

Dec. 24, 1940.

J. M. DUGUID ET AL

2,225,907

RINGING CURRENT SUPPLY SYSTEM

Filed May 25, 1939

4 Sheets-Sheet 1

FIG. 1

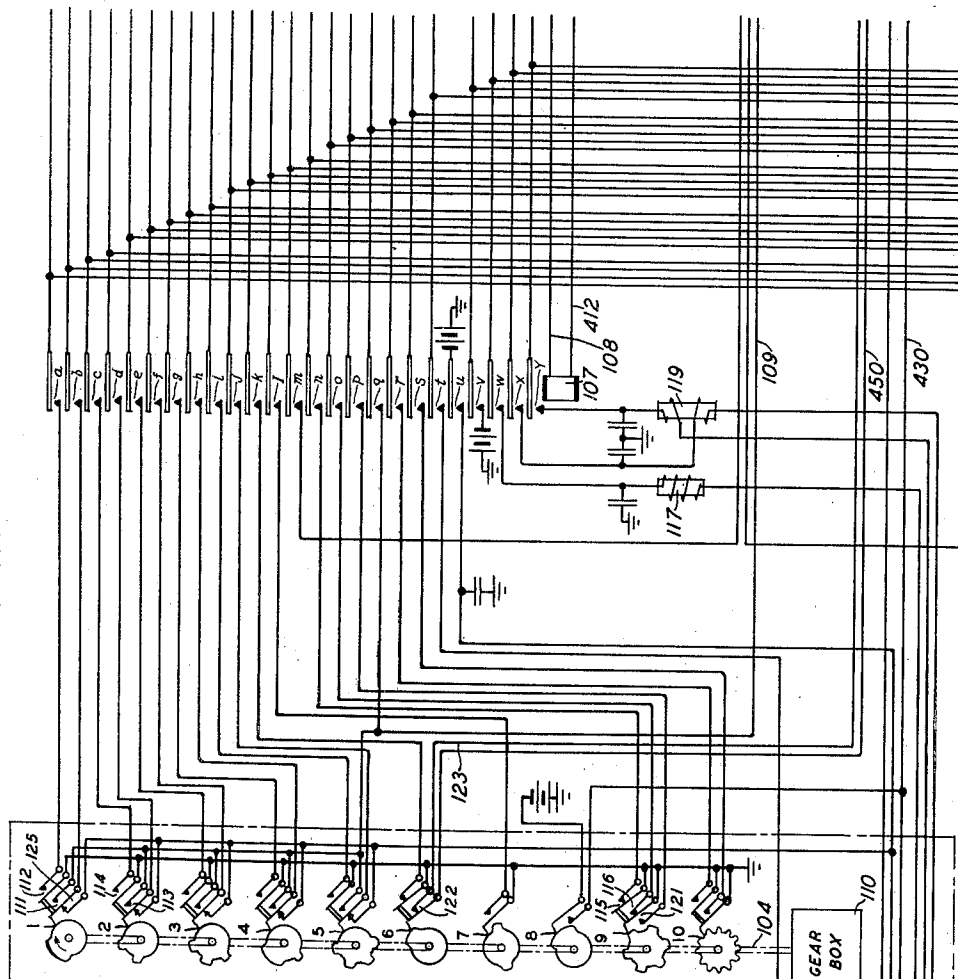


FIG. 5

CAM SPRING	ONE CYCLE = 6 SECONDS				
	1	2	3	4	5
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

— DENOTES CAM SPRING OPERATED

FIG. 6

FIG. 1	FIG. 2
FIG. 3	FIG. 4

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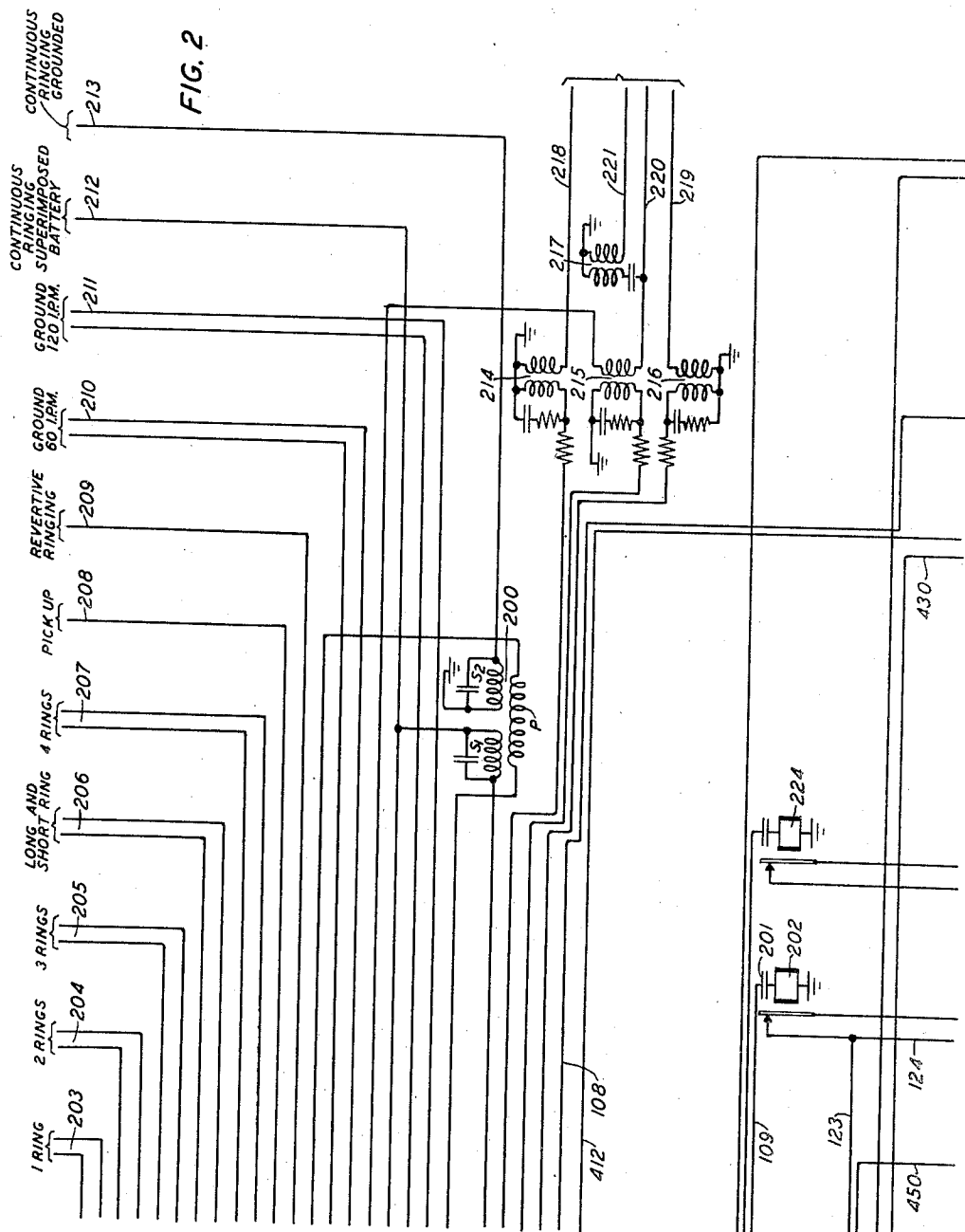
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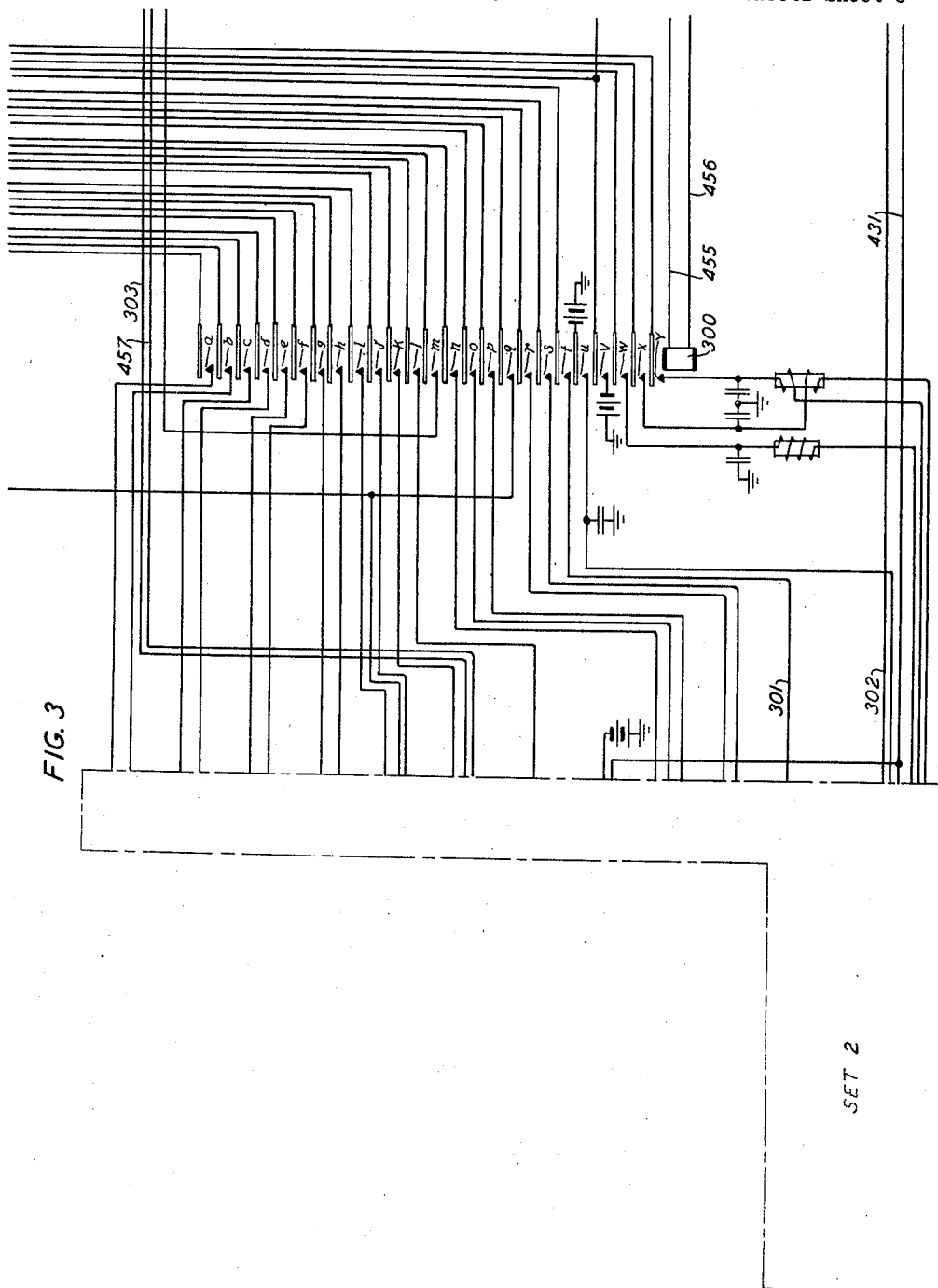
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4 Sheets-Sheet 3



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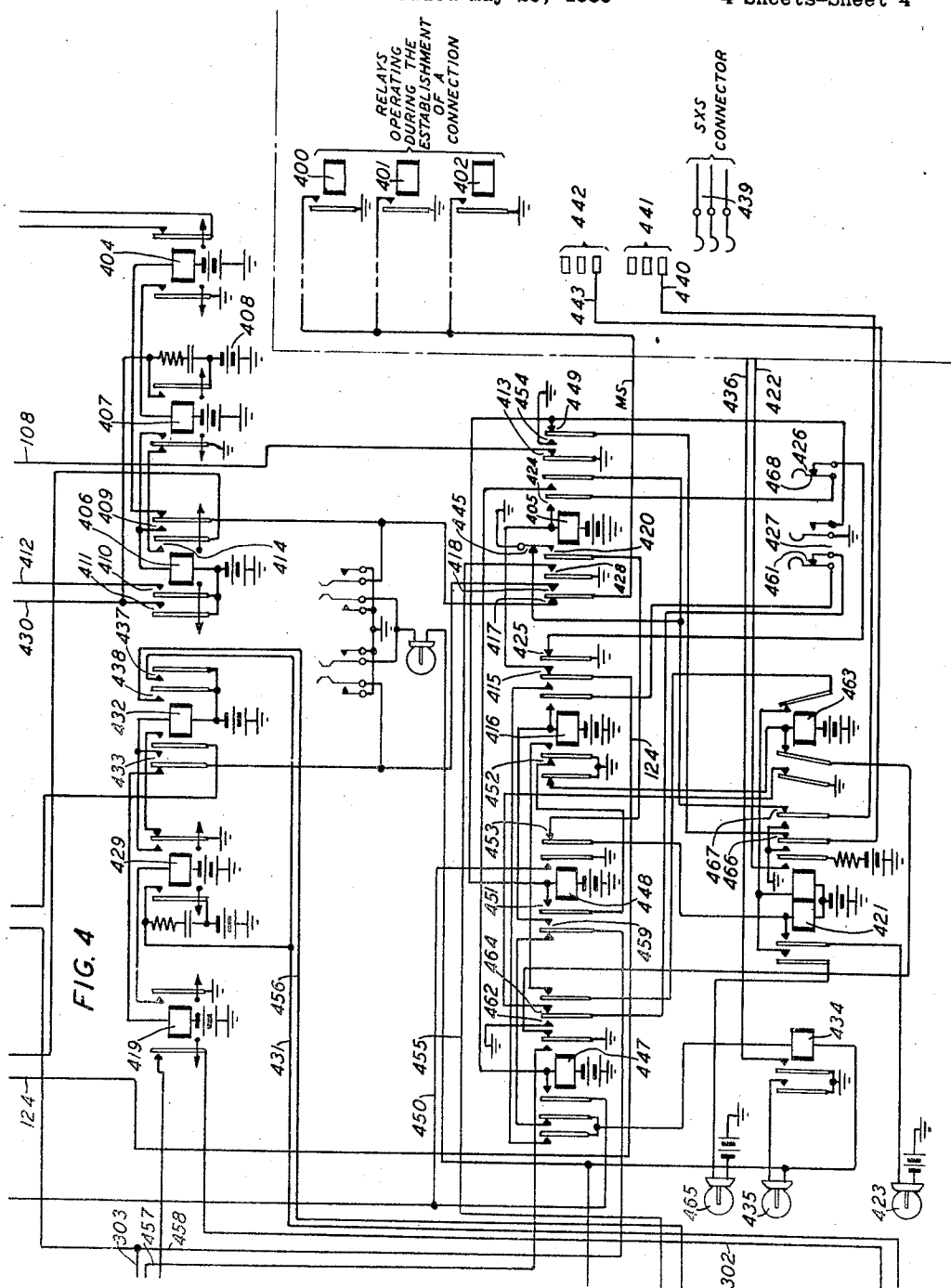
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RINGING CURRENT SUPPLY SYSTEM

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,225,907

RINGING CURRENT SUPPLY SYSTEM

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5 Claims. (Cl. 179—84)

This invention relates to ringing systems for telephone exchanges of the character employing a reserve or auxiliary source of supply, such as a duplicate generator, and more particularly to systems employing code ringing in which the generators are arranged to supply a plurality of different sets of code impulses, it only being necessary to select the proper code combination from the multicode output of the machine and apply it to the line to be rung.

In systems of the above character employing duplicate or auxiliary ringing equipment, in case a transfer of the ringing load is to be effected from the operating machine to the machine in reserve, a switching operation is performed, either manually or automatically controlled, to disconnect the first machine from the load and stop it, and then start the second machine and connect it to the load in substitution for the first machine. Heretofore, such arrangements, particularly those adapted to provide code ringing, have not taken into account the fact that if the transfer is made during the interval that a code ring is being transmitted, the code will be mutilated, that is false ringing will result and a different subscriber from the one intended will be called. This is due to the fact that the interrupting mechanism producing the code may stop before it has completed a complete cycle.

An object of the present invention is to prevent mutilation of code ringing in arrangements of this character.

A feature of the invention resides in an arrangement of the machines and the circuits whereby a switching operation to effect a stoppage of an operating machine and transfer the load to another machine is not effective to stop the machine in operation and transfer the load until the operating machine has effected a complete cycle of code interruptions.

Another feature resides in means whereby, in case the machine supplying the load fails, thereby causing an automatic transfer of the load to the other machine, further switching operations either automatically controlled due to the failure of the second machine, or manually controlled, is ineffective to cause a retransfer of the load to the first machine.

Other features of the invention will appear from the following description and accompanying drawings.

Figs. 1, 2, 3 and 4 of which, when joined as shown in Fig. 6, with Fig. 2 to the right of Fig. 1, Fig. 3 below Fig. 1 and Fig. 4 to the right of Fig. 3,

represent two complete code ringing machines, together with control and transfer means, in accordance with the invention hereinafter described.

Referring to Fig. 1 the apparatus enclosed within the broken line box and designated "Set 1" represents a combined motor and generator 100, for example, a so-called inverted rotary converter, having mounted on its shaft collector rings 101 and circuit interrupters 102 and 103. Driven by the shaft of converter 100 by means of suitable reduction gearing 110, is a shaft 104 carrying a plurality of cams and cooperating circuit closing contacts designated 1-10, inclusive. It will be understood that converter 100 when in operation delivers alternating ringing current at its collector rings 101 which is taken off by brushes 105 and 106 and delivered through a transformer to circuits, hereinafter described for use in a telephone exchange.

Fig. 3 represents an arrangement of circuits and equipments, identical with Fig. 1, including a second or duplicate code ringing machine indicated as "Set 2" within a broken line box, the details of which are not shown, it being understood that the conductors shown as extending into this box are terminated in a similar manner to those extending into and terminating in the box of Fig. 1.

Fig. 2 shows the circuits serving as a link between the exchange or switching equipment of the central office and the ringing machine which is supplying the load as determined by the operated condition of one or the other of multicontact relays 107 or 300.

Fig. 4 shows the circuits whereby control is exercised as to which ringing machine (set 1 or set 2) shall be in operation and connected to the load, said control being determined either by failure of the machine in operation or at the will of an attendant; and

Fig. 5 is a chart showing the closed and open intervals of springs 1 to 10, inclusive, during one complete revolution of shaft 104.

A description of the operation of the system in accordance with the present invention will now be given.

It will be understood, for the purpose of this description, that the ringing equipment shown is associated with a so-called community dial office or automatic exchange of the step-by-step type and that 400, 401 and 402 represent well-known relays present in such an exchange, which are operated in response to a call and the subsequent steps incident to the completion of a connection to a called line.

Call start

Now let us assume that both ringing machines, set 1 and set 2, are in condition for operation and that the permanent wiring is so connected that under normal conditions set 1 will start on demand for ringing current and tone.

Upon the initiation of a call incoming to the dial exchange, above referred to, relay 400 in the line finder operates to start the finder in search for the calling line as is well understood in the art, and this relay connects ground to the machine start conductor MS which operates relay 404 in a circuit which can be traced from ground, contacts of relay 400, conductor MS, outer left normal contacts of relay 405, outer right normal contacts of relays 406 and winding of relay 404 to battery. This ground on the MS conductor is maintained by other relays 401 and 402 in the selector and connector as the call progresses and is not removed until the called subscriber answers or the call is abandoned. Relay 404 operates thereby closing its left-hand contacts to operate relay 407. Relay 404 in operating also opens its right-hand contacts which permit the associated machine, converter 100, to start without the P winding of transformer 200 being connected thereto, thereby requiring a much smaller starting current. Relay 407 in operating closes its right-hand contacts thereby completing a circuit from battery 408 over conductor 430 to the motor of converter 100 which immediately starts. Relay 407 also closes its left-hand contacts thereby energizing relay 406. Relay 406 opens its outer right contacts thereby breaking the circuit of relay 404 which due to its construction releases slowly. Relay 406 also closes its contacts 409 thereby locking itself operated to ground on the MS conductor and this relay will therefore remain operated as long as ground is maintained on the MS conductor by any relay in the exchange (400, 401 or 402). Relay 406 further closes its contacts 410 and 411. Contacts 410 complete a circuit to operate transfer relay 107 which can be traced from battery, contacts 413, conductor 412, winding of relay 107, conductor 109 and contacts 413 of relay 405 to ground.

As previously mentioned, converter 100 was started when relay 407 operated and by the closure of contacts 411 of relay 406 a parallel connection is established to hold the motor circuit closed when relay 407 releases which will occur shortly after relay 404 releases. Relays 404 and 407 are both so constructed that they will release slowly and therefore relay 407 will remain operated for an appreciable period after relay 406 operates.

In the absence of any fault in set 1, the converter will build up its ringing current voltage rapidly and when relay 107 operates and relay 404 releases, the generator brushes 105 and 106 will be connected across the primary winding P of transformer 200, the circuit of which can be traced from brush 105, contacts *t* of relay 107, winding P of transformer 200, contacts *m* of relay 107, right contacts of relay 404 and back to generator brush 106. Alternating current from the generator flowing in winding P of transformer 200 induces a current in the secondary winding S₁ thereof, the circuit of which can be traced from grounded battery, contacts *u* of relay 107, winding S₁, contacts *q* of relay 107, conductor 109, condenser 201 and relay 202 to ground. Relay 202 operates if the generator voltage is above a predetermined minimum potential thereby opening its contacts so that relay 405 does not operate

when relay 407 finally releases which as later explained, would cause the motor circuit of set 1 to be opened, release relay 107, cause set 2 to be started and cause the operation of relay 300, which operations may be described as "low or no voltage transfer." However, we will assume that the generator voltage builds up to a potential which will operate relay 202 before relay 407 releases and closes its outer left contact and therefore the closure of these contacts has no effect.

Code ringing, tones, and signals

It will be noted that converter 100 started as soon as relay 407 operated and that a parallel holding connection between the operating battery and converter was established by the operation of relay 406. Further, it will be observed that rotation of the converter shaft turns the shaft 104, geared thereto, by the reduction gearing indicated at 110, at a very slow rate of the order of one revolution in six seconds. Further, it will be noted from the drawings (Fig. 1) that the springs of cam 8 are open in the normal or stopped condition of converter 100 but close soon after shaft 104 begins to rotate (in a clockwise direction), and the raised portion of the cam moves from under the wiper spring, which will also be noted from Fig. 5 which diagrammatically shows the open and closed intervals of the various spring contacts during a complete revolution of shaft 104.

When cam 8 rotates through an arc of about 45 degrees the associated wiper spring will be lowered, thereby closing its contacts and completing still another parallel operating path from battery to converter 100 and therefore this machine is definitely locked to battery independent of relay 406 and consequently any subsequent switching operation which might cause relay 406 to release and open its outer left contacts, will have no effect to stop the converter until cam 8 has moved through an arc of about 315 degrees which is sufficient to insure that cams 1, 2, 3, 4 and 5 have completed a full cycle of associated contact spring operations which, as hereinafter described, supply differently interrupted code rings to the exchange.

With the converter in operation the shaft 104, and the cams thereon, rotates at the rate of one revolution in six seconds and with relay 107 operated, the various circuits (202—213) extending upwardly from Fig. 2, and which terminate in the exchange equipment, not shown, are energized as follows:

Well-known superimposed ringing current is connected to conductor 2 of pair 203, for one and one-half seconds and disconnected for four and one-half seconds as shown by the chart (Fig. 5), see spring No. 1. The circuit for this connection is as follows: As before described, alternating ringing current is supplied at brushes 105 and 106 of the converter 100 which current flows in the primary winding P of the transformer 200 and therefore current is induced in both secondary windings S₁ and S₂. The circuit for winding S₁ can be traced from battery, contacts *v* of relay 107, winding of S₁, contacts *q* of relay 107, contacts 111 of cam spring 1, when these contacts are closed by the raised portion of the cam, contacts *b* of relay 107 and over conductor 2 of the pair 203 to the exchange equipment and when this conductor is closed through to a line, a circuit will be closed through the subscriber's telephone to ground in the office or at the substation. Due to the length of the open interval of cam spring

1 (four and one-half seconds) as compared with the closed interval (one and one-half seconds) the ringing current impulse transmitted over conductor 2 of pair 203 may be considered as a single ringing impulse of one and one-half seconds duration repeated every six seconds.

Cam 1 in closing its contacts 112 also connects ground over contacts *a* of relay 107, to conductor 1 of pair 203 for one and one-half seconds of each six seconds cycle, which ground impulse may be required in certain cases for other ringing conditions which it is not necessary to describe here. At the end of the one and one-half seconds closed interval of cam spring 1, contacts 125 close thereby connecting tripping battery to conductor 2 of pair 203 for four and one-half seconds.

A similar circuit for two impulses of superimposed ringing current of one-half second duration, each impulse separated by a silent interval of one-half second and repeated every six seconds can be traced over conductor *d* of pair 204 including battery, contact *v* of relay 107, transformer secondary *S*₁, contacts *q* of relay 107, contacts 113 of cam spring 2, contacts *d* of relay 107 over conductor *d* of pair 204 and a connected subscriber's line.

Conductor pair 205 receives three one-half second impulses of superimposed ringing current separated from each other by one-half second silent intervals and repeated every six seconds under control of the cam 3.

Conductor pair 206 receives one relatively long impulse of one and one-half seconds followed, after a one-half second silent interval by a one-half second impulse every six seconds under control of the cam 4; and

Conductor pair 207 receives four one-half second impulses separated by one-half second silent intervals under control of cam 5.

All of the five different codes above described, in which cams 1 to 5 connect ringing current at various intervals to the exchange, are simultaneously duplicated by corresponding applications of ground to the other conductor of the respective pair and controlled by other springs actuated by the respective cams as described in a preceding paragraph in connection with the single or one-ring code. Tripping battery is also connected during the silent interval in all cases.

Conductor 208 is grounded for one second at the end of each revolution of shaft 104 under control of cam 6. This ground impulse following each completed ringing cycle is employed in the case of so-called machine ringing to operate what is known as the "pick-up relay."

Conductor 209 is grounded twice each cycle for one-half second under the control of cam 7 as indicated in Fig. 5. These two ground impulses per cycle are employed in connection with so-called reverberative ringing, i. e., ringing another party on the same line as the party calling.

For indicating certain conditions by means of flashing signals, ground potential, interrupted at different rates (60 and 120 impulses per minute) is usually required in telephone exchanges. These interrupted ground potentials are provided over both conductors of pair 210 (60 impulses per minute) and pair 211 (120 impulses per minute). The 60 impulses per minute being effected by cam 9 whose contacts 115 and 116, when closed, connect ground over contacts *n* and *o* of relay 107 to the respective conductors of pair 210 and the 120 impulses per minute by cam 10 in a similar manner over conductor 211.

In addition to the code ringing impulses con-

trolled by cams 1 to 5, and supplied over pairs 203 to 207, continuous or uninterrupted ringing current is required for certain types of ringing both superimposed and grounded only. The superimposed continuous supply is traced from battery, contacts *v* of relay 107 and winding *S*₁ of transformer 200 to conductor 212. The grounded supply which is not superimposed on, or in series with, current from a battery, can be traced from ground, winding *S*₂ of transformer 200 to conductor 213.

Besides the ringing current supply described certain audible tones of different pitch, i. e., high and low, and both continuous and interrupted at a predetermined rate (60 impulses per minute) are required. These tones are produced by means of interrupters 102 and 103 on the shaft of converter 109 in cooperation with tone transformers 214, 215, 216 and 217 and cams 9.

Transformer 214 applies a high pitch tone to conductor 218 which is generated in the following circuit: Battery, contacts *u* of relay 107, live or conducting segments of interrupter 103, brush 116, retard coil 117, contacts *w* of relay 107 and the left-hand or primary winding of transformer 214 to ground. This rapidly interrupted current flowing in the circuit described induces an alternating current of audible frequency (of the order of 500 cycles) in the secondary winding which supplies conductor 218. Transformer 216 applies a lower pitch tone (of the order of 160 cycles) to conductor 219 in the following circuit: Battery, contacts *u* of relay 107, live or conducting segments of interrupter 102, brush 118, upper winding of retard coil 119, contacts *y* of relay 107 and left-hand winding of transformer 216 to ground. Alternating current is induced in the right-hand winding which is supplied to conductor 219.

Transformer 215 also supplies a low tone to conductor 220 which, however, is interrupted at the rate determined by cam 9, i. e., 60 impulses per minute, the circuit for which can be traced from battery over the same circuits to the interrupter 102 at which point it is traced from brush 121 through the lower winding of retard coil 119 and contact *x* of relay 107 to the left-hand winding of transformer 215 to ground. Alternating current induced in the right-hand winding includes contacts 121 of cam 9 which contacts are made and interrupted 60 times a minute and therefore conductor 220 is supplied with a low frequency current (approximately 160 cycles) which is interrupted at the rate of 60 times a minute. This tone current is usually employed as a line busy indication.

Connected between the lead 220 and ground is the primary winding of a fourth transformer 217, the secondary winding of which supplies conductor 221 with the same frequency tone interrupted at the same rate but in which the ground connection is not broken as is the case of conductor 220.

Automatic transfer due to voltage failure (set 1 to set 2)

It will now be assumed that some trouble develops whereby the voltage of the ringing current, as delivered by the winding *S*₁ of transformer 200 which in turn is supplied by collector rings 101 of the converter 100 when in operation, falls below a predetermined minimum value which is insufficient to hold relay 202, previously mentioned, in an operated condition.

Relay 202 therefore releases under this condition

and if it is assumed that the exchange is demanding ringing current and tone as determined by ground on the MS conductor of Fig. 4, thereby holding relay 405 operated, a circuit will be completed to operate relay 405 which can be traced from ground, left back contacts of relay 407, contacts 414 of relay 406, back contacts of relay 202, contacts 415 of relay 416 and winding of relay 405 to battery. Relay 405 operates thereby disconnecting, at its contacts 417, the conductor MS from relay 406 thereby releasing this relay and transferring the ground on conductor MS over contacts 418 to operate relay 419. Relay 406 is slow to release so that if it loses operating battery due to a fuse failure, it will hold long enough to operate relay 405. Relay 405 in operating also opens its contacts 413 thereby releasing relay 107 which disconnects set 1 from the conductors extending to the exchange equipment. Closure of contacts 423 completes a circuit to operate relay 421 which connects battery to conductor 422 which may be extended to some distant point, for example, a large exchange on "Master office," to light a lamp or display some other signal as an indication that a ringing machine transfer (due to a failure) is taking place at the tributary "Community office." Relay 421 also closes its inner left contact thereby lighting pilot lamp 423 which also indicates a transfer. Closure of preliminary make contacts 424 on the 405 relay establishes a locking circuit for relay 405 which can be traced from ground, contacts 425 of relay 416, contacts 426 of key 468, contacts 424 and winding of relay 405 to battery. These preliminary make contacts assure that the 405 relay will lock up before contacts 417 open to remove the MS ground from relay 406 which relay is in the operating path for the 405 relay. Relay 405 also closes its contacts 428 thereby connecting ground to the winding of transfer relay 300 which corresponds to relay 107 of Fig. 1. Relay 419 in operating closes its right contacts to operate relay 429 which relay, in closing its left contacts, connects battery to conductor 431 which corresponds to conductor 430 previously referred to which is the start conductor for converter 100. Conductor 431 extends in a similar manner to the converter (not shown) of set 2 which starts immediately and begins to build up its voltage which will be supplied over conductors 301 and 302 to energize the primary winding P of transformer 200 when relay 300 operates. Relay 429 also closes its inner right contacts thereby energizing relay 432 which, in closing its contacts 433, completes a holding circuit for itself to ground on the MS conductor as long as this conductor is grounded by a call in the office. This circuit can be traced from ground on conductor MS, contacts 418 of relay 405 and contacts 433 of relay 432 to the winding of the relay. Operation of relay 432 in opening its outer left contacts deenergizes relay 419 which starts to release but due to its construction holds operated for a short interval to delay the subsequent release of relay 429 which latter relay, if released before relay 224 operated, would cause relay 434 to operate to light pilot lamp 435 and connect ground to conductor 436 to give a so-called major alarm at the master office, i. e., to indicate that a transfer from one machine to another has been effected but the machine transferred to is not supplying the load, which will be the case if, following the release of relays 419 and 429, relay 224 has not yet operated.

Operation of relay 432 closes its contacts 437 and 438. Contacts 427 connect battery to conductor 431 in parallel with the connection initially

effected over the left contact of relay 429 to hold the operating circuit of the converter of set 2 closed after relay 429 releases. Closure of contact 438 of relay 432 completes the circuit for transfer relay 300 initially prepared when relay 405 closed its contacts 428.

Operation of relay 405 released relay 107 thereby disconnecting set 1 from the exchange load and release of relay 406 disconnected battery from conductor 430 which would have the effect of stopping converter 100 except for the fact that unless relay 406 released during the last one and one-half seconds of the cam cycle, when the contacts of cam 8 are open, the converter will continue to run until this portion of the cycle is reached whereupon the contacts of cam 8 will be opened and if relay 406 is released, operating current for converter 100 will be removed and the converter will stop in the position substantially as shown in the drawings of Fig. 1. This feature of preventing the converter 100 from stopping earlier in the cycle is of no advantage in the case just described for the reason that it is assumed that the ringing voltage has failed and therefore keeping the set connected to the load and continuing the code interruptions will serve no useful purpose. This feature, however, is of value in the case of dial transfer to be later described, as in this case the set in operation is assumed to be generating its normal voltage at the time of transfer and therefore it is desirable to prevent the set from stopping until it has completed a full cycle of code rings thereby obviating the possibility of false ringing, i. e., transmitting only a part of a selected code. This feature is also of value when a set stops due to "no calls" in the office in order that in the next case it will start at the correct point.

From the foregoing it will be observed that when the transfer is completed relays 405, 432, 421 and 300 are operated under control of the MS conductor, relays 406 and 107 are released, set 1 is stopped and set 2 is in operation, and further that pilot lamp 423 associated with the control circuit of the ringing equipment is lighted and battery is connected to conductor 422 which may extend to a distant master office to light a second lamp or display some other signal.

In case set 2 fails to generate ringing potential sufficiently high to operate relay 224, before relay 429 releases, relay 434 will be operated to light the major alarm pilot lamp 435 and to connect ground to the alarm conductor 436 but no further transfer will be attempted.

When an attendant at the distant master office notes the signal controlled over conductor 422, which will be interpreted as a minor alarm, i. e., that one machine has failed but that the second machine has been substituted and is supplying the load, it will be understood that steps will be taken as soon as convenient to correct the trouble and having done this to retransfer the load to the first machine which is accomplished by momentarily operating key 468 thereby opening the locking circuit for relay 405 which releases, whereupon, if the MS conductor is grounded at the time, relays 404, 407 and 406 will operate in turn and relay 432 will release thereby removing battery from conductor 431 which provides operating current for the converter of set 2 and connecting battery to conductor 430 which will start converter 100 of set 1. Under this condition set 2 will not stop until it has completed its code ring cycle due to the arrangement of its cam shaft which is similar to that of set 1 previously described.

Dial transfer (set 1 to set 2)

As it is assumed that the exchange with which the present ringing equipment is associated is what is known as a community dial office, i. e., a small unattended automatic exchange located at some distance from a so-called master office, i. e., a larger exchange in a neighboring city or large town, the constant attendance of a maintenance man at the community office is not needed and in fact calls from such an employee at such offices may be of very infrequent occurrence. As it is desirable, in cases where duplicate ringing machines are provided, to alternate them in service in order to equalize the wear, as for example, connect set 1 to supply the exchange load for one week, with set 2 in reserve in case of a failure of set 1, and the next week to connect set 2 to the load, with set 1 in reserve. This requires means whereby an attendant either at the master office, or at the community office, can, by dialing either one of two predetermined community office line numbers, which correspond respectively to the two sets, determine whether or not the set whose number is dialed is the set then supplying the load, in which case the usual line busy tone will be heard in the receiver of the telephone set being used. If, however, no busy tone is heard it will be understood that the number of the idle set has been dialed in which case a train of switching operations will thereupon be automatically initiated to cause a transfer of the load from the machine then supplying it to the other machine whose number has been dialed, in other words by dialing either one of two assigned numbers, if the machine, whose number is dialed, is in operation, a busy tone will be heard but if no busy tone is heard the number dialed is the one corresponding to the idle machine which machine will thereupon be started and the machine then in service stopped. The manner by which this transfer is effected will now be described in detail.

439 at the lower right of Fig. 4 represents the brushes of a well-known connector switch in a step-by-step dial office adapted to be moved into engagement, under control of dial pulses, with terminals in a connector bank in which subscribers' lines terminate and 441 and 442 represent two such sets of line terminals not assigned to lines but whose sleeve or third terminal is connected by respective conductors 440 and 443 with the control circuit of the ringing power plant herein described. If we assume the normal condition of the control circuit as indicated by the drawings, set 1 is the equipment which will start and supply the ringing load when a ground is applied to conductor MS by the initiation of a call in the community office. Now assume an attendant at the distant master office reaches a community office over the usual dial trunk and proceeds to dial the number which will move connector brushes 439 into engagement with the bank terminals designated 441. Prior, however, to the connector being reached, and in fact before the line finder reaches the calling line, the relay 400 will be energized which will start set 1 as previously explained in case the set is not already in operation due to another call being in progress.

When the sleeve brush reaches the bank terminals 441, it will encounter ground on the sleeve terminal which can be traced from ground, contacts 445 of relay 405, and contacts 467 of relay 421. This ground, as is well understood, causes a well-known circuit operation to connect a line busy tone to the calling station which will indi-

cate, in the present case, that set 1 is the machine in service. Upon receiving this tone indication, if it is desired to transfer the load to the other machine, the attendant will then hang up, momentarily, and then dial the number corresponding to set 2 which will move the connector sleeve brush into engagement with the sleeve terminal of bank terminals 442. Due to the fact that the sleeve brush of the connector is at ground potential, relay 448 will operate in a circuit including contacts 466 of relay 421 and contacts 449 of relay 405. Relay 448 operates and prepares a circuit to operate relay 405 when cam shaft 104 of Fig. 1 approaches the end of its rotation cycle, i. e., when cam 6 closes its contact 122. The circuit for operating relay 405 can be traced from ground at the inner right contacts of relay 448, conductor 450, contacts 122 of cam spring 6, conductors 123 and 124, contacts 415 of relay 416 and winding of relay 405 to battery. Relay 448 in operating also locks up at its contact 451 to ground at contacts 452 of relay 416 and opens its contact 453 thereby preventing the minor alarm relay 421 from operating due to the closure of contact 420 of relay 405, when that relay operates, it being evident that the present transfer of machines is premeditated and not due to a failure of set 1 as in the case previously described and consequently no alarm signal should be displayed. Relay 405 in operating opens at its contact 439 the previously traced circuit from the sleeve of the connector bank to relay 448 and at its contact 454 grounds the same connector bank sleeve terminal. Relay 405 also opens its contact 413 thereby releasing transfer relay 107 which disconnects set 1 from the various conductors 203, 204, etc., of Fig. 2 which extend to the switching equipment of the community office and supply ringing current and tone thereto.

In this case it will be noted that relay 405 does not operate until the contacts 122 of cam 6 of set 1 are closed at the end of the ringing cycle whereas in the case of the automatic transfer previously described, this relay operated immediately upon the release of the voltage relay 202 and released relay 107 at once regardless of the position of the cam shaft 104. At its contacts 417, relay 405 in operating opens the circuit for relay 406 which releases slowly and opens its contacts 411 thereby removing operating battery for set 1 from conductor 430 and set 1 comes to rest since it has been pointed out that the cam shaft is already in such an angular position that cam 6 has closed its contacts 122 before relay 405 could operate and by referring to Fig. 5 it will be noted that when cam 6 is in position to close its contacts 122, cam 8 is also in position to remove battery from conductor 430.

Operation of relay 405 also closes its contacts 418 thereby causing relays 419, 429 and 432 to sequentially operate. When relay 429 operates it connects battery at its left contact to conductor 431 extending to the converter of set 2 which corresponds to conductor 430 extending to set 1 and therefore set 2 starts and when relay 432 operates it places a holding battery on conductor 431 as before described. Operation of relay 432 also completes a circuit to operate transfer relay 300 associated with set 2 thereby connecting this machine to the load in substitution for set 1. This circuit extends from ground, contacts 428 of relay 405, conductor 455, winding of relay 300, conductor 456 and contacts 438 of relay 432 to battery.

Dial transfer (set 2 to set 1)

If at a later date, for example in a week, it is desired to effect another transfer back to set 1, the same procedure will be followed and the maintenance man or other employee either at the master office or in the dialing area of the community office will dial first one or the other of the two dial transfer numbers, usually the number corresponding to set 1 thereby setting the connector brushes on terminals 441. As the sleeve terminal will be found to be at battery potential, through relay 447, ground on the sleeve of the connector brush will operate relay 447 thereby opening its outer and middle left contact to prevent operation of the major alarm relay 434 which only operates in the case of a low voltage condition in the second set, either 1 or 2.

Relay 447 locks up at its inner left front contacts to the inner right front contacts of relay 448. At its inner right front contacts, relay 447 closes a circuit to operate relay 416, assuming, of course, that the cam shaft of set 2 is in its normal stopping position, i. e., with the contacts of its cam, corresponding to cam 6 of set 1 in a closed condition. This circuit can be traced from ground, inner right front contacts of relay 447, conductor 457 over the closed contacts of the cam of set 2 (not shown) corresponding to cam 6 of set 1, conductor 303, conductor 458, contacts 459 of relay 448 and winding of relay 416 to battery. Relay 416 operates and locks up over its contacts 460, contacts 461 of key 427 and contacts 462 of relay 447 to ground.

Relay 416 in operating opens its contacts 425 thereby releasing relay 405. Relay 416 also opens its outer left normally closed contacts thereby releasing normally operated relay 463 which removes ground, at its outer left contacts, from contacts 464 of relay 447, so that when relay 447 later releases and opens its contacts 462 to open the holding circuit of relay 416 this latter relay will not be held operated by the immediate re-application of holding ground at contacts 464. Relay 416 also opens its contacts 452 thereby releasing relay 448 which relay in releasing removes the holding ground at its inner right front contacts for relay 447 which thereupon releases which in turn opens its contacts 462 thereby breaking the locking path for relay 416 which thereupon releases. Release of relay 416 closes its outer left contacts thereby reoperating relay 463 which re-connects ground at its outer left contacts to provide a locking ground for relay 416 when this relay operates due to an automatic transfer from set 2 to set 1 in the case, to be later described, where set 1 is connected and supplying the load due to a dial transfer and it fails to generate, in which case relay 447 will be in a released condition. Relay 405 in releasing opens its contacts 418 thereby opening the locking path for relay 432 and closes its contacts 417 thereby operating relay 404 which in turn operates relays 407 and 406 as before described to cause converter 100 of set 1 to start, assuming, of course, that conductor MS is still grounded by the progress of a connection in the exchange. Relay 405 in releasing also closes its contacts 413 which connects ground to conductor 108 and when relay 405 operates and closes its contact 410, relay 107 operates, relay 300 having previously been released when relay 405 opened its contacts 428.

Set 1 is now running and connected to the load and set 2 has been disconnected therefrom and stopped. This transfer cycle can be effected as often as desired, as described.

Automatic transfer (set 2 to set 1)

Now let us assume that a dial transfer from set 1 to set 2 has been effected in the manner previously described and relays 448, 405, 432 and 300 are in an operated condition and let it further be assumed that set 2 fails to deliver a sufficiently high potential to hold relay 224 operated and therefore that relay will release. With relay 432 operated and relay 429 released a circuit can be traced to operate relay 416 as follows: ground, right back contacts of relay 429, inner left front contact of relay 432, contacts of relay 224, conductor 458, contacts 459 of relay 448 and winding of relay 416 to battery. Relay 416 operates and locks over its contacts 460, contacts 461 of key 427, contacts 464 of relay 447, to ground at the outer left front contact of normally operated relay 53. Operation of relay 416 completes a circuit for the right-hand winding of minor alarm relay 421 which can be traced from battery, right winding of relay 421, right-hand contact of normally operated relay 463, outer right back contact of relay 447 and inner left front contact of relay 416 to ground. Relay 421 operates and lights the local pilot lamp 465, indicating the failure of set 2, and connects battery to conductor 422 which extends to the distant master office and at the middle and outer right armature relay 421 grounds both sleeve terminals of the connector bank.

Operation of relay 416 also releases relays 448 and 405. As previously described, set 2 will now be disconnected and its operating circuit opened and set 1 will be started and connected to supply the load. When the maintenance man clears the trouble he will restore the circuit to normal by operating key 427 which releases relay 416 by opening contacts 461. Key 427, when operated, also connects ground at its right-hand contact to energize relay 448 whereupon a transfer again takes place removing set 1 from service and substituting set 2 therefor, as previously described.

What is claimed is:

1. In a telephone exchange, a motor driven generator of alternating ringing current, a plurality of ringing conductors, a rotary switching mechanism driven by said motor, adapted to transmit a characteristically different series of cyclically recurring impulses of said ringing current to each of said conductors, said impulses corresponding to predetermined ringing codes, a source of current for driving said motor, relay means for connecting said motor to said source of driving current, and means controlled by said switching mechanism to prevent release of said relay means from disconnecting said motor from the source until a complete cycle of all code impulses has been transmitted.

2. In a telephone exchange, a pair of motor driven generators of alternating ringing current, a plurality of ringing current conductors for each generator, a single plurality of exchange conductors for utilizing ringing current applied thereto, transfer means for connecting either plurality of ringing current conductors to said single plurality of exchange conductors, a rotary switching mechanism individual to each generator and driven by the respective motor adapted to transmit different series of cyclically recurring impulses of said generated ringing current to each associated ringing conductor, said impulses corresponding to predetermined ringing codes, a source of current for driving said motors, individual relay means for connecting either of said motors to the driving source to the exclusion of the other motor and for causing the transfer means to connect the

respective ringing current conductors to the single plurality of exchange conductors, means for initially operating one of said relay means, manually controlled means for causing the transfer means to transfer the exchange conductors from the ringing conductors supplied by the operating generator to the other plurality of ringing conductors, to release the operated relay means and operate the second relay means, and means controlled by the rotary switching mechanism associated with the operating generator to prevent operation of said manually controlled means until a complete cycle of all code impulses has been transmitted from the operating generator.

3. In an automatic telephone exchange, first and second motor generator sets for producing alternating ringing current, normally arranged for said first set to supply ringing current to the exchange, individual relay means for controlling the motors of the sets and the connection of the respective generators to the exchange circuits, means controlled by different predetermined settings of a connector switch in the exchange under control of dial impulses for controlling said individual relay means to stop and disconnect the set supplying current to the exchange and to start and connect the other set to the exchange circuits, thereby transferring the exchange load to the other set, means responsive to failure of one set to supply a predetermined minimum ringing potential to the exchange to control said individual relay means in a similar manner to transfer the exchange circuits to the other set and to prevent any subsequent switching operation, either manually controlled by dialing, or automatically by a second failure of the ringing potential, to effect a retransfer.

4. In a switching system, a telephone exchange, first and second motor generator sets for producing different combinations of alternating ringing current impulses, a source of electrical current for driving the motors of said sets, individual relay means for connecting each motor to said source, means responsive to the initiation of a call in the exchange to normally operate the relay means connecting the first motor to the driving source, exchange circuits for utilizing the ringing current impulses produced by said generators, switching means individual to and responsive to operation of either relay means for

connecting the output of the respective generator to said exchange circuits, a first voltage relay individual to the first generator responsive to predetermined ringing current potential and connected to ringing current conductors of the exchange circuits when the switching means for connecting the first generator thereto is operated, a second voltage relay individual to the second generator responsive to the same potential value and connected to the same ringing current conductors when the other switching means is operated, means responsive to the release of the first voltage relay to release the operated switching and relay means thereby effecting a transfer of the exchange circuits from the first to the second generator by disconnecting the exchange circuits from the operating generator, the respective motor from the driving source, and the first voltage relay from the exchange circuit conductors, and to operate the other relay means thereby connecting the second motor to the driving source and operating the other switching means to connect the second generator output to the exchange circuit and to connect the second voltage relay thereto, said means when operated preventing release of the second voltage relay from effecting any further transfer.

5. In a ringing current supply system for automatic telephone exchanges, duplicate ringing machine sets, each set adapted when in operation to periodically deliver a plurality of different ringing codes, means responsive to the initiation of an exchange connection to start one of said sets and connect it to the exchange equipment, means responsive to the establishment of a predetermined exchange connection to initiate the stoppage of the operating set and its disconnection from the exchange and the starting and connection of the other set to the exchange, means controlled by the set in operation to prevent its disconnection and stoppage before the completion of the code cycle then in progress, and means responsive to failure of an operating and connected set to supply a predetermined minimum potential to immediately disconnect and stop said defective set and start and connect the other set.

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