

United States Patent

[11] 3,604,856

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| [21] | Appl. No. | 828,455 |
| [22] | Filed | May 26, 1969 |
| [45] | Patented | Sept. 14, 1971 |
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[54] **AUTOMATIC DIALING SYSTEM FOR
TELEPHONES**

8 Claims, 8 Drawing Figs.

- [52] U.S. Cl..... 179/90 B
[51] Int. Cl..... H04m 1/26
[50] Field of Search..... 179/90 B,
90 AD, 90 CI, 90 BB

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ABSTRACT: An automatic dialing system for telephones having a plurality of rotatable memory units each of which contains a telephone address, selection means for selecting one of the plurality of memory units, and a dialing switch mechanism

which is rotatable to dial digits, and which is urged towards its rest position by a return spring. The memory units and the dialing switch mechanism are connected to respective first and second outputs of a differential gear mechanism the input of which is driven by an electric motor, and a pawl assembly is associated with the memory units and is operable to prevent rotation of the memory units. A first cam is rotatable with the input of the gear mechanism, and a second cam is rotatable with the first output of the gear mechanism. A cam follower is urged into engagement with the first cam, and is engageable by the second cam, movement of the cam follower operating a switch to control energization of the electric motor driving the input of the gear mechanism. The first cam is provided with a depression which is engageable by the cam follower to break the electric motor circuit and the second cam has a lobe which is engageable with the cam follower to move the cam follower to complete the motor circuit. The cam follower is moved out of engagement with the depression in the first cam to energize the motor, whereafter the cam follower rides on the periphery of the first cam as the first cam rotates, the first cam being rotated through one complete revolution to perform a dialing cycle to dial a single digit. The first and second cams are displaced angularly when a digit is dialed so that at the end of a dialing cycle the motor is deenergized with the lobe of the second cam displaced angularly from the depression in the first cam, and the second cam then being rotated by return movement of the dialing switch mechanism so that subsequently the lobe lifts the cam follower to restart the motor whereafter a further dialing cycle is performed. The dialing system is stopped after the full address has been dialed by performing a cycle at the end of the address in which no digit is dialed, so that the cam follower engages the depression in the first cam fractionally after the lobe of the second cam has past the cam follower.

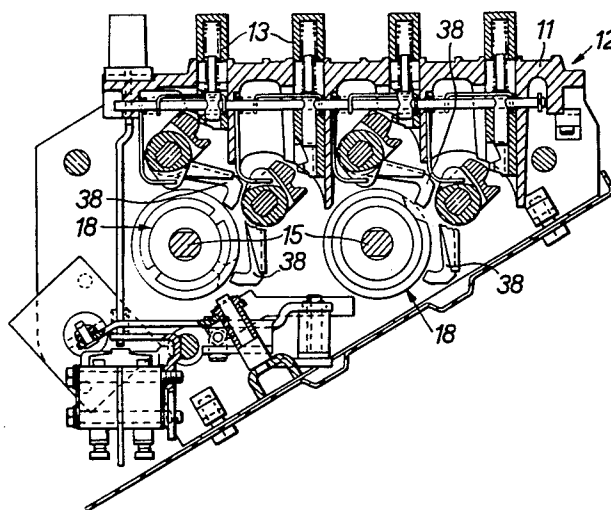


FIG.1.

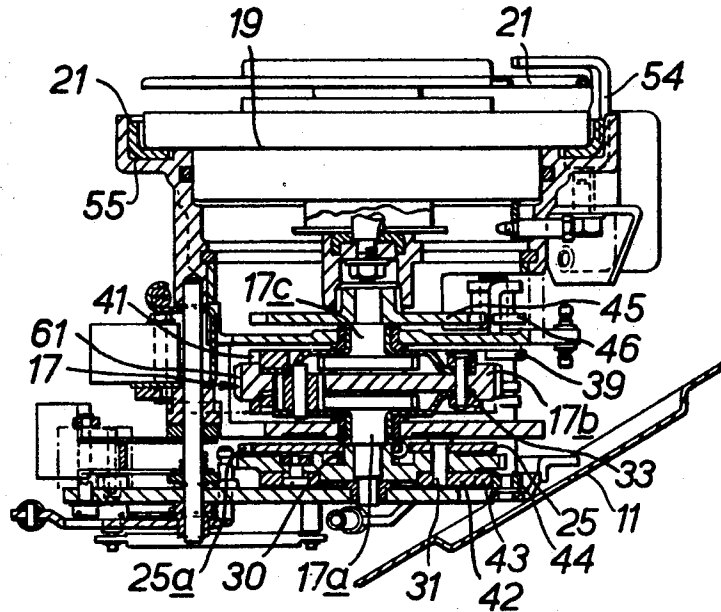
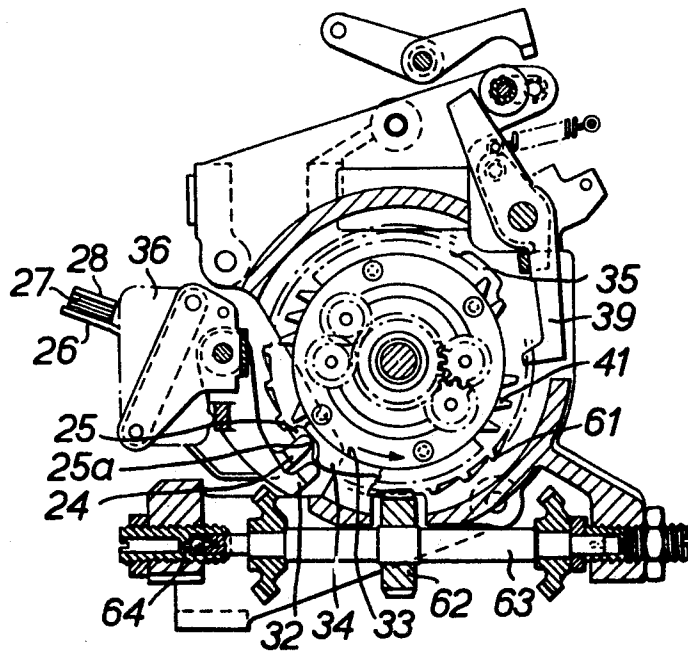
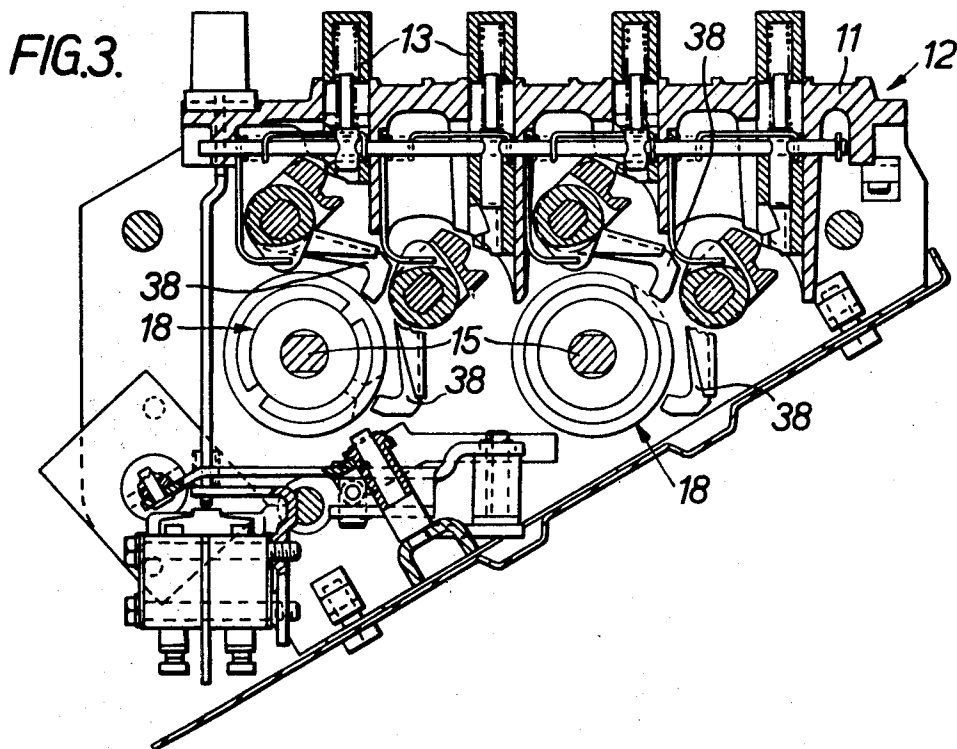
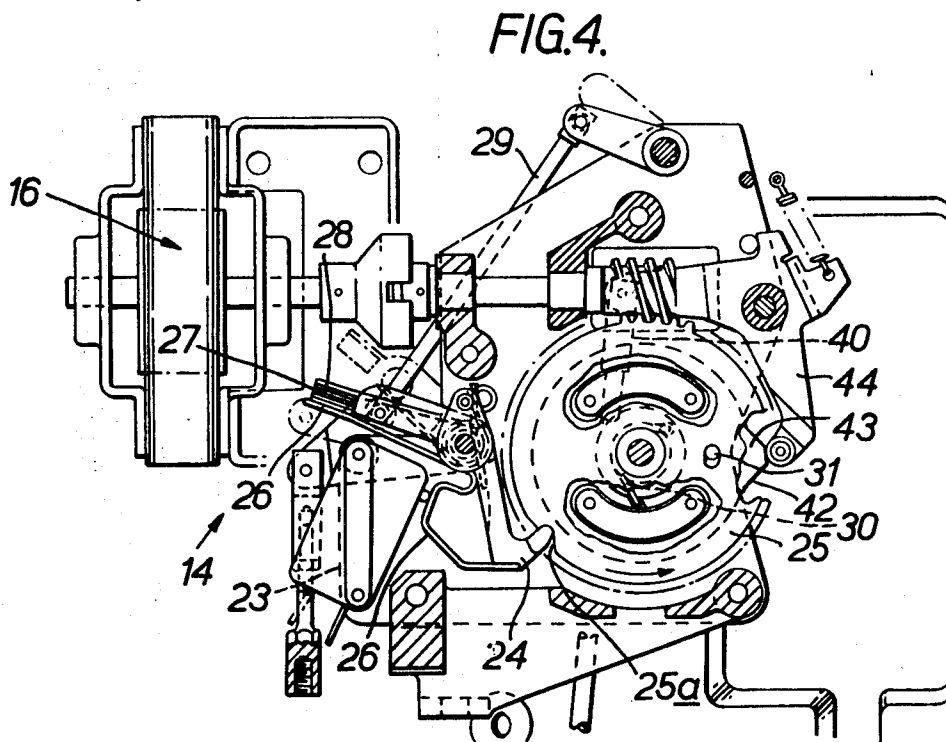


FIG.2.

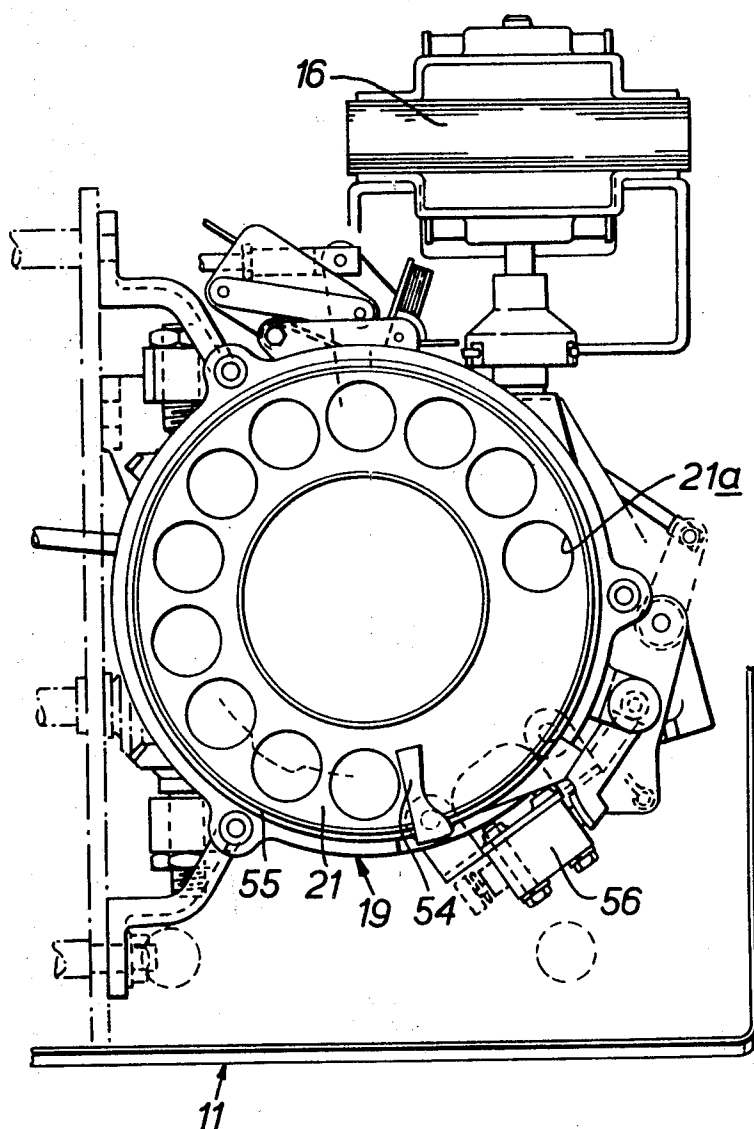


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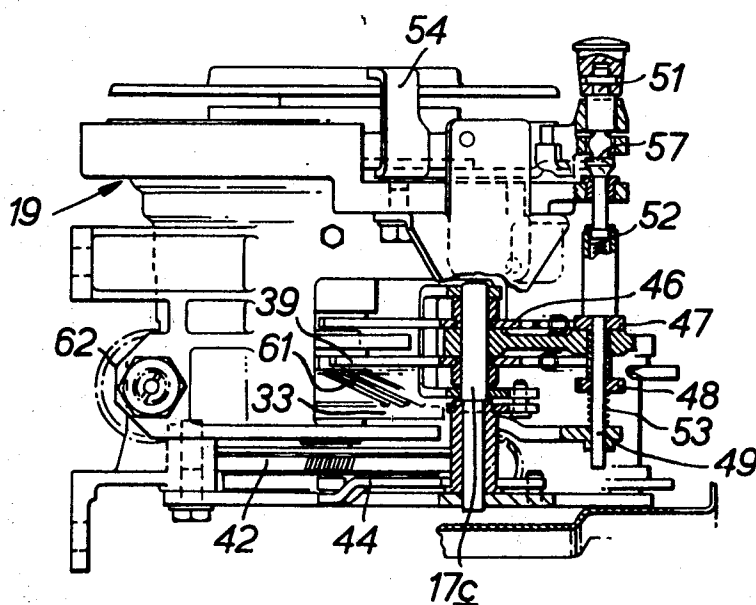
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FIG. 5.

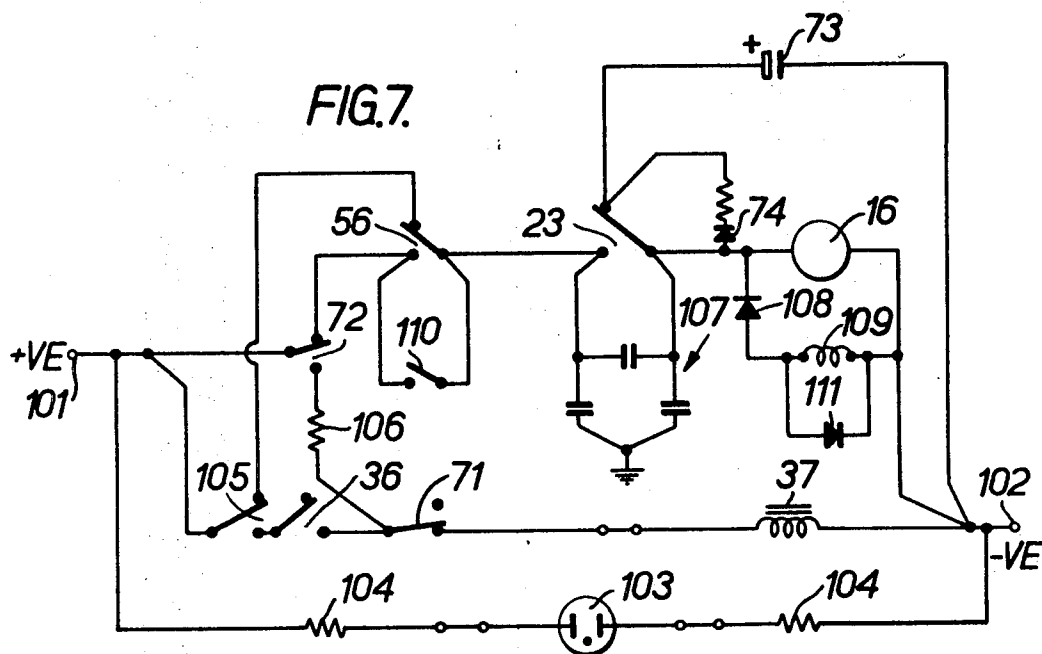
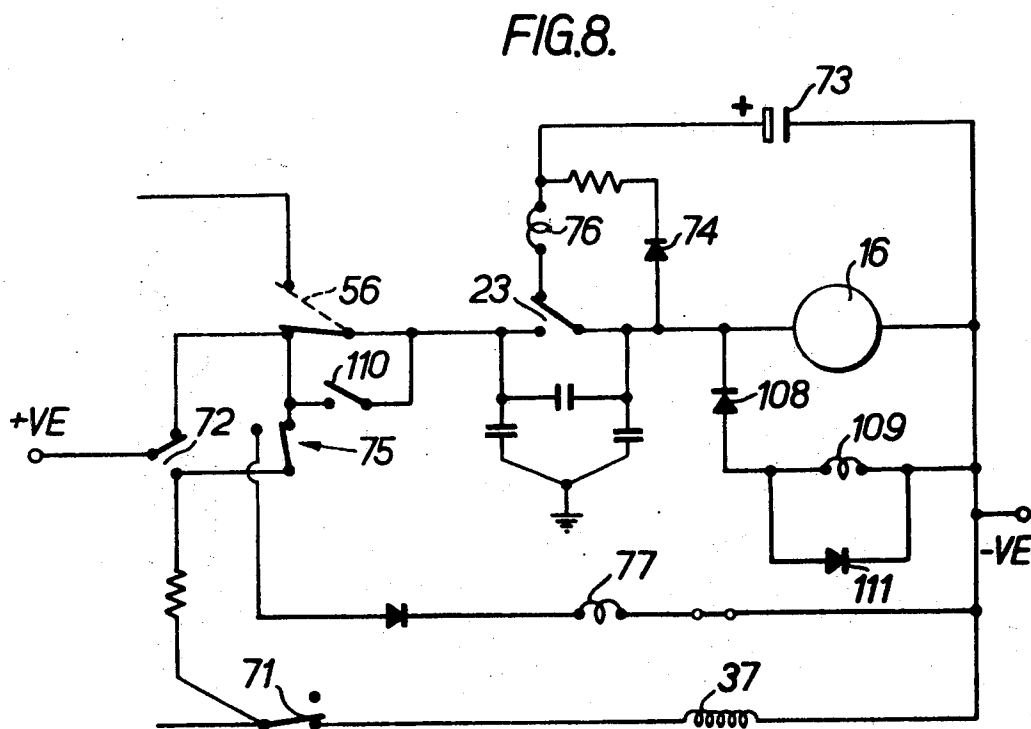


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FIG.6.



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AUTOMATIC DIALING SYSTEM FOR TELEPHONES

This invention relates to automatic dialing systems for telephones.

An automatic dialing system according to the invention includes a plurality of rotatable memory units each of which contains a telephone address, a dialling switch mechanism rotatable from a rest position to any one of a plurality of positions dependent upon the digit to be dialled, and urged towards its rest position by a return spring, selection means for selecting one of said plurality of memory units, a differential gear mechanism having an input driven by an electric motor, a first output coupled to said memory units and a second output coupled to said dialling switch mechanism, a pawl assembly operable to prevent rotation of said memory units, a first cam rotatable with said input of said gear mechanism, a second cam rotatable with said first output of said gear mechanism, a cam follower resiliently urged into engagement with said first cam, and engageable by said second cam, and a switch operable by movement of said cam follower to control energization of said electric motor, said first cam having a depression engageable by said cam follower to permit said cam follower to move in a direction to break the motor circuit and said second cam having a lobe engageable with said cam follower to move the cam follower in a direction to complete the motor circuit and the arrangement being such that in use the cam follower is moved out of engagement with the depression in the first cam so that the motor is energized, whereafter the cam follower rides on the periphery of the first cam as the first cam is rotated, the first cam being rotated through one complete revolution to perform a dialling cycle to dial a single digit, and the first and second cams being displaced angularly when a digit is dialled so that at the end of a cycle the motor is deenergized with said lobe displaced angularly from said depression, the second cam then being rotated by the return movement of the dialling switch mechanism so that said lobe lifts said cam follower out of engagement with said depression to restart the motor whereafter a further cycle is performed, and the system being stopped after the full address has been dialled by performing a cycle at the end of the address in which no digit is dialled, so that the cam follower engages said depression fractionally after said lobe has passed the cam follower and said dialling switch mechanism has not been operated.

One example of the invention is illustrated in the accompanying drawings where:

FIG. 1 is a sectional side view of part of an automatic dialling system,

FIG. 2 is a fragmentary sectional plan view of the part of the system shown in FIG. 1,

FIG. 3 is a fragmentary sectional view of the memory bank of the system,

FIG. 4 is a fragmentary plan view of part of the drive motor control of the system,

FIG. 5 is a fragmentary plan view of part of the apparatus for reprogramming the memory bank,

FIG. 6 is a fragmentary sectional view of a further part of the apparatus shown in Fig. 5,

Fig. 7 is a circuit diagram of the system, and

FIG. 8 is a diagram of part of the circuit of a modification of the system.

Referring first to FIGS. 1 to 6 of the drawings, the dialling system includes a casing memory bank 12 including a plurality of buttons 13 which are depressed to select respective telephone addresses from the memory bank. Coupled to the memory bank is a control and dialling mechanism 14 through which the selected telephone address is automatically dialled.

The memory bank 12 (FIG. 3) includes a pair of memory shafts 15 which are rotated together by an AC mains drive motor 16 through a differential gearing 17, the gearing 17 being such that for each complete revolution of the input 17a of the gearing 17 first output 17b and consequently the memory shafts 15, to which the output 17b is connected, perform half of one revolution. Each memory shaft 15 carries 10

memory units 18 which are axially spaced from one another along the lengths of the shaft 15. One telephone address is contained by each memory unit 18 and the letters and/or digits of the address are each defined by a separate memory disc in the respective unit 18. Thus the preferred embodiment of the system as described herein is capable of retaining and dialling twenty telephone addresses, but it will be appreciated that the number of addresses contained in a system is purely arbitrary and by making the system larger or smaller, more or fewer addresses can be retained.

The gearing 17 has a second output 17c which is drivingly connected to a conventional dialling switch mechanism 19 supported by the top wall of the casing 11 and which will rotate at the same speed as the input 17a. The mechanism 19 includes a dialling disc 21 similar to a conventional dialling disc but having an extra finger hole 21a, and disc 21 is set in a recess 22 in an inclined front wall of the casing 11.

The motor 16 is controlled by a normally open microswitch 23 which when closed energizes the motor. The microswitch 23 is closed in response to movement of a cam follower 24 out of engagement with a cycle cam disc 25 which is rotatable with the input 17a of the gearing 17. The cam follower 24 is supported on a steel carrier 26 and is pivotally mounted for movement towards and away from the cam disc 25 the follower 24 being urged into engagement with the cam disc 25 by resilient means. A permanent magnet 27 is carried by a brass carrier 28 for pivotal movement about the pivotal axis of the follower 24 and engaged with the carrier 28 is a linkage 29 which is movable in response to depression of any of the buttons 13 to select a respective address. Prior to the depression of a button 13 the magnet 27 is engaged with the steel carrier 26 and upon depression of a button 13 the carrier 28 is caused to pivot by the linkage 29.

As the carrier 28 and the magnet 27 move the carrier 26 and the follower 24 are moved with carrier 28 against said resilient means so that the follower 24 is disengaged from a depression 25a in the cam disc 25 and the microswitch 23 is closed to energize the motor 16. The cam disc 25, as previously stated is rotatable with the input 17a of the gearing 17, moreover in addition the cam disc 25 is rotatable relative to the input 17a through a small angular distance. The cam disc 25 is urged to move relative to the input 17a in the direction of movement of the input 17a by a torsion spring 30, and the degree of relative movement between the cam disc 25 and the input 17a is determined by a pin 31 mounted on the input 17a which engages in an arcuate slot in the disc 25.

When the system is in its rest condition with the motor off and the follower 24 is engaged in the depression 25a of the cam disc 25, the spring 30 is stressed and the pin 31 engages the rearward end of the slot in the cam disc 25. However, when the follower 24 is disengaged from the depression 25a the disc 25 moves relative to the input 17a until the pin 31 engages the forward end of the slot in the cam disc 25.

When the follower 24 closes the microswitch 23 the carrier 26 is arrested by engagement with the microswitch. The carrier 26 is arrested before the carrier 28 and the magnet 27 have completed their full range of movement and so the attraction between the magnet 27 and the steel carrier 26 is overcome and the magnet 27 and the steel carrier 26 is overcome and the magnet 27 and the carrier 28 perform the remainder of their travel without the carrier 26. When the magnet 27 is disengaged from the carrier 26 the carrier 26 is free to move under the action of said resilient means to reengage the follower 24 with the cam disc 25. However since the disc 25 is moved relative to the input 17a under the action of the spring 30 when the cam follower was initially disengaged from the disc 25, then the depression 25a is no longer aligned with the follower 24. Thus the follower 24 engages the periphery of the cam disc 25, the movement of the follower 24 into engagement with the periphery of the disc 25 being insufficient to open the microswitch 23. Thus the motor is maintained in an energized condition driving the input 17a of the gearing 17. The follower 24 rides on the disc 25 as the motor 16 drives the

input 17a and the friction between the disc 25 and the follower 24 is sufficient to move the disc 25 back to its original position relative to the input 17a against the action of the spring 30.

Pivotaly mounted for movement about the pivotal axis of the follower 24 is a second cam follower 32 which in the rest condition of the system engages a lobe 34 of a restart cam 33 carried by the output 17b of the gearing 17, the cam 33 being parallel to and coaxial with the cam disc 25. A second microswitch 36 is carried by the steel carrier 26 of the cam follower 24 the switch 36 being operated by relative movement between the cam followers 24, 32. The microswitch 36 is of the normally closed type but is held open in the rest condition of the system. When the button 13 is depressed to start the dialling operation as previously described, the movement of the follower 24 under the action of the linkage 29 is a movement relative to the follower 32 in such a direction that the microswitch 36 is allowed to close. Depression of any of the buttons 13 closes a microswitch (105 FIG. 7) connected in series with the microswitch 36 and a button hold solenoid 37 which when energized by closure of both microswitches acts on the linkage 29 to hold the button 13 depressed.

When the follower 24 is moved out of engagement with the depression 25a in the disc 25, a shoulder 24a on the follower 24 engages the follower 32 so that as the cam 33 rotates and the lobe 34 thereof is moved from beneath the follower 32 the follower 32 can not move towards the periphery of the cam 33 under the action of the contact spring of the microswitch 36.

It will be appreciated that as the input 17a of the differential gear 17 rotates the output 17b is free to rotate and the memory shafts 15 are rotated at half the speed of the input 17a. However the output 17c does not at this stage rotate since the dialling switch mechanism 19 is urged to its rest position by a dialling disc return spring.

Considering now the memory bank 12 when a button has been depressed. The depression of the button 13 moves a respective sensing finger 38 (FIG. 3) into engagement with the periphery of the first memory disc in the memory unit which has been selected by the depressed button 13, and as the memory shafts 15 rotate the finger 38 rides on the periphery of the first memory disc. The finger 38 is urged radially into contact with the memory unit and is also urged in a direction parallel to the respective shaft 15 in a direction towards the last memory disc of its respective memory unit. Each memory disc is spaced from adjacent memory discs in its respective unit by a disclike separator of greater diameter than the diameter of the memory discs and so the finger 38 is maintained in engagement with a particular memory disc by engagement of the finger with a separator. In order that the finger can progress step by step along its respective unit each separator is formed with a slot through which the finger 38 can pass and the slots in adjacent separators are spaced from each other around the unit by 180° so that the finger 38 cannot bypass a memory disc in the address contained in the unit.

When the shafts 15 start to rotate the slot in the separator between the first and second memory discs is spaced by 180° around the memory unit from the point at which the finger 38 engages the first memory disc. Moreover between said point and the slot in the separator the memory disc is itself formed with a slot into which the finger 38 will be urged radially when the slot registers with the finger.

As the input 17a rotates the output 17b is driven at half the speed of the input 17a as described, and so the restart cam 33 is rotated at half the speed of the cycle cam disc 25. Thus the lobe 34 of the cam 33 is being moved away from the original position of the follower 32 and a second lobe 35, spaced around the cam 33 by 180° from the lobe 34 is being moved towards that position. The lobe 35 is of greater arcuate length than the lobe 34, for a reason to be explained later and moreover the follower 24 is such that it can be engaged by the lobes 34, 35 of the cam 33.

The output 17b continues to be rotated by the input 17a until the finger 38 engages the slot in the first memory disc

whereupon the radial movement of the finger 38 is transmitted via a linkage 40 to move a pawl 39 into engagement with a toothed escapement wheel 41 carried by the output 17b, parallel and coaxial with the restart cam 33. The engagement of the pawl 39 with the escapement 41 locks the output 17b and consequently the shafts 15 and the cam 33 against rotation and since the input 17a of the gearing 17 is still being driven by the motor 16, the output 17c is driven. Thus the dialling switch mechanism 19 is driven against the action of its return spring until the input 17a has performed one complete revolution from its start position when the button 13 was depressed, whereupon the depression 25a of the cam disc 25 registers with the cam follower 24, and the cam follower 24 moves under the action of said resilient means into engagement with the depression 25a and the motor 16 is deenergized by opening of the microswitch 23.

It will be appreciated that since neither of the lobes 34, 35 of the cam 33 are beneath the cam follower 32 when the follower 24 moves into depression 25a then the follower 32 is maintained in engagement with the shoulder 24a of the follower 24 by the contact spring of the microswitch 36, the microswitch 36 remaining in its normally closed position so that the depressed button 13 is not released.

Simultaneously with the registry of the depression 25a in the cam disc 25 with the follower 24, a lobe 43 of a kicker cam 42 carried by the input 17a engages and lifts a cam follower 44. The cam 42 is parallel to and concentric with the cam disc 25 and the follower 42 when lifted kicks the pawl 39 out of engagement with the escapement wheel 41 and through the action of the pawl 39 kicks the finger 38 out of the slot in the first memory disc, thereby freeing the output 17b and consequently the memory shafts 15 for rotation.

The motor 16 is now in its deenergized condition and so the input 17a of the gearing 17 is locked. However, the dialling switch mechanism has been rotated through part of a revolution corresponding to the first letter digit of the selected address and the output 17b is free to rotate. Thus the output 17b is driven by the dialling switch mechanism 19 as the dialling switch mechanism returns to its rest position under the action of the dial switch return spring. As the mechanism 19 returns to its rest position, pluses corresponding to the digit dialled are transmitted to the telephone exchange through the telephone line which was opened by depressing the button 13. Moreover, the return movement of the dialling switch mechanism 19 is transmitted through the gearing 17 to the output 17b and the shafts 15 and consequently the memory units are rotated through the remaining part of their half revolution corresponding to the complete revolution which was made by the input 17a.

As the output 17b completes its half revolution the slot in the first separator of the memory unit is brought into registry with the finger 38 which is again riding on the periphery of the first memory disc, and moreover the lobe 35 of the cam 33 is brought into register with the cam follower 24. The lobe 35 of the cam 33 lifts the follower 24 to start the motor again as the finger 38 passes through the slot in the first separator onto the periphery of the second memory disc. Thus the cycle is repeated for the second and subsequent memory discs the letters and digits being dialled in sequence.

When the system stops, after the selected address has been dialled, it is important that the shafts 15 stop in datum position wherein the slots in the first separators of each memory unit are positioned by 180° around the unit from the point at which the respective finger 38 will engage the unit when the respective button 13 is depressed. The return of the shafts 15 to their datum positions is achieved by making the lobe 35 of the cam 33 of longer arcuate length than the lobe 34 as described above and by the provision of one or two blank memory discs after the last digit defining memory disc in each memory unit. A blank memory disc is best considered as a memory disc which does not have a slot into which the respective finger 38 can be urged and if the total number of letters and digits in the address is an odd number then the respective memory unit will

require only one blank memory disc whereas if the total is an even number two blank memory discs are required as explained below. As is also explained below the blank memory discs are not in practice discs without slots, however, the final disc in each memory unit is in fact a plain unslotted disc.

Assuming that the selected address has an odd total of letters and digits then as the respective finger 38 passes through the slot in a separator between the last digit defining memory disc and the blank memory disc the shafts 15 will be 180° of rotation from their datum positions and the motor 16 will be restarted by the lobe 35 of the cam 33 lifting the follower 24 out of the depression 25a in the cam disc 25. Thus the system will commence a cycle with the finger 38 riding on the blank memory disc and the lobe 34 of the cam 33 approaching the position of the follower 24. It will be realized that at the end of this cycle the shafts 15 will be in their datum positions.

Since the finger 38 cannot engage a slot in the blank disc the output 17b will not be arrested and no dialling will take place. The input 17a will continue to rotate as before through one complete revolution in which time the output 17b will be completing one-half of the revolution. As the depression 25a in the cam disc 25 approaches the follower 24 the lobe 34 of the cam 33 will be approaching the cam follower 32 which is positioned further round the circle of revolution of the cam 33 and cam disc 25 than the cam follower 24. Although the depression 25a is moving at twice the speed of the lobe 34 the arrangement is such that the lobe 34 passes beneath the follower 24 before the follower 24 and the depression 25a register.

It is vital to the operation of the system that the follower 24 is not disengaged from the cam disc 25 at this stage since the cam disc 25 would then be advanced rapidly by the torsion spring 30. For this reason the lobes 34, 35 of the cam 33 are so dimensioned that they describe circles of slightly smaller radius than the part of the cam disc 25, which precedes the depression 25a.

Thus the lobe 34 passes under the follower 24 and owing to the relative speeds of the cam disc 25 and the cam 33 as the lobe 34 passes under the follower 32 the depression 25a registers with the follower 24. The follower 24 is now urged into the depression 25a by said resilient means to stop the motor as before. However, the lobe 34 of the cam 33 is now engaged by the follower 32 and the follower 32 is thereby prevented from moving with the follower 24. The resilient means acting on the follower 24 is stronger than the contact spring of the microswitch 26 and so relative movement occurs between the arrested follower 32 and the follower 24 so opening the microswitch 36, deenergizing the solenoid 37 and allowing the depressed button 13 to return to its original position. Thus the system stops with the shafts 15 in their datum positions.

Assuming now that the selected address contains an even total of letters and digits then when the last digit has been dialled the shafts 15 will be at their datum positions but the system will not stop because lobe 34 of the cam 33 will restart the motor. Thus the system will complete one cycle on the first blank disc whereupon the shafts 15 will be 180° from their datum. In order to ensure that the shafts 15 are returned to their datum the lobe 35 of the cam 33 is made sufficiently long to prevent the follower 24 engaging the depression 25a and a second blank memory disc is inserted into the memory unit. Thus, since the system cannot switch off when the shafts are 180° from their datum position because of the elongated lobe 35, the system performs a second blank cycle with the finger 38 riding on the second blank memory disc. Thus the shafts 15 are brought back to their datum position and the system is switched off as explained above.

The system is provided with a cancelling facility so that in the event that the wrong button 13 is pressed the system can be returned to its rest position without having to dial the wrong address.

The cancelling facility includes a normally closed switch (71 FIG. 7) which is manually operable to deenergize the solenoid 37. Upon deenergization of the solenoid 37 the memory

bank is returned to its rest condition with the exception that the shafts 15 are rotating. However, since the respective finger 38 is not engaged with the respective memory unit the system will progress as if the finger 38 were riding on a blank memory disc, and will switch off after one or two cycles depending on the position of the lobes 34, 35 of the cam 33 when the cancelling switch was operated.

It will be appreciated that the system as described above will commence dialling an address immediately a button 13 is depressed. The system has been described in this manner in the interests of simplicity and it will be realized that in practice a short delay is required before dialling is commenced, wherein an external telephone line is opened. The system is provided with a tone monitor equivalent to the ear piece of a normal telephone receiver and through which dialling tone is audible, and in order to delay dialling until the dialling tone is heard there is provided a further microswitch 72 (FIG. 8) operable by the buttons 13 and associated with the microswitch 23. The further microswitch has a first stable position in which it completes a circuit from the electrical supply to the microswitch 23 so that the microswitch 23 controls operation of the motor 16, and a second, unstable position in which said circuit to the microswitch 23 is broken and a circuit to the solenoid 37, through a resistor 106 (FIG. 7) is completed. Initial movement of any one of the buttons 13 moves said further microswitch to said second, unstable position, so that subsequent closure of the microswitch 23 does not energize the motor. Further depression of the button 13 does not affect said further microswitch 72 since the microswitch is coupled to the buttons 13 through a follow up linkage. However, since the circuit to the solenoid 37 is completed through a resistor the solenoid 37 is energized and so aids the action of the operator by urging the button 13 towards its depressed position. When the button 13 is fully depressed the line to the telephone exchange is selected and after a short delay the dialling tone will be heard via the tone monitor as the telephone line opens. The button 13 is held fully depressed until the dialling tone is heard whereupon the button is released and moves outwardly through a small distance to the depressed position in which it is held by the solenoid 37. By virtue of the follow up linkage the small amount of outward movement of the button 13 is sufficient to permit said further microswitch 72 to return to its first, stable position so that the circuit to the now closed microswitch 23 is reestablished and the motor 16 is energized to commence dialling. The arrangement of the follow up linkage and said further microswitch is such that subsequent depression of the button 13 to its fully depressed position from the position in which it is held by the solenoid 37 does not affect the system.

In order to program or reprogram the memory units in the memory bank there is provided a resetting facility in the system. The memory disc in each memory unit are rotatable on their respective memory shafts 15 but during dialling the memory discs are held in their preset positions by friction between the memory discs and the separators, each memory unit being compressed axially by a spring. The output 17c of the gearing 17 carries a ratchet wheel 45 which is coaxial with the escapement wheel 41 of the output 17b and engageable with the wheel 45 is a pawl 46 which is mounted for pivotal movement about the pivotal axis of the pawl 39. As previously described the pawl 39 is movable into engagement with the wheel 41 by the engagement of a finger 38 in 38 is spring urged into engagement with the wheel 45 but except during a resetting sequence the pawl 46 is held out of engagement with the wheel 45 by a blocking piece 47.

The block piece 47 and a second blocking piece 48 associated with the pawl 39 are carried by a resetting rod 49 which is slidably mounted in the casing 11. Engaged with the rod 49 through a spring motion spring 52 is a push rod 51 which projects from the casing 11 adjacent the dialling disc 21. The rod 49 is urged by a spring 53 to a position wherein the blocking piece 48 engages and prevents movement of the pawl 39 but the spring 52 is stronger than the spring 53 and

when the rod 51 is in a depressed position in which it is held by a spring loaded detent the rod 51 holds the rod 49 against the action of the spring 53 in a position wherein movement of the pawl 46 into engagement with the wheel 45 is blocked by the blocking piece 47.

As previously stated the dialling switch mechanism 19 is substantially conventional. However, the finger stop 54 of the dialling disc 21 is mounted on a bezel 55 which is rotatable about the axis of the dialling disc 21. A normally open microswitch 56 is mounted on the bezel 55 and the contact spring of the microswitch 56 urges the bezel to a position wherein the microswitch is open. The microswitch 56 is connected in series with the motor start microswitch 23 and when the rod 51 is in its depressed position a cam form 57 on the rod 51 holds the bezel 55 in a position wherein the microswitch 56 is closed, so that the motor start microswitch 23 controls the motor 16 as described above. Moreover, a further linkage associated with the buttons 13 operates an interlock when any of the buttons 13 are depressed, the interlock serving to maintain the rod 49 in the position it occupies at the instant the button 13 is depressed.

The operation of the resetting facility is as follows. Assuming that the system is in its switched off condition after dialling an address, then the kicker cam follower 44 will be engaged with the lobe 43 of the kicker cam 42.

The rod 51 is moved outwardly manually from its depressed position to a raised position in which it is held by said detent, and in so doing the rod 49 is released to move under the action of the spring 53 to unblock the pawl 46 and to block the pawl 39. The kicker cam follower 44 acts on both the pawl 39 and the pawl 46 and so both pawls are in kicked out position and the block pieces 47, 48 can freely assume their respective positions. The movement of the rod 49 also releases the bezel 55 for movement under the action of the contact spring of the microswitch 56 in the opposite angular direction to the dialling direction of the dialling switch mechanism 19 so that the microswitch 56 is opened. The button 13 corresponding to the memory unit to be reprogrammed is then depressed and the solenoid 37 is energized as before. The microswitch 23 is closed as before but the motor 16 does not start because the microswitch 56 is open. The letter or digit to be programmed onto the first memory disc is then dialled in the normal manner on the dialling disc 21. Since the input 17a of gearing 17 is stationary the dialling movement causes the output 17b and the shafts 15 to be rotated in the reverse direction to that in which they move under the action of the motor 16, the finger 38 being held out of engagement with the first memory disc of its respective memory unit by the kicker cam follower 44 and the kicker 42. Thus the lobe 34 of the cam 23 is moved relative to the depression 25a in the cam disc 25. As the dialling movement is completed the finger stop 54 on the bezel 55 is moved by the finger of the operator in a direction to close the microswitch 56 and upon closure of the microswitch 56 the motor 16 will start because the microswitch 23 is already closed. As the motor 16 starts the lobe 43 of the kicker cam 42 is disengaged from the kicker cam follower and the pawl 46 is thereby allowed to engage the ratchet wheel 45 to lock the output 17c of the gearing 17 and consequently the dialling switch mechanism 19 in the dialled position. Electrical interlock means 109, 110 (FIG. 7) is provided to maintain the electrical connection to the motor 16 while the dialling switch mechanism 19 is locked, but it will be appreciated that a mechanical latch could be utilized if desired. Thus the motor 16 operates and the input 17a of the gearing 17 begins to rotate for one complete revolution, that is to say until the depression 25a in the cycle cam 25 again registers with the cam follower 24.

As the motor 16 turns the input 17a through one complete cycle the shafts 15 are being rotated through one half of one revolution starting from the point rearward from their datum positions to which they were moved by the dialling movement. In the foregoing description the memory discs are described as having one slot but in fact each disc has a pair of diametrically

opposite slots only one of which can be engaged by the respective finger 38 during dialling since the memory units are rotated through half of one revolution for each digit to be dialled. The arrangement of the kicker cam follower 44 with respect to the pawl 39 and the finger 38 is such that although the pawl 39 is blocked by the blocking member 48, from engaging the escapement wheel 41 the sensing finger 38 can move into engagement with a slot in the memory disc under the action of a spring (not shown) at any time during the input revolution, provided that the lobe 43 of the kicker cam 42 is disengaged from the follower 44. The movement of the finger 38 is permitted by a lost motion connection in the linkage 40, which is arranged in such a manner that when the finger 38 is riding on the periphery of the memory disc and the lobe 43 of the kicker cam disengages from the follower 44 then the follower 44 moves inwardly of the cam 42 and lost motion occurs in the linkage 40. Thus when the finger 38 engages the slot in the memory disc the lost motion is taken up so that outward movement of the follower 44 by engagement by the lobe 43 kicks the finger 38 from the slot in the memory disc. During the half revolution of the output 17b one of the slots in the first memory disc will be engaged by the finger 38 and since the pawl 39 cannot engage the escapement wheel 41 the output 17b and the shafts 15 will continue to rotate. The first memory disc cannot rotate with the respective shaft 15 because the finger 38 is engaged in one of the pair of slots in the memory disc and so the shaft 15 and consequently the restart cam lobes 34, 35 are moved relative to the slot in the memory disc. Thus the first memory disc has now been reprogrammed to the digit dialled on the dialling disc 21, and the dialling switch mechanism 19 is still locked in the dialled position.

As the input 17a of the gearing 17 completes one revolution the cam follower 24 engages the depression 25a in the cycle cam 25 and the motor 16 is stopped. It will be appreciated that since neither of the lobes 34, 35 of the restart cam 33 is below the follower 32 the follower 32 will move with the follower 24 and the solenoid 37 will be maintained energized. Simultaneously with the stopping of the motor 16 the kicker cam 42 will, through the kicker cam follower 44, lift the pawl 39 out of engagement with the ratchet 45 and lift the sensing finger 38 out of engagement with the slot in the first memory disc. The release of the ratchet 45 allows the dialling switch mechanism 19 to return under the action of its return spring to its rest condition and also opens the microswitch 56. Since the input 17a of the gearing 17 is now stationary the return movement of the dialling switch mechanism 19 will drive the shafts 15 through the output 17b to a position corresponding to the completion of one-half revolution from their datum positions. As the output 17b completes the movement under the return action of the mechanism 19 the lobe 35 of the cam 33 will engage and lift the follower 24, thereby allowing the cam disc 25 to advance, under the action of its torsion spring 30, relative to the input 17a and closing the microswitch 24. The motor 16 is not energized by closing of the microswitch 23 since the microswitch 56 is again open.

At the completion of the movement of the output 17b the lobe 35 is supporting the follower 24 and the follower 24 is supporting the follower 32 and so no relative movement of the followers 24, 32 has taken place and the button hold solenoid 37 is maintained energized. The finger 38, is now aligned with and passes through the slot in the first separator and so the finger 38 positions itself on the second memory disc. The system is now ready to program the second memory disc in the same manner as the first memory disc was programmed. At the completion of the programming of the second memory disc it is the lobe 34 of the cam 33 which lifts the followers 24, 32 to close the microswitch 23 and as the follower 24 is lifted the cam disc 25 advances as described so that when the lobe 34 halts beneath the follower 32 the follower 24 will be engaged with the periphery of the cam disc 25 and so again the relative movement between the followers 24, 32 which is required to deenergize the button hold solenoid 37 cannot occur.

Where applications require a pause in the dialling sequence of duration longer than the dial return time, a memory disc can be programmed, at the required point in the dialling sequence, so that the system runs through a dialling cycle without any impulses being supplied to the exchange. The pause memory disc is programmed in the same manner as the address memory disc but the dialling disc 21 is moved through a distance insufficient to operate the dialling switch, and the extra finger hole 21a in the dialling disc 21 is positioned accordingly. Thus when the system is dialling an address the digits before the pause will be dialled and then the pause will be dialled. Since the pause memory disc is programmed in just the same way as the memory discs which control the dialling of the digits, then, the dialling system will subsequently dial the remainder of the address but the exchange will receive the required pause between the digits.

As previously stated a blank memory disc is best considered as a disc without a slot, but it will be appreciated that it is inefficient to provide more than one unslotted disc at the end of each memory unit since unslotted discs can never be programmed so as to be included in an address. Moreover, it will further be appreciated that the system would recognize a slotted memory disc, so positioned that the respective sensing finger 38 would engage the slot at the same time as the finger 38 is being kicked out of the slot by the kicker cam 42, as a blank memory disc. Thus in practice where an address contains at least two less letters and digits than the total number of memory discs available then the one or two memory discs following the last digit-containing memory disc are programmed to constitute blank discs. However, it will be appreciated that should the address require all of the available memory discs or should the address contain an even total number of letters and digits which is only one less than the total number of available discs then means must be provided for allowing the system to complete its dialling cycle with the shafts 15 in their datum position. Thus in addition to the memory discs each memory unit includes a plain unslotted disc which is positioned at the finish end of the unit, and moreover positioned adjacent the plain disc is an unslotted separator. It will be appreciated that the plain disc can never be programmed and that the system can perform its end of address routine, that is to say to one or two cycles of the system, to return the shafts 15 to their datum position, with the finger 38 riding on the plain disc. Since the last separator is unslotted, the finger 38 can never progress along the memory unit beyond the plain disc.

Assuming that the whole of the address has been reset then the system will be stationary with the respective finger 38 engaged with the memory disc after the last memory disc of the address. The system will not be in its rest condition but will be in the condition it was in after the first memory disc was reset, that is to say the microswitch 23 will be closed and the system will be awaiting closure of the microswitch 56 before it can perform a further cycle. In order to return the system to its rest condition and to set up the correct number of blank memory discs after the address in the respective memory unit, the push rod 51 is moved manually to its depressed position. Since the respective button 13 is still depressed the resetting rod 49 is locked in position by the action of said interlock on the blocking piece 48 and so the push rod 51 is moved relative to the resetting rod 49 against the action of the spring 52. During the depression of the rod 51 the cam form 57 on the rod 51 moves the bezel 55 to a position wherein the microswitch 56 is closed and so the motor 16 is energized to drive the input 17a of the gearing 17.

The input 17a will now rotate through one complete cycle as before but since the dialling switch mechanism 19 has not been moved and is held by its return spring in the rest position the shafts 15 will start to rotate from their datum positions or from position 180° away from their datum positions and during the half of one rotation of the shafts 15 corresponding to the complete cycle of the input 17a the finger 38 will engage in the slot of the memory disc and the memory disc will be held stationary relative to the shafts until the finger 38 is

kicked out of the slot in the memory disc at the end of the cycle of the input. Thus the memory disc will be so positioned as to constitute a blank memory disc for subsequent dialling operations. If, at the commencement of the setting of the blank disc, the total number of programmed memory discs was an odd number then at the termination of the cycle the lobe 34 of the restart cam 33 will pass under the cam follower 24 and will come to rest under the cam follower 32. Thus the follower 24 will engage the depression 25a in the cycle cam 25 and the follower 32 will engage the lobe 34 of the cam 33 so that relative movement occurs between the followers 24, 32. The movement of the follower 24 opens the microswitch 23 to stop the motor 16 and the relative movement between the followers 24, 32 opens the microswitch 36 so that the button hold solenoid 37 is released and the depressed button 13 is allowed to return to its original condition. The return of the button 13 moves the interlock 59 so that the rod 49 can move under the action of the spring 52 against the action of the weaker spring 53 to the position wherein the pawl 39 is again free of the blocking piece 48 and the pawl 46 is held out of engagement with the escapement wheel 45 by the blocking piece 47. Thus the system is ready to perform dialling operations once again.

However, if at the commencement of the setting of the blank memory disc the total number of the programmed memory discs was an even number then at the termination of the cycle the lobe 35 of the cam 33 would have prevented the cam follower 24 engaging the depression 25a in the cam disc 25 and the system would then have continued for a second cycle wherein a second memory disc would have been set to a blank condition, after which the system would have returned to its rest condition. Thus the system itself determines whether one or two blank memory discs are required, and always stops with the memory shafts 15 in their datum position.

The differential gearing 17 is in the form of an epicyclic gear, the input 17a and the output 17c being sun gears and the output 17b being the planet carrier. The external periphery of the planet carrier defines a helical spur gear 61 (FIG. 2) and the drive from the gear 61 to the shafts 15 is through helical spur gear 62 engaged with gear 61 and a shaft 63 on which the gear 62 is mounted.

The memory bank 12 and the control and dialling mechanism 14 are built, in practice as separate units and so that the alignment between the bank 12 and the mechanism 14 is adjustable, the shaft 63 is supported at its end remote from the bank 12 by an adjustable combination bearing 64 carried by the casing 11.

FIG. 7 illustrates the electrical circuit of the system with the exception of the conventional circuitry connecting the dialling switch mechanism and the telephone instrument to the telephone exchange.

The system includes a pair of terminals 101, 102 which are connected in use to an AC mains supply (not shown). Connected between the terminals 101, 102 is a discharge lamp 103 and a pair of resistor 104, the resistors 104 being in series with the lamp 103 on opposite sides of the lamp. The lamp 103 is mounted on the casing 11 of the system in a prominent position and is illuminated when the AC supply is switched on, and thereby indicates that the system is live. The microswitch 105 is a single pole two-way switch, and the movable contact of the microswitch 105 is connected to the terminal 101. One of the fixed contacts of the microswitch 105 is connected to movable contact of the microswitch 36, while the fixed contact of the microswitch 36 is electrically connected through the normally closed switch 71 and the winding of the solenoid 37 to the terminal 102. As described above, the microswitch 105 completes the circuit to the microswitch 36 when any one of the buttons 13 is in its depressed position. The microswitch 72 which is also operated by depression of any one of the buttons 13 is also a single pole two-way microswitch. The movable contact of the microswitch 72 is connected to the terminal 101, and one of the fixed contacts of the microswitch 72 is electrically connected through a resistor 106 to the movable

contact of the normally closed switch 71. The microswitch 56, which is controlled by the bezel 55 of the dialling switch mechanism is a single pole two-way switch, and the second fixed contact of the microswitch 72 is electrically connected to one of the fixed contacts of the microswitch 56. The other fixed contact of the microswitch 56 is electrically connected to the second fixed contact of the microswitch 105, and the movable contact of the microswitch 56 is electrically connected to a first fixed contact of the microswitch 23 which is also a single pole two-way switch. The movable contact of the microswitch 23 is electrically connected through the motor 16 to the terminal 102, and the second fixed contact of the microswitch 23 and the terminal 102 are bridged by an electrolytic capacitor 73. The first fixed contact, and the movable contact of the microswitch 23 are bridged by a suppressor unit 107 which as shown, includes three capacitors. The suppressor unit 107 minimizes the danger of burning of the first fixed contact and the movable contact of the microswitch 23, and as will be appreciated, the unit 107 could be replaced by a single capacitor of appropriate rating. Connected between the second fixed contact of the microswitch 23 and the motor 16 is a diode 74 and a resistor in series. The diode 74 is so orientated that when the circuit to the motor 16 through the first fixed contact and the movable contact of the microswitch 23 is completed then the capacitor 73 is charged through the diode 74 and the resistor. Thus, when the movable contact of the microswitch 23 engages the second fixed contact thereof, the capacitor 73 discharges through the motor 16 to effect dynamic braking of the motor 16. Bridging the motor 16 is a diode 108 having in series therewith the winding 109 of a relay. The normally opens contacts 110 of the relay bridge the first fixed contact and the movable contact of the microswitch 56, and the relay including the winding 109 and the contacts 110 constitute the electrical means referred to previously for maintaining the electrical connection to the motor 16 while the dialling switch mechanism 19 is locked. The diode 108 is so orientated that the winding 109 does not short circuit the motor 16 during discharge of the capacitor 73. The winding 109 is itself bridged by a diode 111, the diode 111 serving to minimize chattering of the relay.

In an alternative construction the telephone instrument is positioned on the casing 11 covering the dialling disc 21. In this arrangement the resetting rod 51 is held in its depressed position by the telephone instrument and is moved to its raised position by a spring when the telephone instrument is moved to expose the dialling disc 21, the spring-loaded detent being dispensed with.

Where the dialling system is to be incorporated into PABX telephone system then the required pause for an external line to be opened after the access digit has been dialled can be achieved either by programming a pause memory disc between the access digit and the remainder of the address or, by electrical means.

One convenient electrical arrangement for providing a pause after the access digit is as follows. In the system as described above it is essential that the motor 16 stops immediately the supply circuit to the motor is broken. The motor 16 is a squirrel cage AC powered motor and in order to stop the motor immediately the supply circuit is broken a DC pulse is applied to the motor as the AC supply is broken. The DC is supplied by an electrolytic capacitor 73 (FIG. 8) which is charged through a diode 74 by the AC supply when the motor is running. Opening of the microswitch 23 to stop the motor 16, closes a second set of contacts in the microswitch 23 to connect the capacitor 73 to the motor so that the capacitor discharges through the motor 16 thereby causing dynamic braking of the motor.

In order to provide the pause facility after an access digit has been dialled there is provided an impulse-hold relay 75 (FIG. 8), that is to say a relay which is switched by a pulse through a first winding 76 and thereafter held in the switched position by current flow in a hold winding 77 until the circuit through the hold winding is broken whereafter the relay

switches back. As shown in FIG. 8, in the first, stable position of the microswitch 72 the circuit from the supply to the microswitch 23 is completed through the microswitch 72. In the second, unstable position of the microswitch 72 the solenoid 37 is energized and a circuit is completed to the microswitch 23, through a first contact of the relay 75 which is in its rest position. The winding 76 of the relay 75 is connected in series with the capacitor 73 and hold the winding 77 of the relay 75 is connected to a second contact of the relay 75, said second contact being engaged by the movable contact of the relay when the relay 75 is energized. Thus when a button 13 is depressed, the microswitch 72 completes a circuit to the microswitch 23 through the relay 75 which is in its rest position. The microswitch 23 is closed by depression of the button 13 and so the motor 16 is energized and the system dials the first letter or digit of the address, the first letter or digit being the access letter or digit which connects the PABX telephone system to the external exchange. While the access letter or digit is being dialled the button is manually held fully depressed, and so the microswitch 72 is held in its second position.

During dialling the access letter or digit the microswitch 23 will open as described above, thereby deenergizing the motor 16 and connecting the capacitor 73 to the motor 16. The capacitor 73 discharges through the winding 76 and the motor 16 thereby achieving dynamic braking of the motor 16 and energizing the relay 75 so that relay switches, breaking the circuit from the microswitch 72 to the microswitch 23 and completing a circuit through the winding 77. Thus the relay 75 will remain in its switched position until the supply to the winding 77 is broken. Since the microswitch 72 is still held manually in its second position and the relay 75 is in its switched position then when the microswitch 23 closes in readiness for dialling the next letter or digit, the motor 16 will not be energized and so no dialling will take place until the circuit to the motor 16 is completed at the microswitch 72. However, the access letter or digit has been dialled and so an external telephone line will be opened.

The opening of the external telephone line is not instantaneous and so the button 13 is held depressed by the operator until the operator hears the dialling tone, whereupon he knows that the external part of the telephone address can safely be dialled. Upon hearing the dialling tone the operator releases the button 13 which then is restored to the position in which it is held by the solenoid 37. The microswitch 72 returns to its first, stable position thereby completing the circuit to the motor 16 so that the system starts to dial the first letter or digit after the access digit and the relay 75 returns to its rest position.

When the microswitch 72 returns to its first, stable position the circuit through the microswitch 72 to the winding 77 is broken. However, since the switches 105 and 36 are closed the winding 77 is still supplied with current through the resistor 106 and so the relay 75 remains in its switched position until the address has been dialled whereupon the switch 36 opens thereby deenergizing the winding 77.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An automatic dialling system for telephones including a plurality of rotatable memory units each of which contains a telephone address, a dialling switch mechanism rotatable from a rest position to any one of a plurality of positions dependent upon the digit to be dialled, and urged towards its rest position by a return spring, selection means for selecting one of said plurality of memory units, a differential gear mechanism having an input driven by an electric motor, a first output coupled to said memory units and a second output coupled to said dialling switch mechanism, a pawl assembly operable to prevent rotation of said memory units, a first cam rotatable with said input of said gear mechanism, a second cam rotatable with said first output of said gear mechanism, a cam follower resiliently urged into engagement with said first cam, and engageable by said second cam, and a switch operable by move-

ment of said cam follower to control energization of said electric motor, said first cam having a depression engageable by said cam follower to permit said cam follower to move in a direction to break the motor circuit and said second cam having a lobe engageable with said cam follower to move the cam follower in a direction to complete the motor circuit and the arrangement being such that in use the cam follower is moved out of engagement with the depression in the first cam so that the motor is energized, whereafter the cam follower rides on the periphery of the first cam as the first cam is rotated, the first cam being rotated through one complete revolution to perform a dialling cycle to dial a single digit, and the first and second cams being displaced angularly when a digit dialled so that at the end of a cycle the motor is deenergized with said lobe displaced angularly from said depression, the second cam then being rotated by the return movement of the dialling switch mechanism so that said lobe lifts said cam follower out of engagement with said depression to restart the motor whereafter a further cycle is performed, and the system being stopped after the full address has been dialled by performing a cycle at the end of the address in which no digit is dialled, so that the cam follower engages said depression fractionally after said lobe has passed the cam follower and said dialling switch mechanism has not been operated.

2. A system as claimed in claim 1 wherein said first cam is movable angularly relative to said input, said first cam being resiliently urged to move angularly relative to the input so that when said cam follower is moved out of engagement with said first cam said first cam moves angularly relative to said input thereby displacing said depression from the cam follower so that when the cam follower reengages the first cam it engages the periphery thereof, said first cam being returned to its original angular position relative to the input during rotation of the cam by friction between the periphery of the first cam and the cam follower.

3. A system as claimed in claim 1 wherein said outputs of said differential gear mechanism are rotated by the input of the mechanism at half the speed of rotation of the input, and said second cam is provided with a second lobe engageable with the cam follower, said second lobe being spaced around the second cam by 180° from said one lobe.

4. A system as claimed in claim 3 wherein said second lobe is of greater arcuate length than said one lobe, said second lobe serving at the end of dialling an address to prevent the cam follower engaging in the depression in said first cam to switch off the motor when the memory units are displaced angularly from a desired datum position, by 180°.

5. A system as claimed in claim 1 wherein said cam follower includes a ferrous metal member which is engageable by a permanent magnet carried by a linkage movable in response to

selection of one of said memory units, the movement of the linkage during selection of one of said memory units serving to move said magnet and by virtue of the attraction between said magnet and said ferrous metal member, serving also to move said cam follower out of engagement with said first cam to operate said switch, the arrangement being such that said cam follower is arrested before said linkage has completed the movement necessary to complete the selection of the memory unit so that the magnet is moved away from the ferrous metal member thereby overcoming the attraction between the magnet and the ferrous metal member and allowing the cam follower to move to engage the periphery of said first cam.

6. A system as claimed in claim 1 wherein said selection means includes a plurality of manually depressable buttons each of which is associated with a respective memory unit depression of any one of the buttons serving to select its associated memory unit for dialling, to operate the system so that the system is in a condition to commence dialling and to open a further switch to prevent the commencement of dialling by breaking the electrical circuit of the motor, said further switch remaining open until the button is released whereupon the system will commence dialling the address contained in the memory unit associated with the depressed button, the operation of said further switch by said button permitting the operator to delay dialling until an external telephone line opens.

7. A system as claimed in claim 6 wherein the buttons operate said further switch through a followup linkage so that initial depression of the selected button opens the switch and the initial outward movement of the button upon release thereof closes said switch.

8. A system as claimed in claim 6 for use with an internal telephone installation wherein a letter or digit is dialled to connect the internal installation to the external telephone lines the system being modified in that opening of said further switch completes a second circuit to the motor through a switching device, so that dialling of the address contained in the memory unit associated with the depressed button commences when the button is depressed, said switching device being operated, in response to dialling of the first letter or digit of the address, to break said second circuit to the motor, so that operation of the system ceases after the first letter or digit has been dialled, and the system remaining inoperative until said button is released whereupon the further switch closes and the remainder of the address is dialled, the first letter or digit of the address being the access letter or digit which when dialled connects the internal installation with the external telephone lines and the system permitting the operator to prevent dialling of the external part of the address until an external line opens.

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