by switch 43 having contacts 41 and 42. When the handset is at rest, its cradle 169 holds contact 42 out of engagement with contact 41, and when the handset is lifted for use, the cradle moves upwardly and switch 43 automatically closes. As pointed out elsewhere, the closing of switch 43 energizes privacy relay 38 (Figure 1) and also actuates the key latch release relay 96 shown in Figure 5. Subsequently, when the handset is replaced on cradle 169, the solenoid of relay 96 is deenergized so that any keys which are depressed on the keyboard are released. When desirable, the manual ringing button 184 may be operated to transmit a ringing signal to the called station. When solenoid 172 is energized, its armature 178 swings upwardly to thereby move contact 180 into engagement with contact 182. This permits the impulses from the dialing contact unit 171 to go out over the calling circuit.

Figures 7 to 10 show a multiple-unit contact assembly of the central selector relay which is sturdy in construction and which has a number of advantages in use. As shown best in Figure 7, a pair of angle bars 330 and 332 are provided, each having a plurality of supporting posts 334 rigidly attached thereto, and extending between these angle bars are arcuate bridge members 336 of insulating material. Supported by bridge members 336 are rods 338 each of which extends through a set of holes which are in alignment in the bridge members. The holes in each bridge member through which rods 338 extend are positioned along an arcuate line which is near the center line of the bridge member, and in radial alignment with each rod 338 is a contact clip 340. When assembled for use, a set of wires 342 is positioned as shown around the periphery of the bridge members and an insulated jumper 344 connects each of the contact clips 340 to one of the wires 342.

As shown in Figures 9 and 10, a pair of wipers 346 and 348 are provided for each of the bridge members 336, and when these wipers are rotated, wiper 346 moves along a line to engage contact clips 340 and wiper 348 moves along a line to engage rods 338. In practice, each rod 338 and its associated wire 342 is the calling circuit of a particular station to be called, and during the selecting operation, wipers 346 and 348 are swung clockwise by the "dialing" impulses with a step-by-step movement, stopping at the end of each movement in engagement with one rod and its associated contact clip. When the selecting operation is completed, the calling station is connected to a particular station depending upon the number of impulses in the "dialing" signal. Illustratively, wipers 346 and 348 are shown in Figure 9 engaging the first rod 338 and clip 340; after three impulses have been transmitted, the wipers are in the position shown in Figure 10, engaging the rod, designated 338', and the contact clip 340' corresponding to the wire designated 342'. If no further selecting impulses are transmitted, the calling station is connected to the station corresponding to rod 338' and wire 342'.

Referring again to Figure 1, for convenience, the various electrical lines have been given a single number, even though a break is made in the line at a jack or at a fuse, and during normal use any one line is at one potential throughout. Whenever a switch is provided, the line on one side of the switch is given one numeral and the line on the other side of the switch is given another numeral. In connection with keyboard assembly 50, the various key switches 108 have been given separate sub-numerals, —1, —2, etc., and the corresponding plungers 274 have been given subnumerals, —1, —2, etc. Likewise, the leads 348 connecting the switches and the corresponding contacts 146 of the commutator assembly 118 have been given sub-numerals, —1, —2, etc.

Under normal conditions, the solenoid 11 of relay 10 has one side connected through line 350 to terminal 8 of receptacle 60, and thus to the negative side of battery 12, and the other side of the solenoid is connecteed through line 352 to key switch 108—12. All of the key switches 108 are in series and have been designated 108—12 to 108—1, and the other side of key switch 108—1 is connected to line 354 which extends to terminal 1 of receptacle 60, which is connected to the positive side of battery 12. Thus, with all of the key switches closed, line 352 is connected through the key switches to the positive side of battery 12, and the solenoid 11 of relay 10 is connected directly across the battery.

This energizes the relay and holds armature 14 to the right so that contact 16 is out of engagement with contact 18. Contact 18 is connected to line 354 and thus to the positive side of battery 12, and contact 16 is connected through line 356 to the juncture 20 of two resistance units 21 and 22. When the "dialing" operation is to occur, one of the keys is pressed, thereby opening the corresponding key switch 108, and this breaks the circuit to solenoid 11 of relay 10 and de-energizes the relay with the result that armature 14 moves to the left and contact 16 engages contact 18. This carries current from line 354 through line 356 to the juncture of resistance units 21 and 22. At the right, resistance unit 22 is connected through a line 358 to one side of the solenoid 360 of relay 24 and the other side of the solenoid is connected directly to line 350 which extends to the negative side of battery 12. Thus, solenoid 360 of relay 24 is connected in series with resistance unit 22 directly across battery 12, and the solenoid is partially energized.

Resistance unit 22 has a resistance of 450 ohms, and the partial energization of solenoid 360 is sufficient to swing armature 26 counterclockwise to thereby operate through a dummy switch unit 361 and move switch contactor arm 28 to the right so that contact 30 is moved away from contact 32. Switch contactor arm 28 and contact 32 are connected to line 354, and contact 32 is connected through lead 362 to switch 34 of the privacy relay 38. The other side of switch 34 is connected through line 362 to the solenoid 364 of control relay 36, and the other side of solenoid 364 is connected to line 350. Thus, the control relay normally may be energized and the movement of contact 30 away from contact 32 prevents the energization of control relay 36 and, as will be explained below, this resets the mechanism to the normal starting position.

It should be noted at this time that switch 34 is held closed during this operation by the energization of privacy relay 38 which has one side connected through line 350 to the negative side of battery 12 and which has its other side connected through line 366 to terminal 40—3 of receptacle 40. As will be explained below, terminal 40—3 is connected through the privacy handset unit 62 (Figure 2) to terminal 40—1 (Figure 1) of receptacle 40 which is connected through line 368 to contact 45 of the switch assembly 136; with cam 132 in the position shown, contact 45 is in engagement with contact 44 which is connected through line 354 to the positive side of battery 12. In this way, privacy relay 38 is held energized and switch 34 is held closed.

To answer a call, control relay 36 is energized sufficiently to swing armature 68 to the left so as to move contact 64 into engagement with contact 66. Contact 66 is connected through line 370 to terminal 3 of receptacle 60 which, as pointed out above, is connected to the outgoing S-circuit, and contact 64 is connected through line 372 to the sensitive transmitter circuit. The sensitive transmitter circuit includes a three mfd. condenser unit 106, a choke-coil 104 and a microphone unit 98, all of which are connected through a line 374. The other side of the microphone unit 98 is connected through a line 376 to the adjustable tap 102 on the voltage divider unit 100, which is connected directly between lines 350 and 354. The other side of the choke coil unit 104 is connected to line 354 which is connected through terminal 1 of receptacle 60 to the positive side of battery 12.

The swinging of armature 68 also opens the circuit of the buzzer relay 90 by moving contact 70 away from contact 72, and the circuit of the privacy handset unit is closed by the movement of contact 70 into engagement with contact 74. Contact 72 is connected through line 380 to the buzzer relay 90 and contact 70 is connected through line 382 to terminal 2 of receptacle 60 which is connected to the outgoing L-circuit. Contact 74 is connected through line 384 to terminal 76 of the privacy relay 38 and also to terminal 40—6 of receptacle 40. Terminal 40—6 is connected as shown in Figure 2 through line 386 to the handset transmitter 200.

Control relay 36 also closes a circuit which provides the plate voltage to the amplifier unit 54 by swinging armature 67 to the right sufficiently to move contact 80 into engagement with contact 82, contact 80 being connected through line 390 to terminal 7 of receptacle 60 and thus to the positive side of battery 194, and contact 82 being connected through line 392 to the plate of the tube in the amplifier unit. The swinging of armature 67 to the right also moves contact 84 into engagement with contact 86 and this supplies field current to the loud speaker unit 56. That is, contact 86 is connected directly to the field winding of the loud speaker through line 393, and contact 84 is connected through line 394 to terminal 40—8 of receptacle 40 which is connected through the privacy handset unit 62 to terminal 40—1 and terminal 40—1 is connected through line 368, contacts 45 and 44 and line 354 to the positive side of battery 12. The other side of the loud speaker field winding is connected to the negative side of battery 12 through line 350.

One side of buzzer relay 90 is connected directly to line 350 and the buzzer relay is operated on incoming calls when it receives a signal through contacts 92 and 94. As indicated above, contact 92 is connected through line 380 to contact 72 and when control relay 36 is de-energized, contact 72 is connected through contact 70 to line 382 which is connected through terminal 2 of receptacle 60 to the L-circuit. Line 380 also extends to terminal 5 of receptacle 60 and is connected through this terminal to an auxiliary external buzzer (not shown). This external buzzer operates in parallel with buzzer relay 90 and is used as a "remote signal."

As indicated above, privacy relay 38 is energized when the handset of privacy handset unit 62 (Figure 2) is removed from the cradle 169, thus bringing contact 42 into engagement with contact 41. The energization of privacy relay 38 inserts the talking circuit of the privacy

handset in place of the talking circuit of the amplifier unit.

In this embodiment, the keyboard assembly 50 is provided with twelve key switches 108, but key switches 108—1 and 108—2 are provided with additional switch units and are used for other purposes. Accordingly, key switch 108—1 is provided with an auxiliary switch 110 which opens and closes with key switch 108—1, and when the key corresponding to this switch unit is pressed, a manual signal is transmitted over the line. Similarly, key switch 108—2 is provided with an auxiliary switch 112 which opens and closes with key switch 108—2 and when the key corresponding to this switch unit is pressed, the station is automatically connected to the general call line. This general call line is used to call a particular person when the caller does not know the station at which the person being called will answer.

An additional manual ringing switch 114 is provided to be used in transmitting a manual code ring to the receiving station. Switch 114 is normally open and has one side connected to line 394 and the other side connected to line 382. As indicated above, line 382 is connected to the L-circuit and line 394 is connected to terminal 40—8 of receptacle 40, and thus through the privacy handset unit of Figure 2 to terminal 40—1 of receptacle 40 and through line 368, contacts 45 and 44 and line 354 to terminal 1 of receptacle 60 which is connected to the C-circuit. A similar switch 116 is provided which is used in connection with the handset unit to remotely release the dial mechanism of the handset unit. Switch 116 has one side connected to line 362 and the other side connected through line 398 to the solenoid 364 of control relay 36. As explained above, line 362 is connected through contacts 30 and 32 of relay 24, and during the mechanical "dialing" operation contacts 30 and 32 are separated so that switch 116 is rendered ineffective.

In this embodiment key switches 108 and switches 110 and 112 are normally closed, and current flows through all or some of them depending upon the station being called. Thus the contacts carry current and do not corrode, and infrequent use of a particular key does not impair its condition.

Passing now to the motor assembly unit 52 and its operation, motor 120 is normally stationary, but when once started, it rotates shaft 122 through two complete revolutions to thereby carry on the "dialing" and signaling operation. During this procedure, control cam 132 actuates the switch assembly 136 to cause the various operations to be performed in the proper sequence. Cam 132 is rotated one complete revolution while shaft 122 is completing two revolutions, but the movement of cam 132 is intermittent, in this embodiment the drive being through the gear unit of Figure 3.

Cam 132 has four sections or segments designated A, B, C and D. These segments are contacted by a switch operating arm 134 which is spring pressed against the cam and which controls the positioning of the various contacts of switch unit 136. When the mechanism is idle, arm 134 engages segment A of the cam and when in this position, the only two contacts of switch assembly 136 which are engaged are 45 and 44. As indicated above, when contacts 44 and 45 are in engagement, line 368 is connected to line 354 which extends to the positive side of battery 12, and line 368 is connected to the privacy handset unit and to the manual ringing switch 114. Thus, the "dialing" operation may be carried on with the handset and the operator may use the manual ringing switch 114.

When a key is pressed, solenoid 360 of relay 24 is partially energized in the manner outlined above. The partial energization of solenoid 360 of relay 24 swings armature 26 to the right and moves contact 30 out of engagement with contact 32 and into engagement with contact 31. This connects the positive side of battery 12 through line 354, contacts 30 and 31, line 410, contacts 34 and 35, and line 408 to the motor. The other side of the motor is connected to line 350 which extends to the negative side of the battery, and the motor is therefore started.

Relay 24 also conditions the circuits for the impulsing operations. Accordingly, line 410 is also connected through resistance unit 154 and line 398 to solenoid 364 of control relay 36. Due to the presence of resistance unit 154 in the circuit, control relay 36 is only partially energized, and this partial energization is sufficient to swing armature 68 to the left, but it is insufficient to move armature 67 as armature 67 has only a small portion extending over the core of the solenoid. The swinging of armature 68 to the left moves contact 64 into engagement with contact 66 and contact 70 is moved away from contact 72 and into engagement with contact 74.

When motor 120 starts its operation, timing cam 132 is immediately rotated clockwise so that segment B is positioned below arm 134, and this moves contact 44 away from contact 45 and contact 140 is moved into engagement with contact 138. Contact 140 is connected to line 370 which, as pointed out above, is connected through terminal 3 of receptacle 60 to the outgoing S-circuit, and contact 138 is connected through line 400 to impulsing switch 142. The other side of impulsing switch 142 is connected through line 402 to a sliding contact 144 of the commutator assembly 118. Sliding contact 144 engages wiper 126 and as the wiper is rotated clockwise across contacts 146 a circuit is completed between each of the contacts and impulsing switch 142.

Impulsing switch 142 is closed by impulsing cam 128, and the cam 128 and wiper 126 are accurately positioned on shaft 122 with respect to each other. When wiper 126 is moving between the various contacts 146, impulsing switch 142 is open, but when wiper 126 is in complete engagement with each of the contacts, switch 142 is closed and then opened again. Thus, the impulsing is initiated by the impulsing switch.

Contact 146' is connected to line 354 which is connected through terminal 1 of receptacle 60 to the positive side of battery 12. Contact 146—1 is connected through line 348—1 to the juncture of switches 108—1 and 108—2, and contacts 146—2, 146—3, etc., are similarly connected through correspondingly numbered lines to the junctures of the other key switches.

As pointed out above, the key switches 108 are connected in series with one side of key switch 108—1 connected to line 354 so that when all of the switches are closed, the positive potential of battery 12 is carried through all of the switches and along all of lines 348 to all of the contacts 146. However, when one of the key switches is opened, this disconnects the lines 348 which are beyond it in the circuit from the bat-

tery and the corresponding contacts 146 are disconnected.

Illustratively, if key switch 108—3 is opened by the pressing of its key 266, lines 348—1 and 348—2 remain connected to line 354 and contacts 146', 146—1 and 146—2 remain connected to the battery while the remainder of the lines and the remainder of the contacts are disconnected. Thus, as wiper 126 moves over the top of contact 146', the closing of switch 142 initiates an impulse which is transmitted over the outgoing circuit. Switch 142 then opens and the wiper moves to contact 146—1 whereupon switch 142 momentarily closes again to send out a second impulse. A third impulse is sent out through contact 146—2, but the remainder of the contacts are disconnected and no further impulses are transmitted. In this way, the calling station will be connected to the called station which is identified by three impulses.

At the beginning of the second rotation of shaft 122, cam 132 is turned so that segment C engages arm 134, and this moves contact 140 away from contact 138 to thereby open the "dialing" circuit of switch 142. Simultaneously, contact 44 is moved into engagement with contact 45 and this connects line 354 to the ringing circuit as outlined above. The ringing switch 148 has one side connected to line 368 and has its other side connected through line 406 to switch 112, the other side of which is connected through switch 110 to line 382 which is connected through terminal 2 of receptacle 60 to the L-circuit. The ringing cam 129 is so shaped as to close switch 148 at the proper intervals to transmit a code ring to the station being called. Accordingly, cam 129 is provided with raised segments X, Y and Z, and when the cam rotates clockwise, a ringing signal is transmitted of one long ring and two short rings.

It will be noted that this ringing circuit is completed through switches 112 and 110 which are switches operated simultaneously with key switches 108—2 and 108—1, respectively. As indicated above, key switch 108—1 is used to call a station when it is desirable to ring manually and thus the motor unit carries on its usual operation except that the ringing circuit is open. Key switch 108—2 is used to answer a call on the general call circuit, which is a general line connecting all of the central selector relays and in this embodiment having its bus positioned in place of the first station. The station is connected to this general call circuit in the same manner as it is connected to the other station but no ringing signal should be transmitted. Accordingly, when the key corresponding to switches 108—2 and 112 is pressed, motor 120 carries on its usual operations, but the ringing circuit is held open so that there is no ringing signal.

At the end of the signaling cycle, cam 132 is moved so that its segment D engages operating arm 134 to thereby move contact 44 upwardly so that contact 45 is moved into engagement with contact 150, and contact 150 is moved into engagement with contact 152. Thus, line 354, which is connected to the positive side of battery 12, is connected through contacts 44 and 150 to line 408 which carries the potential of the positive side of the battery to motor 120, the normal circuit being from relay 24 through contacts 30 and 31, line 410 and contacts 34 and 35. By connecting line 408 directly to line 354, this normal circuit to the motor from the positive side of the battery may be broken without stopping the motor.

Contact 152 is connected to line 358 which, as indicated above, is connected to one side of solenoid 360 of relay 24. Solenoid 360 was initially only partially energized as it was connected in series with resistance unit 22 across the battery, and this partial energization was insufficient to raise armature 25 as armature 25 extends only a short distance over the top of the solenoid core. However, the connecting of line 358 directly to line 354 through contacts 44 and 150 fully energizes solenoid 360. When solenoid 360 is fully energized, armature 25 is swung to the left, thereby moving contact 21 into engagement with contact 23 and lifting contact 34 away from contact 35. By moving contact 34 away from contact 35, the above-recited circuit connecting line 408 to line 354 is broken and the motor receives power through contacts 150 and 44 in the manner outlined above.

As pointed out above, the initial energization of relay 24 as the motor was started resulted in the partial energization of control relay 36, the solenoid of the control relay being in series with resistance unit 154. However, when relay 24 is fully energized, and armature 25 moves contact 21 into engagement with contact 23, resistance unit 154 is shorted out of the control relay circuit, and the positive side of the battery is carried from line 354 through contacts 30 and 31, line 410, contacts 23 and 21 and line 398 directly to the solenoid 364 of control relay 36. This full energization of relay 36 lifts armature 67 and contact 80 is moved into engagement with contact 82 and contact 84 is moved into engagement with contact 86. This is effective in the manner outlined above to condition the transmitting and receiving circuits.

When these operations are completed, timing cam 132 is moved on to the position of rest as shown so that contacts 45, 150 and 152 are separated to thereby stop motor 120 and break the direct connection between solenoid 360 of relay 24 and line 354. However, solenoid 360 remains partially energized as it is still connected in series with resistance unit 22 and contacts 16 and 18 of relay 10 to line 354 and this partial energization is sufficient to maintain armatures 25 and 26 in their raised positions.

If a key is pressed so that the impulsing mechanism or motor unit 52 starts its operations and the key is then released, it is important that motor 120 continue to rotate until timing cam 132 is returned to its normal position of rest as shown. This result is insured by the provision of resistance units 21 and 22 which are connected in series and deliver partial current to solenoid 360 of relay 24 when motor 120 is energized. Thus, during the major portion of the impulsing cycle, if the key is opened so as to energize relay 10 and move contact 18 away from contact 16, power is delivered from line 354 through contacts 30 and 31, line 410, contacts 34 and 35, line 408 and resistance units 21 and 22 to line 358 and thence to solenoid 360. Even though the presence of these two resistance units in series with solenoid 360 cuts down the energization of the relay, the partial energization is still sufficient to hold armature 26 in the raised position. Later, when segment D engages operating arm 134, to connect line 408 directly to line 354, current will also tend to flow down through line 408 through resistance

units 21 and 22 to line 358, and solenoid 360 remains energized even though contact 152 is not engaged by contact 150.

The filament of the pentode amplifying tube 412 is heated by the twenty-five-volt, sixty-cycle alternating current source and has one side connected through line 414 to terminal 6 of receptacle 60 and thus to line 192; the other side is connected through line 354 to terminal 1 of receptacle 60 and thus to line 190. When desirable, the alternating current source may be dispensed with and the filament may be heated from battery 12. When this is to be done switch 418 is closed and the filament is supplied with its operating current through line 414, through the jumper line 416 and switch 418 from the negative side of battery 12, and from the positive side of the battery through line 354. The input to the amplifier providing the voice currents comes in through line 420 through the two mfd. condenser 422 to the primary of the input transformer 156 and the other side of which is connected through the common return line 354. The voice currents are induced in the secondary of the input transformer 156 and pass to the grid 164 of the pentode amplifying tube 412 and to the plate of the tube, and then through line 424 to the input of the loud speaker circuit. A spark gap 426 is provided from the secondary of the amplifying transformer 156 to the negative side of the power supply to dissipate induced stray currents. A one-hundred-ohm choke coil 428 is provided from the input line 420 of the amplifier to the common return line 354; this provides the input circuit with a positive polarity when it is connected into the operating circuit so that there is energizing current to the L-circuit of the selector. The one-hundred-ohm choke coil supplies plate current for tube 412, and causes the voice currents to flow through the two mfd. condenser.

The amplifier input line 424 extends to the power output transformer 158, the primary of which is connected to battery 194 which is of one hundred and twenty-five volts. An indicator is provided at the loud speaker unit in the form of a miniature neon-lamp 430 which is provided with a timing circuit to cause the neon-lamp to flash periodically when plate current is being supplied to the amplifier unit. The field coil 432 of the loud speaker has one side connected to line 350 and thus to the negative side of battery 12, and the other side of the field coil is connected through line 393 to contact 86 of control relay 36 and thus through contact 84 and line 394 to terminal 40—8 of receptacle 40. As has been explained in detail above, terminal 40—8 is connected to the outgoing C-circuit through terminal 1 of receptacle 60.

A volume control potentiometer 160 is provided which is connected across the secondary of the amplifying transformer 156 and which has a movable contact arm 162 which is connected to the grid 164 of the pentode tube 412. By swinging arm 162 from one end of the resistance unit to the other, the polarity of the grid is varied, thus affecting the volume.

A tone-control unit 167 is provided which includes a variable high resistance unit 166 and a one-tenth mfd. condenser 169 which are connected in series across the loud speaker output transformer 158. The movable contactor of the resistance unit 168 is moved to regulate the amount of resistance in the circuit, and in this way, the tone-control unit is adjusted to absorb the desirable amount of the higher audio-frequencies.

When the privacy handset unit of Figure 2 is used, the removal of the handset from cradle 169 permits contact 42 to move into engagement with contact 41. This connects line 366 (Figure 1) from receptacle 40—3 (see Figure 2) through line 436, contacts 42 and 41, line 438, terminal 40—1 of receptacle 40 (Figure 1), line 368 and contacts 45 and 44 to line 354 which is connected to the positive side of battery 12. As indicated above, line 366 is connected to the solenoid of privacy relay 38 and thus the closing of contacts 42 and 41 (Figure 2) energizes the privacy relay; line 366 is also connected to the keyboard release relay 96 so that this relay is energized. Subsequently, when the handset is replaced on the cradle, relay 96 is deenergized and any depressed keys on the keyboard are released in the manner pointed out above.

When it is desirable to dial manually and yet use microphone 98 and the loud speaker unit 56, the dial 170 of the privacy handset unit is used for this purpose. Accordingly, the dial is first set to the position corresponding to the proper dialing and switch 116 is then closed with the result that relay 172 is energized to release the dial and send out the signal. This energization of relay 172 occurs due to the fact that one side of the relay solenoid 173 is connected through line 440 to terminal 40—7 of receptacle 40 and thus through line 398, switch 116, line 362 and contacts 32 and 30 of relay 24 to the positive side of battery 12 through line 354. The other side of solenoid 173 is connected through line 442 to terminal 40—4 of receptacle 40 which is connected through line 350 to the negative side of battery 12.

The energization of relay 172 (Figure 2) moves latch hook 174 to the right to thereby release latch 176 and at the same time, armature 178 lifts contact 180 into engagement with contact 182. The releasing of latch 176 permits the dial spring to rotate dial 170 and thereby actuate the make-and-break contactor unit 171 and initiate the proper dialing impulses. The closing of contacts 180 and 182 permits the impulses to go out over the dialing circuit, the circuit from the make-and-break contactor unit being through line 444, contacts 180 and 182, line 446, terminal 40—2 of receptacle 40 and thus to the outgoing S-circuit through line 372, contacts 64 and 66 and line 370 to terminal 3 of receptacle 60. When the conversation is completed, switch 116 is raised manually, but if the operator fails to do this, the initiating of another call will release the latch on the switch.

At times, it is desirable to omit the use of the privacy handset unit and under these circumstances, the unit is disconnected at receptacle 40. A normally open switch 446 at receptacle 40 is closed when the handset unit is removed to provide the connection between terminals 40—1 and 40—8.

When the general call line is removed from the system, two additional contacts 146a and 146b of the commutator assembly 11C are energized by closing a pair of normally open manual switches 448 and 450. Also, at this time, line 382 is connected to line 406 by means of a jumper 452 and a normally open switch 454.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter here-

inbefore set forth, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In apparatus of the character described, a contactor assembly comprising, a supporting frame construction formed by a pair of spaced parallel frame members and a plurality of bridge members of insulating material extending in parallel relationship between said frame members, a plurality of contactor rods rigidly supported in parallel relationship and substantially parallel to said frame members with all of said rods positioned substantially along a plane which is a segment of a cylinder and with said rods thus providing arcuately extending rows of contacts, and auxiliary contactor means rigidly carried by said bridge members with a row of auxiliary contacts along each bridge member with the axis of the arcuate row of auxiliary contacts substantially coincident with the axis of said segment of a cylinder.

2. In apparatus of the character described, a contactor assembly comprising, a supporting frame construction formed by a pair of spaced parallel frame members and means to rigidly support said frame members, a plurality of arcuate bridge members of insulating material extending in parallel relationship between said frame members, a plurality of elongated contactor members rigidly supported by said bridge members in parallel relationship and positioned substantially on a plane which forms a segment of a cylinder which plane intersects each of said bridge members along an arcuate line which arcuate line has its axis substantially coincident with the axis of the bridge member.

3. In an automatic telephone system in which a plurality of stations may communicate with each other and in which intercommunication is completed by a central selector mechanism including a central selector relay and wherein said plurality of stations includes an executive station, the combination with said relay of an impulsing mechanism at said executive station to produce a variety of impulse designs in accordance with which said central selector relay connects the calling station to the proper called station, said impulsing mechanism being mounted behind a front panel and comprising, an impulsing unit which is capable of producing a selected number of impulses of predetermined characteristics, and means connecting said impulsing unit to a line which extends to said central selector relay and including a switch structure and a plurality of operating keys to operate said switch structure, said keys being adapted to be individually operated to thereby determine the number of impulses to be produced by said impulsing unit, said keys being positioned to be operated from said front panel and each of said keys having a key surface upon which appears a notation corresponding to the station which is connected in response to the actuation of the key.

4. In an automatic telephone system in which a plurality of stations may communicate with each other and in which intercommunication is completed by a central selector mechanism including a central selector relay and wherein said plurality of stations includes an executive station, the combination with said relay of an impulsing mechanism at said executive station to produce a variety of impulse designs in accordance with which said central selector relay connects the calling station to the proper called station, said impulsing mechanism being mounted behind a front panel and comprising, an impulsing unit which is capable of producing a selected number of impulses of predetermined characteristics, means connecting said impulsing unit to a line which extends to said central selector relay and including a switch structure and a plurality of operating keys to operate said switch structure, said keys being adapted to be individually operated to thereby determine the number of impulses to be produced by said impulsing unit, said keys being positioned to be operated from said front panel and each of said keys having a key surface upon which appears a notation corresponding to the station which is connected in response to the actuation of the key, a motor-operated impulsing unit which is controlled by said keys, an auxiliary manual impulsing unit to permit manual dialing of a station to be called, and an auxiliary key means to render said auxiliary manual impulsing unit effective and to simultaneously render said motor-operated impulsing unit ineffective.

5. In a telephone system having a plurality of transmitting and receiving stations in which one station is automatically connected to another, a signal switch mechanism comprising: a rotatable shaft; a switch-operating cam rigidly mounted on said shaft; a wiper rigidly mounted on said shaft and positioned to successively engage a plurality of contacts when said shaft is rotated; a control cam mounted to be rotated by the rotation of said shaft and having four distinct segment portions designated as first, second, third and fourth segments; a switch assembly unit including, a cam follower member which engages said control cam and assumes a position corresponding to the four segments of said control cam, a first switch unit which is held closed when said second segment engages said follower member, and a second switch unit which is held closed when said third segment engages said follower member; and circuit means including, a circuit which is completed by the closing of said first switch unit to connect said wiper in the outgoing circuit so that an impulsing signal is produced to designate the station being called, a second circuit which is completed by the closing of said first switch unit to cause said switch-operating cam to be effective when said follower member engages said second segment, circuit means to form an interlock circuit when said first segment moves out of engagement with said follower member to insure the continuance of the delivery of power to said shaft, and means responsive to the engagement of said follower member by said fourth segment to stop said shaft when said control cam is returned to its initial position.

6. In an automatic telephone system in which a plurality of stations may communicate with each other and in which interconnection is completed by a central selector mechanism including a central selector relay, and wherein said plurality of stations includes an executive station, the combination with said relay of an impulsing mechanism at said executive station to produce a variety of impulse designs in accordance with which said central selector relay connects the calling station to the proper called station, said impulsing mechanism comprising, an impulsing unit which is capable of producing a selected number of impulses of predetermined characteristics, and means connecting said impulsing unit to a line which extends to said central selector

relay and including a plurality of key switches which are connected in series and which are adapted to be individually operated to thereby determine the number of impulses to be produced by said impulsing unit, and a plurality of keys including a key associated with each of said key switches, which key has a key surface upon which appears a notation corresponding to the station which is connected in response to the key being actuated.

7. In a telephone system having a plurality of transmitting and receiving stations in which one station is automatically connected to another, a signal switch mechanism comprising: a rotatable shaft; a first switch-operating cam rigidly mounted on said shaft; a second switch-operating cam rigidly mounted on said shaft; a control cam rotatably mounted on said shaft having four distinct segment portions designated as first, second, third and fourth segments; means imparting an undulant movement to said control cam and deriving its power from said shaft; a switch assembly unit including, a cam follower member which engages said control cam and assumes four distinct positions corresponding to the four segments of said control cam, a first switch unit which is held closed when said third segment engages said follower member, a second switch unit which is closed when said second segment engages said follower member, and third and fourth switch units which are held closed when said fourth segment engages said follower member; and circuit means including, a circuit which is completed by the closing of said second switch unit to cause said first switch-operating cam to be effective when said second segment engages said follower member, a second circuit which is completed by the closing of said first switch unit to cause said second switch-operating cam to be effective when said follower member engages said third segment, and means to form an interlock circuit when said first segment moves out of engagement with said follower member to insure the continuance of the delivery of power to said shaft and to maintain said interlock until said cams are returned to their initial positions.

8. In an automatic telephone system in which a plurality of stations may communicate with each other and in which interconnection is completed by a central selector mechanism including a plurality of central selector relays, said central selector mechanism including a contact assembly and a plurality of pairs of wipers each pair of which is part of one of said central selector relays and is adapted to be moved in step-by-step fashion to successively engage the various pairs of contacts of said contact assembly, said contact assembly comprising a pair of angle-bars between which are mounted a plurality of bridge members of insulating material and a plurality of rods extending parallel to said angle-bars and rigidly supported by said bridge members, the combination with one of said relays of an impulsing mechanism at one of said stations to produce a variety of impulse designs in accordance with which the pair of wiper arms assume a position on said contact assembly.

9. In apparatus of the character described, a contact assembly comprising, a pair of frame members rigidly supported in spaced parallel relationship, a plurality of arcuate bridge members of insulating material extending in parallel relationship between said frame members and having a common axis which is parallel to said frame members, a plurality of contact rods rigidly supported by said bridge members in parallel relationship with respect to said common axis and substantially on a plane which forms a segment of a cylinder, and a plurality of contact clips attached to each of said bridge members and insulated from said contact rods.

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