

Feb. 19, 1946.

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2,395,132

ELECTRICAL SIGNALING SYSTEM

Filed May 27, 1941

4 Sheets-Sheet 1

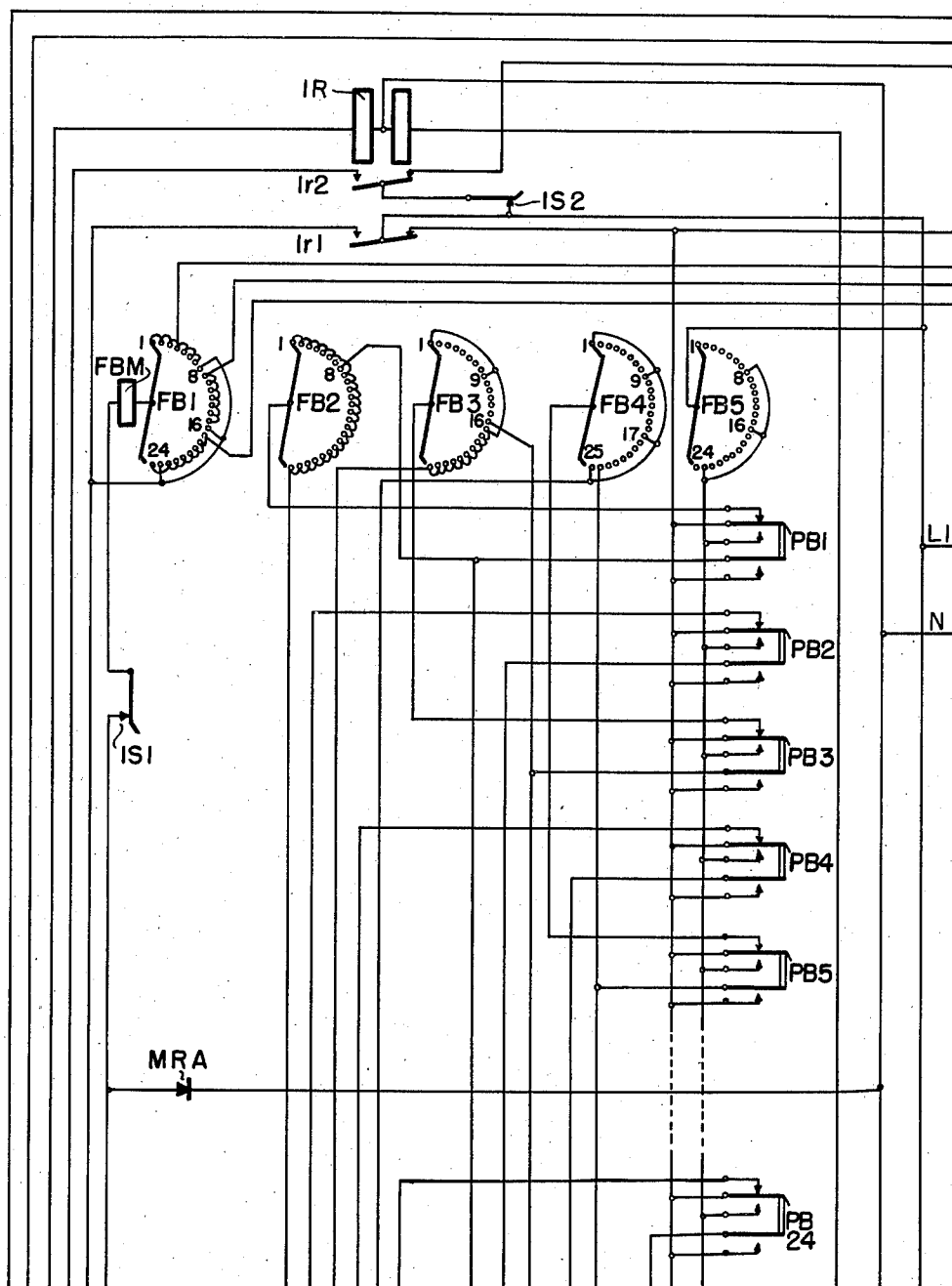


FIG. 1

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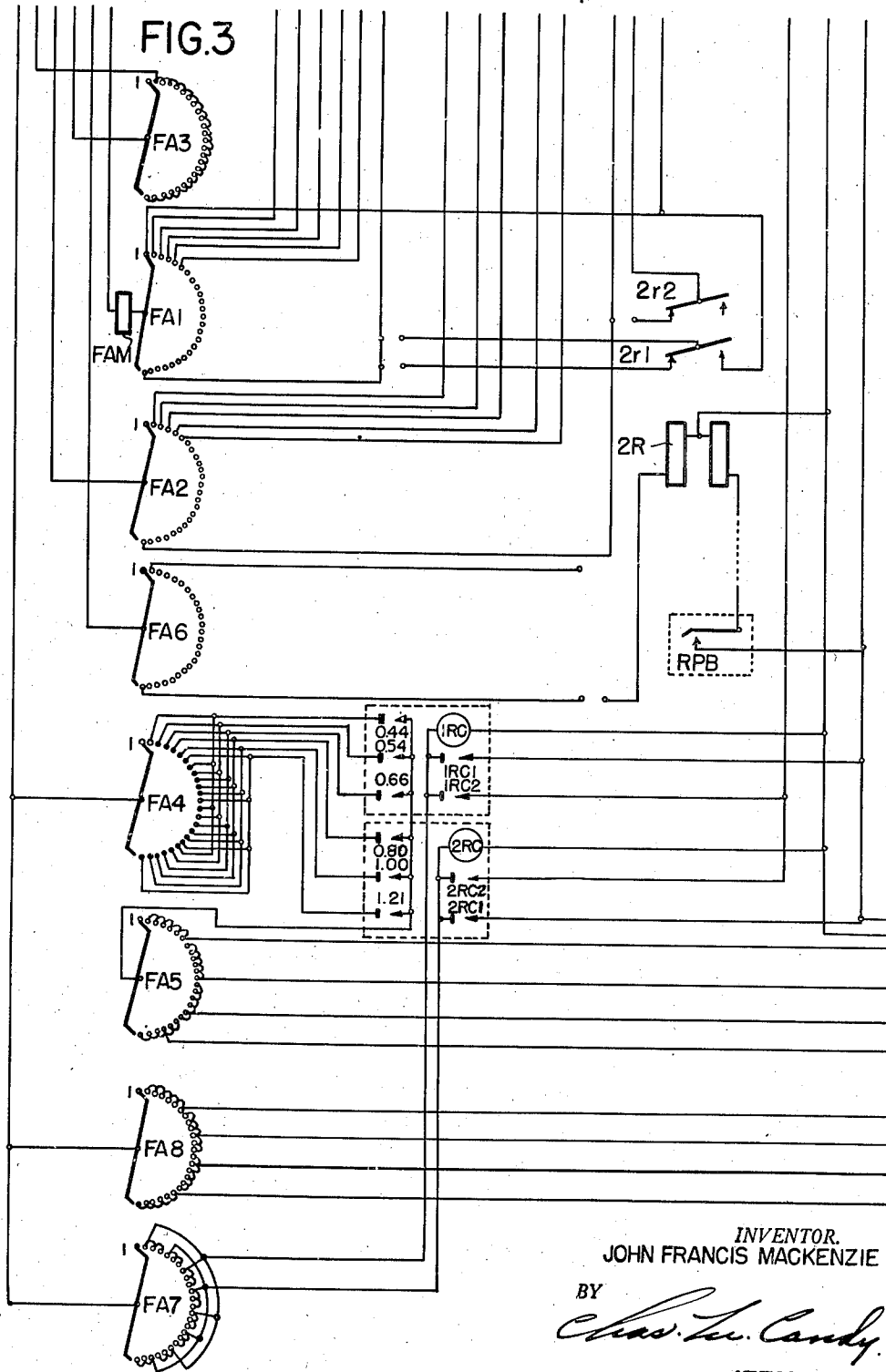
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4 Sheets-Sheet 3



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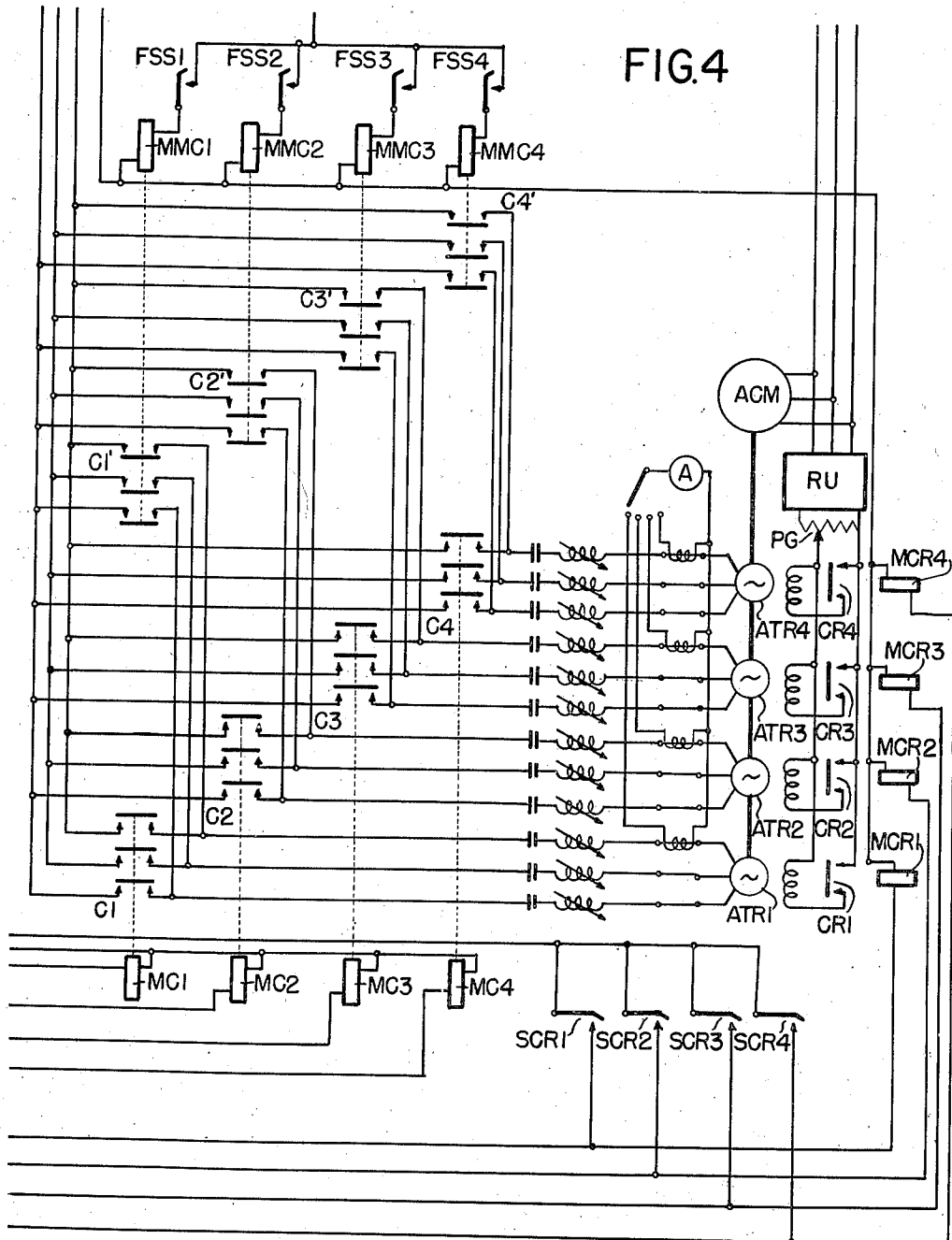
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4 Sheets-Sheet 4



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ELECTRICAL SIGNALING SYSTEM

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In Great Britain May 30, 1940

10 Claims. (Cl. 177—380)

The present invention relates to electrical signaling systems and is more particularly concerned with centralised control systems in which signaling is effected over electric supply networks by the use of currents of high frequency compared with the supply frequency, such systems finding application to the centralised control of street lights, domestic water heaters, public warning signals and the like. The invention is more-over particularly concerned with equipment for use at the controlling point in so-called cadence or rhythm signaling systems, that is to say, systems in which a number of the control signals employed are of the same high frequency, the required selective control being effected by interrupting this frequency at differing slow rates or cadences. The general object of the invention is to provide improved control station equipment for cadence signaling over power mains which gives reliability, simplicity and efficiency of operation.

According to one feature of the invention in a transmitting arrangement for the application of characteristic control currents to an electric supply network, the transmitting equipment is provided in common to a plurality of signal initiating elements, conflict between signals initiated substantially simultaneously being prevented by connecting the initiating elements to transmitting equipment over an automatically operated multi-way switching device which is adapted to have its operating circuit opened while a transmission is in progress.

According to another feature of the invention, in a transmitting arrangement for the application of characteristic control currents to an electric supply network, the necessary transmission is automatically effected for a predetermined time in response to the momentary operation of the appropriate one of a plurality of push buttons or the like which is adapted to set in operation transmitting equipment common to all the push buttons.

The invention will be better understood from the following description of one method of carrying it into effect, reference being had to the accompanying drawings comprising Figs. 1-5. Figs. 1-4 when arranged in the manner indicated in Fig. 5 show the circuits of the control apparatus in conventional manner.

Referring particularly to Fig. 2, it will be seen that the supply network over which the rhythm signals are to be extended is assumed to be of the 4-wire 3-phase type and responding relays of the type described in my British Patent No. 518,877,

issued May 30, 1940, are assumed to be connected between any one of the phase leads L1, L2, L3 and the neutral lead N.

The equipment caters for four different signal frequencies, and six rhythms of each can be applied giving a total of twenty-four distinctive signals. The assumed periods of the rhythms are as follows: .44 second, .54 second, .66 second, .8 second, 1.0 second and 1.21 seconds, while the frequencies utilised are within the range 500-3000 cycles.

The signal source comprises a single three-phase alternating current motor ACM arranged to drive four alternators ATR1-ATR4 by way of a common shaft, one alternator being provided for each control frequency. This arrangement enables progressive installation of additional signaling frequencies to be effected in a simple and convenient manner. Each of the alternators is of the inductor type in which the rotor consists of a rotating iron circuit with no windings, slip-rings or commutator, and gives a 3-phase output at a potential of the order of 50 volts. Starting up of the motor alternator set is effected by an automatic starter ASE directly and indirectly under control of signaling push buttons.

The injection circuit from each alternator extends via a resonant circuit including adjustable inductors, capacitors and suitable fuses to the low tension windings of the service transformer ST whence the signals extend over the local network and also by transformation through into the high tension circuit and thence into other L. T. networks connected thereto. The output circuits of the various alternators are adapted to be interrupted by means of so-called rhythm contactors C1-C4 controlled by commutator or camshaft rhythm controllers driven by small synchronous motors 1RC and 2RC, and the rhythm contactors may be of the oil-immersed type under heavy duty conditions.

The initiation of a control signal is effected manually by depressing the required one of a group of twenty-four push buttons PB1-PB24, corresponding to the twenty-four distinctive signals provided for, whereupon all the necessary operations follow automatically. Automatic control is also available from time switches, particularly for street lighting control purposes, while signals can also be communicated to the control equipment from a remote point, such signals being received on relays which simulate the operation of selected push buttons. In addition, manual control is provided to enable signal

emission to be effected in the event of any abnormal condition arising in the automatic control equipment which would prevent it functioning properly. For the manual control circuit it is preferable to duplicate certain items such as the rhythm contactors and the rhythm controllers, two of which are ordinarily provided for the six different rhythms.

To ensure that a plurality of signal transmissions can never be initiated simultaneously, electrical interlock arrangements are provided between the various push buttons and the auxiliary services such as time switch and remote control. The arrangements are broadly such that when a signal is initiated, a telephone-type reverse-drive step-by-step uni-directional 25-point selecting switch FA operated from half-wave rectified alternating current is caused to rotate to a position corresponding to the particular signal required and so effect connection to the generator starting equipment. As this switch can only occupy one position at a time, there is no possibility of two signals being transmitted simultaneously. Other signals initiated during the transmission of a signal are dealt with one by one as each transmission is concluded.

It will be seen that the push buttons PB1—PB24 are associated with contacts 2—25 respectively of banks FA1 and FA2 of the stepping switch FA, the wipers of which normally occupy the home position 1 as shown. The switch FA and also the switch FB, the function of which will be described subsequently, are of the type commonly employed in telephone systems.

Considering now the detailed circuit operations and assuming that push button PB4 is actuated, a circuit is completed from neutral, rectifier MRA, Fig. 1, stepping magnet FAM of the switch FA, wiper FA1 and its first bank contact, operated contacts of push button PB4, resting armature 1r1, of the mechanical locking relay 1R, to L1 (the live side of the supply main).

On the first half cycle of alternating current during which rectifier MRA is conductive, magnet FAM will be energised and on the release of the magnet during the next half cycle, the wipers of the switch FA are stepped from contact 1 to contact 2. This process is repeated and the switch continues to advance its wipers one step for each alternate half cycle until they reach the contacts associated with the particular actuated push button whereupon the driving circuit is disconnected. It will be seen that the driving circuit is maintained at each successive step via the normally made upper break contacts of the push buttons PB1—PB3 and is finally disconnected at the operated upper break contacts of push button PB4. With a mains frequency of 50 cycles a second, the switch FA operates at 50 steps per second and the total time to find even the last push button PB24 is therefore less than half a second.

When the switch FA has been correctly set to position 5 corresponding to the operated push button PB4, a circuit is completed from the supply main L1 via resting armature 1r1 and operated lower contacts of this push button, contact 5 in bank FA2, wiper FA2 and the left-hand "operate" winding of the two-coil mechanical locking relay 1R to neutral. Relay 1R thereupon operates and disconnects its own circuit at armature 1r1 but it remains mechanically locked in the operated position. Relay 1R also at its armature 1r2, completes a circuit from L1 over isolating switch IS2, contact 1r2, wiper and

bank FA3 to the starting equipment ASE associated with the motor alternator set, and also to the motor MS of a small motor-driven delay period timing mechanism. Motors MS and ACM both start. Contacts MS1 close immediately the motor MS starts to run, while contacts MS2 change over after a delay period has elapsed sufficient to enable the motor alternator set to run up to speed, which period is of the order of 20 seconds. Contacts MS2 on operating disconnect the driving circuit for the motor MS which therefore stops, and at the same time complete circuits over wipers and banks FA8, FA4 and FA7 in parallel.

Wiper and bank FA3 serve to complete a circuit to the appropriate one of the operating coils MCR1—MCR4 of the contactors CR1—CR4 and thereupon effect the excitation with direct current supplied via the rectifying unit RU and the field regulator PG of the stator winding of the particular alternator which delivers the frequency of the required signal. In the present instance with wiper FA8 positioned on contact 5, coil MCR1 will be energised and will operate its contactor CR1 to energise the field winding of alternator ATR1 so that of the four alternators shown this alternator only will deliver a suitable audio frequency output, which output will extend via the resonant circuit and contactor C1 to the supply network.

Wiper and bank FA4 select the particular rhythm required, in this case the rhythm with a period of .8 second, while wiper and bank FA5 select the operating coil of the contactor associated with the required signal frequency, in this case coil MC1. Wiper and bank FA7 select the required rhythm controller, two of which are provided, controller 1RC serving the three small period rhythms, .44, .54 and .66 second and controller 2RC serving the three longer period rhythms, .8, 1 and 1.21 seconds. In this case controller 2RC is selected and is started up.

Transmission of .8 second rhythm audio frequency impulses now follows for a period of 30 seconds which represents the time required by the controller 2RC to complete one revolution. It will be remembered that the alternator set required 20 seconds to run up to speed and the total time required for complete transmission of any set of pulses under control of controller 2RC is therefore 50 seconds, while 35 seconds only is required in the case of controller 1RC which performs four complete revolutions per minute.

The rhythm controller 2RC in moving off-normal completes a local locking circuit for itself via its off-normal contacts 2RC1 and when it has nearly completed a revolution, an additional pair of release contacts 2RC2 are momentarily closed and complete a circuit from neutral, right-hand "release" coil of relay 1R, momentarily operated release contacts 2RC2 and operated off-normal contacts 2RC1 to the live side of the mains. Relay 1R therefore restores to its normal position in which the armatures 1r1 and 1r2 each occupy the position shown in the drawings. Since the push button PB4 will now have been restored, the selector switch FA will proceed to step onwards in the same manner as has already been described in connection with the initial finding operation until it reaches the home position 1 where the driving circuit is opened owing to the fact that all push buttons are normal and the switch thereupon remains in this position in readiness for a subsequent selection. Relay 1R upon releasing also at armature 1r2, recloses the

circuit to the delay period timing motor MS over operated contacts MS1 and this motor restarts. Contacts MS2 now restore and further on towards the end of the operating cycle, contacts MS3 are momentarily opened in order to trip the motor alternator starter ASE. At the end of the operating cycle, contacts MS4 open to halt the operation of the timing motor. The motor alternator set runs down to a stand-still owing to the tripping of the starter ASE while the rhythm controller 2RC also stops itself at the completion of the operating cycle by opening its own driving circuit at its off-normal contacts 2RC1. The apparatus is now ready for the next selection.

In the event of there being any preselected or stored signal waiting at the conclusion of any transmission cycle, the switch FA on reaching its home position will immediately recommence to hunt to a new position whereupon it will reoperate relay IR. Alternatively, if any one of the keys PB5 to PB24 has been already depressed, the switch FA will stop at the calling position during its homing operation and will re-operate relay IR. Transmission of the new signal will then follow in the manner already described.

Similar operations to those described take place in response to depression of any other of the buttons PB1—PB24 and it will be readily appreciated that if more than one button is depressed at a time, the switch FA will set itself to a position corresponding to the lowest numbered button operated in the sequence 1-24 and the signal transmission corresponding to a higher numbered push button cannot therefore be transmitted at the same time as the first signal.

For checking purposes it is arranged that the state of the sets of responding devices associated with the various facilities is permanently indicated on the control panel and preferably a responding switching device similar to those which are remotely controlled is provided at the control station for each of the facilities catered for. Assuming that the operation of push button PB4 switches on water heaters, the responding device at the control point associated with this facility will close a pair of contacts to light the "on" lamp associated with this facility. Assuming further that in order to switch the water heaters off it is necessary to operate push button PB6, then in response to the depression of this push button, signals are sent out to restore the distant responding devices for this facility to normal and at the same time the corresponding check responding device is also restored. In so doing it closes another pair of contacts to light the "off" lamp and at the same time opens the first pair of contacts to extinguish the "on" lamp.

In addition to the provision of push buttons for emergency control of street lights, control may be exercised normally by a time switch, for instance, of the electrically driven type such as that shown in Fig. 2 which provides for so-called "half-night" street light switching. This comprises two synchronous motor driven units each of which is equipped with a solar dial, one closing the contacts *tsd* at dusk and opening them at dawn, and the other closing the contacts *tsm* for a short period at midnight.

When at dusk the contacts *tsd* are closed, the non-locking relay 5R operates and at armature 5r1, completes a circuit from neutral, rectifier MRA, isolating switch IS1, magnet FBM of switch FB, wiper and bank FB1, armatures 5r1 and 1r1 to the live side of the mains. Switch FB now advances its wipers step-by-step to contact 8

where the driving circuit is opened and the switch comes to rest. Wiper FB5 on contact 8 thereupon completes a circuit to advance the switch FA from position 1 to position 2. Switch FA cannot advance any further than this position, since the driving circuit is opened at bank and wiper FB2 and an operating circuit is now completed for relay IR from neutral over the left-hand "operate" winding of relay IR, wiper FA2 in position 2, FB2 bank contact 8 and wiper FB2, normally made upper break contacts of push button PB1 and resting armature 1r1 to the live main. Relay IR operates and mechanically locks and at its armature 1r1 completes a stepping-on circuit for switch FB via bank and wiper FB1 to advance the FB switch wipers to contact 9.

Dusk, midnight and dawn control of street lights is also effected by push buttons PB1, PB3 and PB5 respectively, and it will be seen that in the above instance when the switch FA is positioned under time switch control on to contact 2 associated with push button PB1, relay IR on operating effects transmission of the same signal as though push button PB1 had been operated, thereby to switch on the street lights. On the completion of this signal, the switch FA restores to its home position and relay IR is restored to normal as previously described, while the wipers of switch FB remain on contact 9.

At midnight the contacts *tsm* of the other unit close for a short period and operate a non-locking relay 4R whereupon at armature 4r1, a circuit is completed from L1 via resting armature 1r1, operated armature 4r1 and bank FB1 for causing, switch FB to advance its wipers from contact 9 to contact 16. A stepping-on circuit for switch FA is now completed due to the extension of live mains potential over wiper FB5 in position 16 and thence over bank and wiper FA1 to neutral via magnet FAM and the switch FA now hunts from contact 1 to contact 4 where its movement is arrested due to the hunting circuit being opened at wiper FB3 on contact 16. Relay IR now operates via neutral, the left-hand winding of relay IR, wiper FA2 in position 4, wiper FB3 in position 16, normal contacts of push button PB3 and normal armature 1r1. Relay IR operates, causing switch FB to advance its wipers to contact 17 where they remain until in due course the dawn switching operation is made. Transmission of the so-called half-night or midnight switching signal now proceeds as though push button PB3 had been operated and upon its completion, switch FA returns its wipers to the home position and relay IR releases as before.

At dawn the "dusk and dawn" time switch contacts *tsd* open and relay 5R releases and at armature 5r1 causes switch FB to advance its wipers from contact 17 to contact 24, the hunting circuit being maintained from L1 over resting armatures 1r1 and 5r1, bank and wiper FB1. Switch FA now hunts to position 6 after being stepped on from position 1 over a circuit extending from L1 over wiper FB5 in position 24 and wiper FA1 in position 1. Relay IR then operates via neutral, left-hand winding of relay IR, wiper FA2 in position 6, FB4 bank contact 24 and wiper FB4, normal contacts of push button PB5 and armature 1r1 to live mains and in so doing at its armature 1r1 causes switch FB to advance to position 25. Subsequently when relay IR releases the switch FB is advanced to the home position 1 in readiness for the next series of time

switch controlled street light switching operations. Transmission of the "lights out" dawn signal proceeds in the manner described after which the switch FA and all the other apparatus returns to normal.

Remote control of the injection apparatus from one or more distant points is provided for by means of mechanical locking relays such as 2R each of which connects by a single pilot wire to a remote push button such as RPB and which are provided with armatures to simulate the operation of any of the local control station push buttons which they are replacing. Relay 2R is shown to be associated with certain conductors leading to the local push button PB24, and it will be appreciated that either this relay or another one of the remotely controlled relays may be connected in identical fashion to be corresponding conductors for any of the remaining local push buttons; for this purpose, the armatures of these relays are arranged to be conveniently connected by means of tag blocks to the appropriate contacts in the banks FA1 and FA2. The release coil on these relays connects with contacts in bank FA5 corresponding to the appropriate push button, and hence when relay 1R operates, the operation of contact 1r1 causes the particular remote control relay which initiated the signal to be restored.

For emergency manual control purposes certain of the items of apparatus are duplicated, for instance, the rhythm controllers and the rhythm contactors. When bringing manual control into operation, the automatic control apparatus involving the time switch-controlled switch FB and the timing motor MS is first disconnected by opening the isolating switches IS1 and IS2, and the motor alternator set is then run up by momentarily depressing the start push button STB, Fig. 3. Appropriate ones of the rhythm and frequency selector switches RSS1—RSS6 and FSS1—FSS4 are next closed while the required one of the alternator field winding contactors CR1—CR4 is also operated by manually operating one of the switches SCR1—SCR4 to complete an electrical circuit to the operating winding thereof. Lastly, the start push button 1RSB or 2RSB of the desired duplicate rhythm machine is momentarily actuated and machine 1MRC or 2MCR as the case may be locks in to its off-normal contacts 1MCR1 or 2MCR2 and a transmission cycle is then initiated. The selected rhythm contactor coil of the group MMC1—MMC4 is impulsed in accordance with the selected cadence or rhythm and so by means of the associated contactor controls the extension of audio frequency current from the alternator in question. At the end of the cycle the rhythm machine disconnects itself and the motor alternator set is then stopped by operation of the stop push button SPB.

In case a time switch signal or a signal from a remotely controlled point should be received during a normal transmission initiated from one of the push buttons, this call will be stored until completion of the transmission in progress and will be dealt with in the manner already described when relay 1R releases and completes the homing circuit for switch FA.

For record and observation purposes the values of the injected voltage and current can be indicated on the voltmeter V and ammeter A, by connecting them up to the appropriate signal

frequency channel over the four-position manually operable radial switches shown.

The invention is not limited to the particular type of high frequency alternator described, and use can also be made of a single-phase high frequency alternator from which connection to the L. T. side of the service transformer may be effected in the manner disclosed in the U. S. Patent No. 2,319,633, issued May 18, 1943, to Philip Norton Roseby and John Francis Mackenzie. The time switch need not be moreover of the particular type described since if use were made of a momentary contact time switch the switching could be effected in a similar way to the remote control facility thereby avoiding the use of the additional switch FB.

I claim:

1. In combination, a plurality of independently operable devices, a register common to said devices and responsive to an operation of any of said devices to identify the device operated, means controlled by said register for generating alternating current of a frequency dependent upon the identity of the device operated, said frequency being different for different ones of said devices, and other means controlled by said register for repeatedly interrupting said generated current at a rate independent of the frequency of said current but dependent upon the identity of the device operated, said rate being different for different ones of said devices.

2. In combination, a plurality of independently operable devices, a register common to said devices responsive to an operation of any of said devices for identifying the device operated and thereafter, independently of any of said devices, maintaining a registration of the identity of the operated device for a predetermined interval of time, means controlled by said register for generating, during said interval, alternating current of a frequency dependent upon the identity of the device operated, said frequency being different for different ones of said devices, and other means controlled by said register for repeatedly interrupting said generated current at a rate independent of the frequency of said current but dependent upon the identity of the device operated, said rate being different for different ones of said devices.

3. In combination, a plurality of devices, means for operating any desired one of said devices transitorily at will, a register normally responsive to a transitory operation of any one of said devices to register the identity of the operated device, means effective upon said registration of the identity of the operated device to render said register temporarily non-responsive to the subsequent operation of any of said devices, a sender operative responsive to said registration, means in said sender controlled by said register for generating alternating current of a frequency dependent upon the identity of the device operated, said frequency being different for different ones of said devices, other means in said sender controlled by said register for repeatedly interrupting said generated current at a rate independent of the frequency of said current but dependent upon the identity of the device operated, said rate being different for different ones of said devices, and means controlled by said sender after an interval for again rendering said register responsive to the operation of any one of said devices.

4. In combination, a plurality of independently

operable devices, a register common to said devices and responsive to an operation of any of said devices to identify the device operated, means controlled by said register for generating current of a character dependent upon the identity of the device operated, the character of said current being different for different ones of said devices, and other means controlled by said register for repeatedly interrupting said generated current at a rate dependent upon the identity of the device operated, said rate being different for different ones of said devices.

5. In combination, a plurality of devices arbitrarily divided into a plurality of primary groups and a plurality of secondary groups so that each device belongs to a particular primary group and also to a particular secondary group and so that none of the devices belonging to the same primary group belong to the same secondary group and none of the devices belonging to the same secondary group belong to the same primary group, means for operating any desired one of said devices at will, equipment responsive to an operation of any of said devices to determine both the primary group and the secondary group to which the operated device belongs, means controlled by said equipment for generating alternating current of a frequency dependent upon the primary group to which the operated device belongs, said frequency being the same for all devices belonging to the same primary group but being different for devices belonging to different primary groups, and means controlled by said equipment for repeatedly interrupting the generated current at a rate depending upon the secondary group to which the operated device belongs, said rate being the same for all devices belonging to the same secondary group but being different for devices belonging to different secondary groups.

6. In combination, a plurality of devices arbitrarily divided into a plurality of primary groups and a plurality of secondary groups so that each device belongs to a particular primary group and also to a particular secondary group and so that none of the devices belonging to the same primary group belong to the same secondary group and none of the devices belonging to the same secondary group belong to the same primary group, means for operating any desired one of said devices at will, equipment responsive to an operation of any of said devices to determine both the primary group and the secondary group to which the operated device belongs, means controlled by said equipment for generating current of a character dependent upon the primary group to which the operated device belongs, the character of said current being the same for all devices belonging to the same primary group but being different for devices belonging to different primary groups, and means controlled by said equipment for interrupting the generated current at a rate depending upon the secondary group to which the operated device belongs, said rate being the same for all devices belonging to the same secondary group but being different for devices belonging to different secondary groups.

7. In combination, a plurality of devices arbitrarily divided into a plurality of primary groups and a plurality of secondary groups so that each device belongs to a particular primary group and also to a particular secondary group and so that none of the devices belonging to the same primary group belong to the same secondary group and none of the devices belonging to the same second-

ary group belong to the same primary group, means for operating any desired one of said devices at will, equipment responsive to an operation of any of said devices to determine both the primary group and the secondary group to which the operated device belongs, means controlled by said equipment for generating a wave characteristic of the primary group to which the operated device belongs, and other means controlled by said equipment for modulating said wave in a way characteristic of the secondary group to which the operated device belongs.

8. In combination, a plurality of devices arbitrarily divided into a plurality of primary groups and a plurality of secondary groups so that each device belongs to a particular primary group and also to a particular secondary group and so that none of the devices belonging to the same primary group belong to the same secondary group and none of the devices belonging to the same secondary group belong to the same primary group, means for operating any desired one of said devices at will, equipment responsive to an operation of any of said devices to determine both the primary group and the secondary group to which the operated device belongs, means thereupon effective to render said equipment non-responsive to the operation of any of said devices for an interval of time, means controlled by said equipment for generating, during said interval, a wave characteristic of the primary group to which said one operated device belongs, other means controlled by said equipment for modulating said wave in a way characteristic of the secondary group to which said one operated device belongs, and means operated at the end of said interval for again rendering said equipment responsive to the operation of any of said devices.

9. In combination, a plurality of independently operable devices, a register common to said devices and responsive to an operation of any of said devices to identify the device operated, means controlled by said register for generating current of a character dependent upon the identity of the device operated, the character of said current being different for different ones of said devices, a plurality of motors each having associated therewith a different group of contactors, means in said register for selecting one of said motors in accordance with the identity of the operated device and causing the selected motor to operate each of the contactors of its associated group repeatedly, the different contactors in such group being operated at different speeds, means in said register for selecting one of the operating contactors in accordance with the identity of the operated device, and means including the selected contactor for repeatedly interrupting said generated current at a rate dependent upon the speed at which said selected contactor is operating.

10. In combination, a plurality of devices arbitrarily divided into a plurality of primary groups and a plurality of secondary groups so that each device belongs to a particular primary group and also to a particular secondary group and so that none of the devices belonging to the same primary group belong to the same secondary group and none of the devices belonging to the same secondary group belong to the same primary group, means for operating any desired one of said devices at will, equipment responsive to an operation of any of said devices to determine both the primary group and the secondary group to which the operated device belongs, means controlled by said equipment for generating a wave

characteristic of the primary group to which the operated device belongs, a plurality of groups of controllers, means in said equipment for selecting different ones of said groups at different times and, at each of said times, preparing all controllers in the selected group to exercise a control over said generated wave, other means in said equipment for selecting a particular one of

the prepared controllers in accordance with the secondary group to which the operated device belongs, and means including the selected controller for modulating the generated wave in a way characteristic of the secondary group to which the operated device belongs.

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