

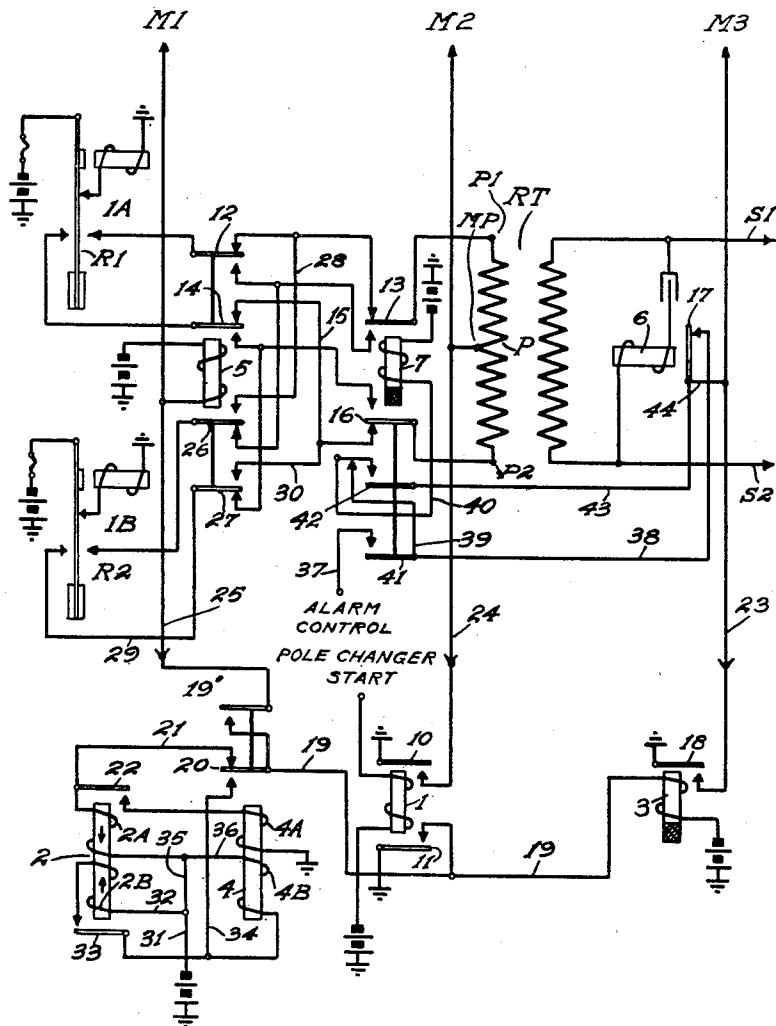
April 13, 1943.

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2,316,730

POLE CHANGER CONTROL CIRCUIT

Filed Oct. 30, 1940



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## UNITED STATES PATENT OFFICE

2,316,730

## POLE CHANGER CONTROL CIRCUIT

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Application October 30, 1940, Serial No. 363,489

9 Claims. (Cl. 179—87)

This invention relates to pole changers and more particularly to a pole changer control system.

In the telephone art, it has been the practice to provide a plurality of sources of different frequency ringing currents. If a single pole changer or set of pole changers is utilized, and for some reason or other it becomes defective or inoperative, it then becomes impossible to ring a subscriber. To avoid such a condition, the use of duplicate pole changers has been resorted to. With either duplicate or individual pole changers, a relatively heavy starting current is needed to begin the operation of the frequency ringing device or pole changer.

One feature of the present invention is to maintain these bell ringing pole changers vibrating at all times to avoid the need of frequent heavy starting currents.

With duplicate pole changer circuits wherein the secondary ringer is used only when the primary ringer is inoperative, the primary ringer will take all of the normal wear and the secondary ringing device will be almost continuously idle. It is, therefore, desirable to alternate the use of these duplicate pole changers so as to distribute the wear on the equipment.

If, in the alternate use of the ringing equipment, one or the other of the pole changers becomes defective or inoperative, an attempt to apply ringing current from that source would be ineffective to call the subscriber. Thus, it is desirable to provide test and selection means so that if one of the pole changers is defective, the other always will be used.

One object of this invention is to provide a ringing circuit having duplicate pole changers which are normally used alternately, means being provided whereby, if one of the pole changers should become inoperative, the other will always be employed.

Another object is to provide a multiple frequency ringing source wherein any inoperative pole changer is cut out and an operative pole changer is applied for each different frequency, at all times, whereby an operative source is always available. A further object is to eliminate heavy starting currents and no-load primary currents.

A feature of this invention is the provision of alarm control which will indicate the inoperative condition of any one of the ringing devices.

Another feature of this invention is to obtain the foregoing desirable results by means of a relatively simple pole changer control system. Yet

another feature resides in the provision of means whereby any good pole changer for any frequency can be used in any group. Other features and advantages will appear from the following description taken in connection with the accompanying drawing.

Although this system is described and illustrated with a single frequency ringing station, it is to be readily understood that the system is equally applicable to multiple ringing frequencies since the circuit diagram for the additional ringing frequencies would be a mere addition to that shown.

In the drawing, a single figure is used showing a preferred circuit diagram to illustrate the features of this invention.

Referring to the drawing, means for providing but a single frequency ringing current is shown, comprising two alternative pole changers; to wit, pole changer 1A and pole changer 1B. The primary of ringing transformer RT is arranged to be connected to one or the other of the pole changers by means of appropriate switching means, and the secondary of the ringing transformer is joined, by suitable conductors S1 and S2, to a subscriber's circuit to be rung.

In the preferred system, the duplicate pole changers 1A and 1B are constantly running since their operating current is a small fraction of the starting current. The output from either pole changer need only be connected to a line to ring the subscriber. Thus, the need for automatic starters is eliminated.

This system is especially useful where five frequency harmonic ringing is used, portions only being duplicated for each frequency. The entire system is adapted for unattended dial exchanges, or manual exchanges.

A pole changer starting relay 1 is used to initiate the application of ringing current to a subscriber's line. Other relays and switches are utilized, to alternate the use of the pole changers, to test the pole changers for operativeness, and to select an operative pole changer for ringing purposes.

A more detailed description of the operation of this device will be given to illustrate its preferred manner of use.

What may be called the "normal operation" of the circuit will first be described. This is the operation in which the duplicate sources of each frequency ringing current are properly working and are being alternately used during a ringing period.

Relay 1 has its winding connected to ground

by either a ringing relay, or manually, to operate armatures 10 and 11. Armature 10 at its front contact places ground on an intermediate or center tap MP of the primary P of its ringing transformer RT. Energizing potential of the proper frequency is alternately applied at the opposite terminals P1 and P2 of the primary over a circuit traced from grounded battery, through reed R1, its right contact, armature 12 of relay 5 and its back contact, back contact and armature 13 of relay 7 to P1, thence to MP and through the front contact and armature 10 of relay 1 to ground; or from grounded battery through reed R1, its left contact, armature 14 and back contact of relay 5, conductor 15, back contact and armature 16 of relay 7 to P2, thence to MP and through the front contact and armature 10 of relay 1 to ground. The above application of energizing current to the primary of transformer RT causes alternating ringing current to flow in the secondary. This current actuates relay 6 to remove armature 17 from its back contact.

When relay 1 operates, a circuit for relay 3 is completed to ground at armature 11 of relay 1. Relay 3 operates and moves its armature 18 against its front contact. Armature 17 being open, nothing operates.

Armature 11 also closes a circuit from ground through armature 11 and front contact of relay 1, conductor 19, armature 20 and back contact of relay 4, conductor 21 and through the winding 2A of relay 2 to battery and ground. Relay 2 operates, closing its armature 22 and front contact. The ringing continues until terminated by release of relay 1 which in turn removes the ground for the ringing transformer and relay 2. This in turn releases relay 6.

The removal of ground at armature 11 does not release relay 2 because ground on winding 4A of relay 4 is supplied over armature 22, thereby causing relay 4 to operate, locking both 2 and 4 until the next application of ringing current is to be made.

Upon the next call for ringing current, relay 1 again operates to place ground on conductors 24 and 19. Relays 2 and 4 being held from the previous operation, ground on conductor 19, passes through operated armature 19', to conductor 25 to operate relay 5; which latter disconnects 1A at armatures 12 and 14, and substitutes 1B at its front contacts and armatures 26 and 27. This places the energizing current from 1B on the ringing transformer by alternately effective circuits from grounded battery, reed R2, armature 26 and its front contact, conductor 28, armature 13 to P1 to MP, and conductor 29, armature 27 and its front contact, conductor 30, back contact and armature 16 and P2 to MP, and thence by conductor 24 to armature 10 and ground. The application of ringing current again operates relay 6 to open contacts 16 to prevent closure of the alarm circuit and the circuit of slow relay 7 at armature 18 of slow-operating relay 3.

On this call for ringing current, coils 2B and 4B of relays 2 and 4 are energized. The circuit of 2B is from grounded battery, through conductors 31 and 32, winding 2B, front contact and armature 33 of relay 2, conductor 34, front contact and armature 20 of relay 4, conductor 19 and armature 11 to ground; and the circuit of 4B is from grounded battery, conductors 31, 35, and 36, winding 4B, parts 34, 20, 19, and 11 to ground. The energization of 2B counteracts the effect of 2A thereby restoring the differential relay 2 to

open the circuit of 4A and 2A at 22 and 2B at 33. The winding 4B holds relay 4.

At the end of the ringing, relay 1 is again released, thereby restoring relays 3, 4, and 5. The latter substitutes 1A for 1B. Relay 6 restores responsive to the cessation of ringing current resulting from the opening of the primary circuit at armature 10.

The foregoing operation covers the alternate use of 1A and 1B for ringing as long as these devices are functioning normally. The same mode of operation applies to the four other duplicate frequency sources where a five frequency harmonic system is used.

The secondary terminals S1 and S2 of each ringing transformer will be connected to the line to be called. The secondary terminals of each ringing source will be selectively connected by a suitable multiple frequency switch control, not shown. These other frequency sources are multiplied on the control circuits M1, M2 and M3. The alternating control by relays 1, 2, 3 and 4 will be common to the entire group, with each set having its controlled, corresponding terminals S1 and S2.

During what may be termed the normal operation of the device, the duplicate pole changers are alternately used as described. This alternation of use is applicable at all times and where one or the other of the ringing sources is defective, the alternation also takes place, but in such a case, if the defective pole changer happens to be the one connected for ringing, the relay 1 shifts the connection to the operative ringing pole changer, as will be described. The use of a pole changer out of its normal alternate use when one of the ringing sources is defective, does not alter the basic operation. In other words, the sources are alternately applied and the substitute use of one for the other does not interfere with this cyclic operation.

The operation of the system will now be further described, considering first that 1A is inoperative and then that the pole changer 1B is inoperative.

Assuming the pole changer 1A to be inoperative, and starting with pole changer 1A about to be used for the next ringing operation, relays 2 and 4 are in restored condition, and the system functions as follows: Relay 1 is energized and by its armatures 10 and 11 places ground upon the conductors 24 and 19. This, in turn, completes the energizing circuit for slow-operating relay 3 and for operating coil 2A of relay 2. It also places the ground on the ringing transformer RT over conductor 24. With the connected pole changer 1A defective, the application of ground to the primary of the ringing transformer fails to cause ringing current to flow in the secondary windings. In this case, relay 6 is therefore not actuated, thereby leaving armature 17 closed. Then, when slow-operating relay 3 operates, a moment later, it closes a circuit as follows: from ground, through contacts 18, conductor 23, contacts 17, conductors 38 and 39, contacts controlled by armature 42, conductor 40, relay 7, to battery. Relay 7 thereupon operates. At armature 42 it locks itself directly to conductor 23, independent of contacts 17, at the same time opening its initial circuit, while at armature 41 it applies ground potential to alarm conductor 37. At armatures 13 and 16, relay 7 shifts the outer terminals of the transformer primary P from the defective pole changer 1A to pole changer 1B. Assuming the pole changer 1B to

be operating properly, ringing current is immediately applied over conductors S1 and S2. This application of ringing current immediately energizes relay 6, removing ground at contacts 17 from conductor 38 which extends to the alarm circuit. Pole changer 1B will continue to serve, for relay 7 remains locked to conductor 23.

Upon the termination of the ringing operation, relays 1, 6, 3, and 7 restore, and relay 4 operates in the locking circuit of relay 2 to prepare for the next operation to be that of 1B.

The apparatus is now in the condition with relays 2 and 4 held in operated position by coils 2A and 4A. With the beginning of a new ringing operation, relay 1 is again energized. Relay 5 thereupon operates over conductor 19, contacts 19' and conductor 25 to substitute 1B for 1A, differential relay 2 restoring as hereinbefore described.

Since pole changer 1B is operative, relay 6 is energized barring an application of ground to relay 7 by slow-operating relay 3. With the termination of this ringing period, relays 1, 4, 5, 6, and 3 release as hereinbefore described. The apparatus is now in condition for a further ringing call which would connect the currently defective pole changer 1A, as previously described, with the consequent substitution of 1B.

Let it now be assumed that pole changer 1A is operative and 1B is inoperative, and that the next pole changer to be connected up is 1A. The operation of relay 1 places ground on the ringing transformer with the resultant energization of relay 5 and the application of ringing current. With relay 6 operated, the operation of slow relay 3, when it occurs, is without effect. Relay 2 operates as hereinbefore described, to prepare for the operation of relay 4 when relay 1 again restores.

Upon the termination of the ringing operation, relay 1 is deenergized, resetting the apparatus and operating relay 4 for the next operation. On the next operation of relay 1, relay 5 is operated through contacts 19' to substitute device 1B, in its regular turn, for device 1A. With device 1B defective, as assumed, no ringing current flows over leads S1 and S2. Relay 6, therefore, fails to operate, permitting relay 7 to operate as before described. Relay 7 energizes the alarm conductor 37 and at armatures 13 and 16 shifts the transformer terminals P1 and P2 to the stand-by leads, to which operative device 1A is now connected, through armatures 12 and 14, and their front contacts. Ringing current now flows over leads S1 and S2, operating relay 6 to disconnect ground from alarm lead 37. Relay 7, however, remains locked to conductor 23, independent of contacts 17.

All of the illustrated relays of the system restore when relay 1 next falls back, preparing for the starting of a new cycle of operation.

As will be apparent from an inspection of the drawing, when relay 7 has been operated to substitute the other one of the devices 1A and 1B for the one currently connected, through armatures 12 and 14 or through armatures 26 and 27, to the back contacts of armatures 13 and 16, and the second pole changer is likewise defective, relay 6 is not operated by this second pole changer, in which case ground potential remains applied to alarm control conductor 37 to sound any suitable alarm. The circuit for applying ground potential to alarm control conductor 37 is from ground through armature 18 and its front contact, over common conductor 23, through armature 17 and its back contact, over conductor 38,

and thence through armature 41 of relay 7 and its front contact, to conductor 37.

It will be observed that each of the conductors 23, 24, and 25 extending upwardly from contacts of relays 3, 1, and 4, respectively, has a symbol applied thereto indicating that such conductor is common to a plurality of sets of equipment, one of which is shown. The illustrated set of equipment includes pole changers 1A and 1B, relays 5 and 7, ringing transformer RT, test relay 6, and ringing leads S1 and S2. Leads 23, 24, and 25, therefore, are indicated as extending to other similar sets of ringing equipment, each of which includes a pair of pole changers, such as 1A and 1B. This fact is further indicated by the arrow-headed extensions of conductors 23 to 25 labeled "M3," "M2," and "M1," respectively. It will be understood, therefore, that the set of ringing equipment illustrated above the common equipment comprising relays 2, 4, 1, and 3, is only one of a plurality of such sets of ringing equipment, each of which contains its own provisions for alternating the use of the pair of pole changers and for substituting the other pole changer in the event that the one currently connected up is defective, as indicated by a failure to operate of the relay therein corresponding to relay 6.

One advantage of this device is that the ground connection is only placed on the ringing transformer when it is to be used. This reduces the no-load primary current in the system, even with the vibrators operating.

A further advantage is due to the continuous operation of the pole changers. Heavy starting currents are eliminated upon each application of ringing current. The open primary circuit also eliminates no-load current in the transformer.

Another advantage resides in the application of a good pole changer in every frequency set upon every application of ringing current.

Although the preferred embodiment of this invention is illustrated and described, variations within the true spirit and scope of the same will be determined by the appended claims.

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

1. In a ringing-current supply system, a pair of alternative pole changers for controlling the flow of ringing current, switching means for applying either pole changer to the system to the exclusion of the other, means periodically effective for operating said switching means to substitute the other pole changer for either currently applied one, means for testing each newly applied pole changer to determine its condition, and means controlled by said test means responsive to an abnormal condition of the newly applied pole changer for operating said switching means to reverse the substitution.

2. In a ringing-current supply system, a pole changer for controlling the flow of ringing current, said pole changer including a vibratory arm and contacts alternately closed thereby, circuit connections including said contacts for supplying ringing current to said system, said circuit connections being open when ringing current is not needed, means for maintaining said arm in vibration at all times whether ringing current is needed or not, and switching means effective responsive to a condition indicating a demand for ringing current for closing said circuit connections.

3. In a ringing-current supply system, a transformer having a secondary winding for supply-

ing ringing current and having a primary winding for exciting the secondary winding alternately in opposite directions, a pair of alternative pole changers for controlling the flow of current in the primary winding, means for maintaining both of said pole changers constantly in operation, switching means for applying either operating pole changer to the primary winding to the exclusion of the other, and means periodically effective for substituting the other pole changer for the currently applied one.

4. In a ringing-current supply system, a pair of alternative pole changers for controlling the flow of ringing current, the demand for ringing current being intermittent, switching means operative responsive to a condition indicating a demand for ringing current for applying one of said pole changers to the system to the exclusion of the other, means for testing the applied pole changer to determine its condition, and means controlled by the said test means responsive to an abnormal condition of the applied pole changer for operating said switching means to substitute the other pole changer for the applied one.

5. In a ringing-current supply system, a pair of alternative pole changers for controlling the flow of ringing current, the demand for ringing current being intermittent, switching means operative responsive to a condition indicating a demand for ringing current for applying one of said pole changers to the system to the exclusion of the other, means for testing the applied pole changer to determine its condition, and means controlled by the said test means responsive to an abnormal condition of the applied pole changer for operating said switching means to substitute the other pole changer for the applied one, an alarm-control conductor, and means for applying a potential thereto dependent upon the last said pole changer being also in an abnormal condition.

6. In a ringing-current supply system, separate ringing circuits, a separate pair of alternative pole changers for each of said ringing circuits for controlling the flow of ringing current therein, the demand for ringing current being intermittent, switching means operative responsive to a condition indicating a demand for ringing current in any of said ringing circuits for applying a pole changer of each of said pairs to its respective ringing circuit, separate testing

means for each ringing circuit for testing the pole changer applied thereto to determine its condition, and separate means in each ringing circuit controlled by the said test means thereof responsive to an abnormal condition of the pole changer applied thereto for bringing about the substitution of the other pole changer of the concerned pair for the applied one.

7. In a ringing-current supply system, a ringing circuit, a pair of pole changers for controlling the flow of ringing current therein, means for maintaining both of said pole changers constantly in operation, both of said pole changers being normally out of effective circuit relation with said ringing circuit, switching means operative responsive to successive occurrences of the same condition indicating a demand for ringing current for operatively placing said pole changers alternately in effective circuit relation with said ringing circuit.

8. In a ringing-current supply system, a ringing circuit, a pair of pole changers for controlling the flow of ringing current therein, means for maintaining both of said pole changers constantly in operation, both of said pole changers being normally out of effective circuit relation with said ringing circuit, switching means operative responsive to successive occurrences of the same condition indicating a demand for ringing current for operatively placing said pole changers alternately in effective circuit relation with said ringing circuit, means for testing each of said pole changers upon its being placed in circuit relation with the ringing circuit, and means controlled by said testing means responsive to the currently connected pole changer being not in operation when so placed in circuit relation for operating said switching means to substitute the other pole changer.

9. In a ringing-current supply system, a ringing circuit, a pair of alternative pole changers for controlling the flow of ringing current therein, means for applying one of said pole changers to said ringing circuit to the exclusion of the other, means for substituting the other pole changer for the applied one at the end of a predetermined time interval beginning with said application, and means responsive to the flow of ringing current in said circuit for disabling said substituting means.

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