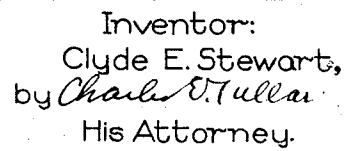


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INDICATING SYSTEM

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My present application relates to certain improvements in the system disclosed in my former application, Serial No. 260,168, filed March 8, 1928, entitled Supervisory control systems corresponding to British Patent 307,469, and it deals with indicating system which, while not limited thereto, is particularly adapted for use in connection with supervisory systems of the type therein disclosed.

In supervisory control systems in which synchronously operated rotary selector switches are employed, one in the dispatcher's station and the other in the remote station, by means of which line conductors extending between the two stations are connected to any one of a plurality of supervised devices in the remote station and to a corresponding control key or indicating device in the dispatcher's station, some means is necessary to indicate to the operator the position in which the selector switches stand. By such means the operator may be informed as to when the selector switches are in position such that a desired control operation may be performed.

In the system described in my above mentioned application this indication is had by providing lamps one of which corresponds to each position of the selector switch in the dispatcher's station and which is lighted whenever the switch comes to rest in any off-normal position. While this means produces a very reliable indication and one that is suitable for most practical purposes, it sometimes occurs where important circuit breakers are controlled and supervised by the equipment that additional means are desired to indicate the position of the remote switch, thereby to eliminate any possibility of a discrepancy in the position of the two switches resulting in error in the control operation.

Accordingly one of the objects of my invention is to provide means for indicating to the operator the position of the selector switch in the remote station independently of the position of the switch in the dispatcher's station.

In large supervisory systems where a great many remote devices are controlled and supervised through the same line conductors it is desirable, for reasons of economy, that the same equipment be utilized, in so far as possible, to indicate a large number of positions of the remote switch, or switches where more than one are employed. Accordingly another purpose of my invention is to provide equipment which is associated with the switch in the remote station whereby a simple indicating device such as a frequency meter having, for example, ten frequency responsive vibrating reeds, may be utilized in the dispatcher's station to indicate a much larger number of positions of the remote switch, or switches.

A further purpose of the invention is to provide a system for indicating quantities, which while having particular utility in connection with the indication of the positions of a remote element such as the remote distributor switch of the supervisory system above indicated, is not limited thereto but may be employed in a wide variety of applications.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 represents an embodiment of my invention, and Fig. 2 represents a detail.

Referring to Fig. 1 of the drawing I have shown at the lower portion thereof, in as great detail as is necessary for an understanding of my invention, a supervisory control system with which my present invention has particular utility. This system includes a selector switch A at the dispatcher's station and a selector switch A' at a remote station, each of which comprises a plurality of banks of contacts and associated wipers s , n , i and c . These selector switches are joined by four line conductors s , i , c and g which extend between the stations. The conductor s includes a pair of polarized relays p and p' , one of which is located in each of the stations, and which are employed for synchronizing the operation of the switches A and A'. Conductor c which joins wipers of the banks c of selector switches A and A' is used for transmitting impulses to effect control operations at the remote stations. Conductor i which joins the wipers of the banks i of switches A and A' is used for transmitting impulses to control the indicating equipment at the dispatcher's station. Conductor g is a common return or ground wire for all of the circuits extending between the two stations.

An understanding of the supervisory system may best be had by reference to its operation. Let us assume that the operator at the dispatcher's station desires to operate switch 14 at the remote station to its closed position. He will first open the contacts of selecting key 14' corresponding to the remote switch which is to be operated. He will then close the contacts of starting key k and thereby start the selector switches into synchronous operation. This operation results from completing a circuit which extends from the positive side of the battery 15 in the dispatcher's station through the key k , normal contact and wiper of the bank i of switch A, conductor i , wiper and normal contact of the

bank *i* of switch A', winding of relay 16 and ground conductor *g'* to an intermediate point upon the source of potential 15. Relay 16 will then operate to close its contacts, thereby completing a circuit extending from the positive side of the battery 15' in the remote station through the contacts of relay 16, normal contact and wiper of the bank *s* of switch A', windings of polarized relays *p'* and *p*, wiper and normal contact of the banks of switch A the selecting key, which is associated with the normal contact of bank *s* of switch A and which is closed except under certain conditions when it is desired to stop the selector in its initial position, to the negative side of the battery 15. Polarized relays *p* and *p'*, which constitute the synchronizing relays of the system, will then actuate their armatures to the upper position. In this position relay *p* will complete a circuit extending from positive potential at the upper contact of relay *p* through the contacts and winding of motor magnet 17 of switch A and wiper and normal contact of the bank *n* of switch A to negative potential. Similarly relay *p'* at the remote station completes a circuit which extends from negative potential through the contacts of relays *p'* contacts and winding of motor magnet 17' of switch A' and wiper and normal contact of the bank *n* of switch A' to positive potential.

Motor magnets 17 and 17' are connected to the wipers of their respective switches through a suitable ratchet and pawl mechanism such that at each deenergization thereof, the switch is actuated one step forward in the direction in which it is adapted to rotate. Upon energization, as previously described, motor magnets 17 and 17' deenergize themselves, thereby stepping the selector switches to their first off-normal position. Since alternate contacts of the banks *s* and *n* of each of the switches are connected to points of opposite polarity on the respective batteries 15 and 15', it will be seen that in the next position of the switches A and A', the current in the circuit previously traced including the polarized relays *p* and *p'* will be reversed, and the armatures of these relays therefore will be actuated back to the position shown in the drawing. When this occurs the motor magnets 17 and 17' are again energized and in operating advance the wipers another step. This operation would continue were it not that the operator, prior to closing the starting contact *k*, separated the contacts of the key 14' of the selecting keys. In so doing the second off-normal contact of the bank *s* of switch A was disconnected from the battery, and hence when the selector switches engage this contact the polarized relays *p* and *p'* are deenergized and the switches stop in this position.

The operator will now operate key 14'' in the dispatcher's station, corresponding to the switch 14 in the remote station, from the position shown in the drawing to the other position and, in so doing, will reverse the current in a circuit which extends from the positive side of battery 15 through the upper contacts of key 14'', second contact and wiper of the bank *c* of switch A, conductor *c'* and second off-normal contact of the bank *c* of switch A', winding of polarized relay 18 at the remote station and ground conductor *g'* back to an intermediate point upon the source of potential 15. Relay 18 will then operate its armature to the lower position, thereby energizing the closing coil of the switch 14 causing that switch to operate to its closed position. In its

closed position the switch 14 will complete a circuit which extends from the negative side of the source of potential 15' at the remote station, through the interlock 11 of the switch 14 and its upper stationary contacts, second off-normal contact and wiper of the bank *i* of switch A', conductor *i'*, wiper and second off-normal contact of the bank *i* of switch A, winding of relay 12 and conductor *g'* back to an intermediate point on the source of potential 15'. Polarized relay 12 will then operate its armature from the position shown to the opposite position, thereby deenergizing a red lamp *r* and energizing a green lamp *g* indicating that the switch 14 is in the closed position. If the operator desires again to open the switch 14, he will reverse the position of the key 14'', thereby reversing the polarity of the current in the polarized relay 18, which in turn energizes the trip coil of the switch 14. As the switch 14 returns to the position shown in the drawing, the interlock 11 engages its lower contacts, thereby reversing the polarity of current in the polarized relay 12 which in turn extinguishes the green lamp *g* and relights the red lamp *r*.

In returning the selector switches to their normal positions, the operator will again close the contacts 14', thereby again energizing polarized relays *p* and *p'* causing synchronous operation of the selector switches to be resumed and continued until the wipers return to their normal positions. When this occurs the circuit of the polarized relays is interrupted at the contacts of relay 16 and the switches stop in this position.

After having closed the starting contacts K, it is necessary for the operator to have an indication of the position in which the selector switches A and A' come to rest since, due to faulty operation of the equipment, they may not always stop in the position determined by the selecting key the contacts of which were opened by the operator. An indication of the position of the switch A in the dispatcher's station may be had by means of indicating lamps (not shown), one of which is lighted whenever the switch A is in any position. This means forms a very reliable indication also of the position of the switch A', and one which is suitable for most practical purposes of the equipment. However, in the supervision of important circuit breakers where an erroneous operation is likely to result in great damage to equipment or interruption in service, it is desirable that the operator should also have an indication of the position of the switch A', and that this indication should be independent of the position of the switch A or any other element of the system, whereby the possibility of error may be reduced to a minimum.

In accordance with my present invention this indication may be had by means of the equipment shown in the upper portion of the drawing together with a simple vibrating reed frequency meter 13 in the dispatcher's station. This means comprises a transmitter including a plurality of oscillation generators 1' to 10', which may comprise tuning forks connected and arranged in any well known manner such as in the manner shown in Fig. 2. These oscillation generators are all adapted to produce alternating current of different frequency in their output windings 38. These windings are connected in parallel and arranged to supply current through condensers 21 to the line conductors *c'* and *i'*. At the dispatcher's station the frequency meter 13 is connected through condensers 22 to these line conductors whereby it responds to the frequency of

the current produced by any of the generators 1' to 10'. Of course suitable amplifying equipment may be included if desired, in the circuit extending from the source 38 to the meter 13.

5 For the purpose of controlling the generators 1' to 10', a plurality of selecting relays S are provided, each of which corresponds to one position of the switch A' and is energized whenever the switch A' occupies the corresponding position. To selectively complete the circuits of these relays a wiper is provided upon the shaft of the switch A' which operates over a bank of contacts *t*, each of which contacts are included in circuit with one of the relays S. Each of the
10 selecting relays have one or more contacts each of which is included in the energizing circuit of one of the tuning fork generators, these circuits being periodically completed by means of a rotary switch 19 presently to be described.

20 In the form shown the rotary switch 19 comprises a selector switch of the same type as switches A and A' having three wipers B, C, and D. The wiper D is utilized to control the energizing circuits of the tuning forks which circuits, in effect, constitute the frequency determining
25 circuits of the transmitter. Wipers B and C together with relays, which are later to be indicated and which cooperate with wipers B and C constitute a motor mechanism for operating the rotary switch.

30 For a better understanding of the operation of the transmitter, provided in accordance with my invention, let us assume that the switches A and A' have been operated to the second off-normal position, as previously described. When
35 either of the switches A or A' leaves its normal position a circuit is interrupted which extends from the negative side of the source of potential 15 through normal contact and wiper of the bank c of switch A, conductor c', wiper and normal
40 contact of the bank c of the switch A', relay 20, the positive side of battery 15', intermediate point of battery 15' and conductor g' to the intermediate point of the source of potential 15. Relay 20 is then deenergized and its armature is
45 operated to the circuit-closing position. Upon deenergization of the relay 20 the driving circuits for operating the rotary switch 19 are set into operation, and the wiper D then periodically completes each of the energizing circuits of the tuning
50 forks which have been selected by the S relays, in succession such that the vibrating reeds of the frequency meter at the dispatcher's station vibrate in resonance with the frequency, or frequencies, of the transmitted currents thereby
55 indicating the position of the remote switch.

Upon deenergization of the relay 20 a circuit is completed which extends from the positive side of the source of potential 23 through the contacts of relay 20, wiper C in its normal position, relay 24 and armature and lower contact of relay 25 to the negative side of the source of potential 23. Relay 24 then energizes thereby
60 connecting motor magnet 26 in shunt with its own winding. Motor magnet 26 operates its armature thereby deenergizing itself and stepping the wipers B, C and D in a clockwise direction on to their first contacts. The first contact of the banks with which wipers B and C cooperate are both connected to points having the same
70 polarity as the normal contacts of these banks and, accordingly, the motor magnet 26 is again energized, stepping the wipers B, C and D on the second contact. In this position relay 24 is short circuited through wiper C and its second contact

which contact is connected to the same side of the battery as the opposite terminal of the coil of relay 24. After a time interval, its armatures are actuated to the right thereby completing a circuit which extends from an intermediate point on the battery 23 through the right-hand armature and contact of relay 24, winding of polarized relay 25, wiper B and second contact of the associated bank back to the negative side of the source of potential 23. Polarized relay 25 will then actuate its armature to the upper position thereby disconnecting one side of the winding of relay 24 from the negative side of battery 23 and connecting it to the positive side of battery 23. Relay 24 is now again energized thereby causing a subsequent actuation of the motor magnet 26 and a stepping of the wipers B, C and D onto their third contacts. When the wiper C steps from its second to its third contact, it disconnects one terminal of relay 24 from the negative side of battery 23 and connects it to the positive side of battery 23, which in turn again short circuits and deenergizes this relay. Its armatures are then actuated to the right, after a time interval, again completing a circuit for relay 25. Since wiper B is now on its third contact, however, the polarity of the current in relay 25 will be reversed, and this relay will operate its armature back to the position shown in the drawing. Since the alternate contacts of the banks associated with wipers B and C are connected to points of opposite polarity, it will be seen that this operation will continue as long as the contacts of relay 20 are closed or as long as either of the switches remains in an off-normal position, the wipers B, C and D rotating continuously over their respective banks of contacts.

Since the selector switch A' is in its second off-normal position, a circuit is completed for the winding of relay S₂ which extends from the negative side of the battery 23 through the wiper and second off-normal contact of the bank *t*, actuating winding of relay S₂ and conductor 27 to an intermediate point on the source of potential 23. Relay S₂ controls an energizing circuit for oscillation generator 2', this circuit extending from the negative side of battery 23 through conductor 28, oscillation generator 2', contacts of relay S₂, contacts 29 and 30 of the bank associated with wiper D of the switch 19 and conductor 27 to an intermediate point on the source of potential 23. Thus whenever the wiper D engages either of the contacts 29 or 30, the energizing circuit of generator 2' will be completed and alternating current will be supplied to the frequency meter 13 having a frequency determined by this generator, which frequency will cause corresponding vibrating reed 2 of the meter 13 to respond. Thus, when the operator observes the intermittent vibration of the vibrating reed 2 in the proper period, he will be informed that the remote switch is on its second off-normal contact.

Let us assume that the switch A' has been operated to its 12th contact. The operation will of course be as previously described, with the exception that relay S₁₂ is energized through the twelfth off-normal contact of bank *t*. This relay controls two energizing circuits, one for generator 1' and the other for generator 2'. The circuit for generator 1' includes the left-hand armature of relay S₁₂ and the contacts 29 and 30 of the bank associated with wiper D of the switch 19. The energizing circuit for generator 2' includes the right-hand armature of relay S₁₂ and contacts 31 and 32 of the bank associated

with wiper D. Thus the wiper D first passes over contacts 29, thereby causing operation of the generator 1', and then over contacts 31 thereby causing operation of generator 2' after which an interruption occurs in which no generator is energized. The wiper then passes over contacts 30 thereby energizing generator 1' and, subsequently, contacts 32 thereby energizing generator 2'. Thus the operator, by observing the frequency meter 13, will observe a vibration first of vibrating reed 1, then of vibrating reed 2 in quick succession after which an interruption occurs, and then a repetition of the vibration of reeds 1 and 2 in quick succession. Thus he is informed that the remote selector switch A' is upon its 12th contact.

If we now assume that the selector switch A' is upon its 21st contact, relay S₂₁ will be energized thereby again establishing energizing circuits for generators 1' and 2', but in this case the energizing circuit of generator 2' is connected to the contacts 29 and 30 through the left-hand armature of the relay S₂₁, and the energizing circuit of generator 1' is connected to the contacts 31 and 32 through the right-hand armature of the relay S₂₁. Thus in this case as the switch D rotates first vibrating reed 2 will be actuated and then vibrating reed 1 in quick succession after which an interruption will occur. The repetition of this vibration of these reeds, first 2 and then 1, will inform the operator that switch A' is on its 21st contact.

If we assume that the switch A' is in engagement with its twenty-second contact, relay S₂₂ will be energized. This relay connects the energizing circuit of generator 2' to contacts 29 and 30 through its left-hand armature and to contacts 31 and 32 through its right-hand armature. Thus during operation of rotary switch D vibrating reed 2 will vibrate twice in rapid succession after which a long interruption will occur, and then the indication will be repeated thereby informing the operator that the switch is on its twenty-second contact. It will be apparent that this indication is distinct from that produced in response to actuation of switch A' to its second off-normal position, since in that case reed 2 vibrated in about equal intervals of time rather than as above described.

It will be noted that each of the relays S are of the slow-closing type. The time interval provided in connection with these relays is such that they do not respond as the wiper of the bank t passes rapidly over its contacts as in moving from a normal position to one of the other positions but only respond when this wiper definitely comes to rest upon a selected contact.

It will now be apparent that each group of alternating current impulses which is produced by the transmitter includes as many impulses as there are digits in the number of the position which is occupied by the switch, and that the frequency of each impulse corresponds to the integer of the digit which the particular impulse represents in the number to be indicated by the group of impulses. Where a plurality of selector switches are employed in the remote station as, for example, in the manner shown in my above mentioned copending application, the number of the position to be indicated may well have more than two digits. Such positions may, of course, be indicated by utilizing as many armatures on each of the series of selecting relays S, which correspond to these positions as there are digits in the number to be indicated and

an equal number of sets of contacts in each of the groups 29, 31 and 30, 32. It may be desirable where a large number of positions are to be indicated to transmit only one group of impulses during each rotation of the switch D i. e., one of the two groups of contacts 29, 31 and 30, 32 may be omitted. In any case the interval between groups is greater than that between the different impulses of any group. In this way the impulses are clearly divided into distinct groups which may be readily read as position numbers on the frequency meter 13.

It will of course be apparent that the speed at which the rotary switch D revolves may be controlled by varying the time delay of the relay 24. The duration of each of the alternating current impulses as well as the duration of the time intervals between successive impulses may also be controlled by adjusting the number of contacts in each set and by suitably spacing the contacts, or sets of contacts 29 and 30, and 31 and 32 in the bank of contacts.

In Fig. 2 I have shown the circuit connections of a tuning fork oscillation generator which may be utilized in connection with my invention. This circuit is a well-known arrangement having an energizing coil 33 which is connected in shunt with the battery terminals 34. When this coil is energized a variation is produced in the current flowing through the circuit extending from one side of the battery at one of the terminals 34 through the microphone button 35, primary winding of transformer 36 back to the other side of the battery. This variation in current in the transformer 36 sets up a current in the loop circuit 37 which in turn affects the tuning fork causing a continuation of the vibration thereof and, hence, the production of alternating current which appears in the output circuit 38.

It will of course be understood that while I have particularly mentioned the use of tuning forks in the transmitter, as described, I do not wish to be limited thereto since other means for producing oscillations of variable frequency may be used as well. Such modifications are of course to be regarded as within the scope of my present invention.

While I have shown a single embodiment of my invention, it will of course be understood that I do not wish to be limited thereto since many modifications, both in the circuit arrangement and in the instrumentalities employed, may be made without departing from the spirit and scope of my invention, as set forth in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In combination, a movable element, means for operating said element to a plurality of positions, a plurality of oscillation generators, said generators being arranged to produce oscillations of different frequencies, frequency responsive indicating means, a rotary switch having a wiper and a plurality of stationary contacts, means for rotating said wiper over said contacts, and means responsive to the position of said element for selectively establishing connections to said generators through said wiper and certain of said contacts so that the rotation of said wiper causes said generators to supply to said indicating means oscillations of different frequencies in a predetermined sequence determined in accordance with the positions of said element.
2. In combination, a movable element having

a plurality of positions, remotely controlled means for operating said element to any one of said positions, a plurality of normally inoperative oscillation generators, each of said generators being adapted to produce oscillations of different frequency, a rotary switch having a wiper and a plurality of stationary contacts, means for rotating said wiper over said contacts, means responsive to operation of said element to any position for selectively establishing connections through said wiper and certain of said contacts so that the rotation of said wiper renders a predetermined combination of said generators operative in a predetermined sequence, and indicating means at a remote point controlled by the frequency of the oscillations generated to indicate the position of said element.

3. The combination, in a remote control system, a dispatcher's station, a remote station, a movable element in the remote station having a normal position, means controlled from the dispatcher's station for operating said element from said normal position to any one of a plurality of other positions, alternating current transmitting means in the remote station, means responsive to operation of said element from its normal position for actuating said transmitting means, means responsive to the position of said element for controlling the frequency of the currents transmitted and means in the dispatcher's station controlled by the frequency of the currents transmitted for indicating the position of said element.

4. The combination, in a remote control system, a dispatcher's station, a remote station, conductors joining said stations, a rotary distributor switch in said remote station connected to said conductors, means for actuating said switch to predetermined positions, means for transmitting alternating current of predetermined frequency over said conductors to the dispatcher's station including a plurality of sources of alternating current having different frequencies, a rotary switch having a wiper and a plurality of stationary contacts, means for rotating said wiper over said contacts, and means responsive to the position of said distributor switch for selectively establishing connections through said contacts and wiper to certain of said sources so that the rotation of said wiper causes a code of current impulses of different frequencies to be transmitted over said conductors, and means in the dispatcher's station responsive to the frequency of said alternating current impulses for indicating the position of the remote switch.

5. The combination, with an element which is operable from a normal position to any of a plurality of other positions, means for indicating at a remote point the position of said element, comprising means responsive to movement of said element from its normal position for transmitting to the remote point successive groups of alternating current impulses, the current transmitted during the different impulses of each group being of different frequency, the frequency of each impulse being determined by the position of said element and means at the remote point responsive to the frequency of said alternating current for indicating the position of said element.

6. The combination, with an element which is operable from a normal position to any of a plu-

ality of other positions, means for indicating at a remote point the position of said element comprising means responsive to movement of said element from its normal position for transmitting to the remote point a group of alternating current impulses, the current transmitted during each of the different impulses being of different frequency, each of said frequencies being determined by the position of said element and means at the remote point responsive to the frequency of said alternating current for indicating the position of said element.

7. The combination, with an element which is operable from a normal position to any of a plurality of other positions, means responsive to movement of said element from its normal position for transmitting to the remote point alternating current having a predetermined combination of frequencies, each of the frequencies comprising said combination being determined by the position of said element and means at the remote point responsive to said frequencies for indicating the position of said element.

8. The combination, in a remote control system, an element having a normal position, means for actuating said element to a plurality of other positions, a rotary switch having a wiper and a plurality of contacts, driving means for actuating said wiper over said contacts, alternating current transmitting means including a plurality of frequency determining connections, each of said connections including one of said contacts, means responsive to movement of said element from said normal position for actuating said driving means, means responsive to the position of said element selectively to establish certain of said connections including said contacts thereby to cause said transmitting means to transmit current having predetermined frequency upon each engagement of said rotary switch with contacts included in said certain connections and indicating means responsive to the frequency of said current.

9. In combination, a first station, a second station, a distributor switch in said second station, means for actuating said distributor switch to predetermined positions, and means for indicating at said first station the position of the distributor switch when it remains in any of said predetermined positions a predetermined time including conductors joining said stations, means at said second station for transmitting over said conductors a combination of impulses of different frequencies including a plurality of sources of alternating current having different frequencies, a rotary switch having a wiper and a plurality of stationary contacts, means for effecting the rotation of said wiper over said contacts when said distributor switch remains in any of said predetermined positions for a predetermined time, and means responsive to the position of said distributor switch for selectively establishing connections through said contacts to said sources so that the rotation of said wiper causes a combination of alternating current impulses which is determined by the position of the second station distributor switch to be transmitted over said conductors, and frequency responsive indicating means at said first station responsive to said impulses.

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