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CONTROL SYSTEM

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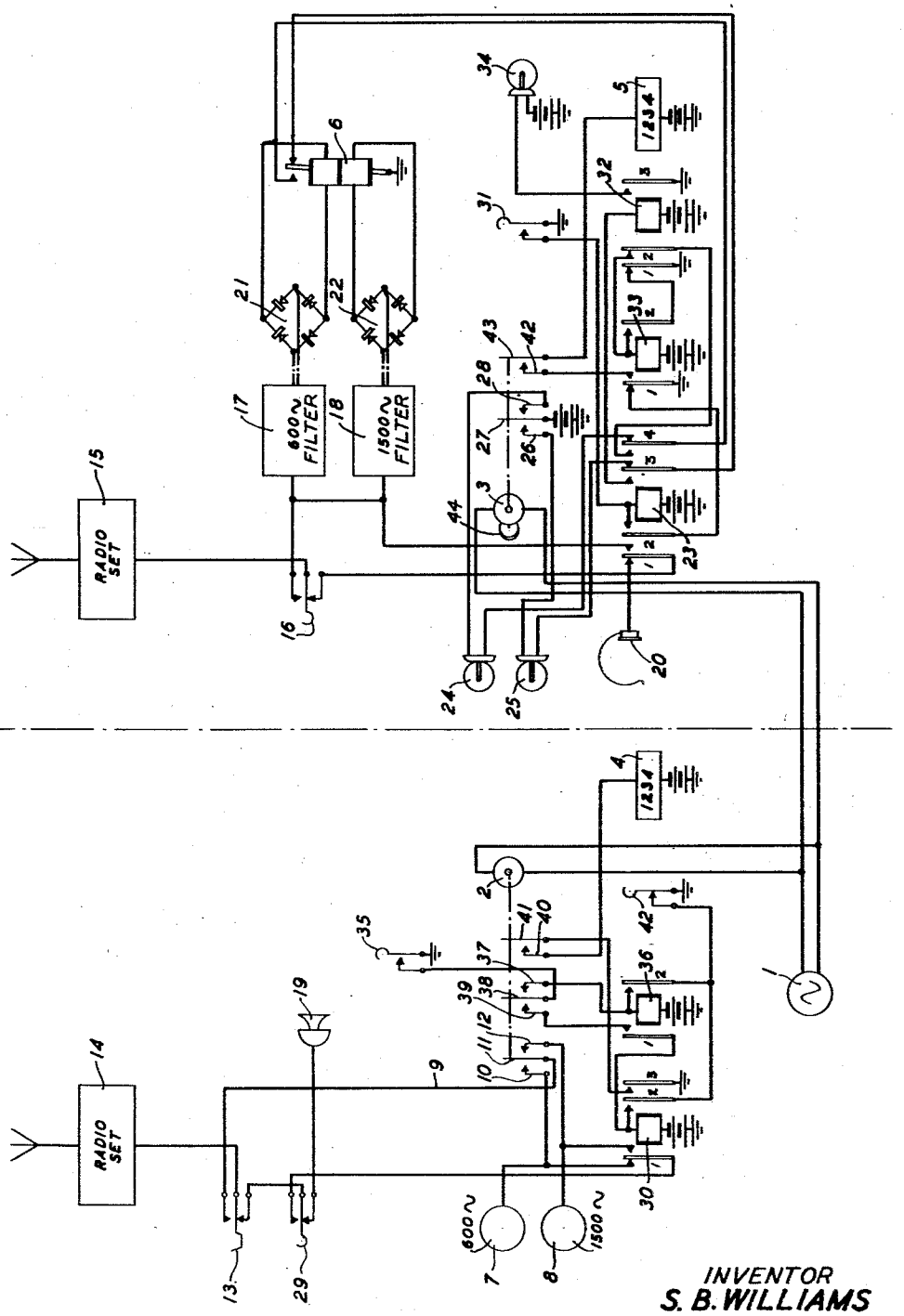

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CONTROL SYSTEM

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5 Claims. (Cl. 172—245)

This invention relates to control systems and particularly to means for establishing exact time relations between devices operating at equal speeds at two or more remote points.

The object of the invention is to provide accurate means for adjusting the time relation between the operation of two or more timing devices located at points remote from each other. In modern electrical distribution systems supplying 60-cycle alternating current the source of supply is so accurately controlled that it is possible to operate two or more synchronous motors at remotely distant points in exact synchronism. Where two or more such motors are employed to operate timing devices for various purposes, such as impulsing contacts, it then only becomes necessary to adjust such motors so that the impulsing contacts close or open at the same instant, after which adjustment continued synchronous operation is assumed. The object of the invention is therefore to provide means for making such initial adjustment.

A feature of the invention is the temporary use of a communication channel for transmitting timing signals from one point to another, which timing signals at the transmitting station are controlled by the operation of the timing device thereat and at the receiving station are compared with matching signals produced by the timing device thereat. The time relation of the timing device at the receiving station is then adjusted until the matching signals indicate exact synchronism between the two remotely situated timing devices.

Another feature of the invention is a pick-up circuit controlled over a communication channel whereby counting devices remote from each other and operated synchronously may be started simultaneously so that the indications of each will always correspond to the other.

According to one embodiment of the invention two different sources of tone are controlled by a timing device at a transmitting station and the tones from these sources are alternately transmitted to a receiving station. Receiving means at such station then differentiate between the two tones received and alternately apply closed circuits to matching signals which are under control of a timing device thereat. If the signals indicate that the two timing devices are out of synchronism then an adjustment of the device at the receiving station is made as by a hand brake or a differential gear until synchronism is attained. Thereafter a starting switch is operated at the control station to place the pick-up circuit in operation whereupon a counting device at each station will simultaneously start operation.

Thereafter operations at the various stations may be collated by reference to the timing index provided by the readings of the said counters.

Other features will appear hereinafter.

The drawing consists of a single sheet of circuit diagram mostly schematic in nature.

At the left of the broken line there is shown a control station and to the right thereof an observation station, of which there may be one or several. It will be noted that all stations are served by a single source of current 1, this being either a commercial source of 110-volt, 60-cycle alternating current suitable for ordinary household and industrial use, or a source of current of the proper potential and frequency maintained under precise conditions for scientific application. There are two synchronous motors 2 and 3 which are operated from this source of current and which keep in step with each other continuously.

At each of the stations there is a counter, such as the counter 4 at the control station and the counter 5 at the observation station. The object of the circuit arrangement is to keep these two counters in step with each other and both reading the same. The invention provides means for starting such counters simultaneously and holding them in step with each other.

Fundamentally, the arrangement employs two low frequencies which control a polarized relay 6. The circles 7 and 8 represent sources of 600 and 1500-cycle current, respectively, which may be alternately applied to the line 9 through the operation of the contacts 10, 11 and 12 under control of the motor 2. When the switch 13 is operated, then these two frequencies will be applied to the radio set 14 and transmitted in well-known manner to the radio set 15, where during the operation of the key 16 they will be applied to the filters 17 and 18, respectively and eventually control the upper and lower windings of the polarized relay 6. The polarized relay 6 will therefore vibrate its armature in synchronism with the movement of the spring 11 at the control station.

When the keys 13, 29 and 16 of both stations are normal, a microphone 19 is connected to the radio set 14 and a receiver 20 at the observation station is connected to the radio set 15. When it is desired to synchronize the contacts of the two interrupters the key 13 at the control station and the key 16 at the observation station are

operated. This connects the two oscillators 7 and 8 to the radio set 14 and the filters 17 and 18 and rectifiers 21 and 22 to the radio set 15 at the observation station. The relay 6 provides insurance against interference. This is a polarized relay and operates only when either the 600-cycle or 1500-cycle current is flowing. With the relay 23 not operated, the lamps 24 and 25 are connected between the contacts 26, 27 and 28 controlled by motor 3 and the contacts of relay 6. As relay 6 operates to close its front or back contact, the lamps 24 and 25 will be lighted when the corresponding contacts of the timer are closed. The connections can be so arranged as to have synchronism occur when the lamps light in rapid succession or when neither lamp lights. After the timers are synchronized, they sustain synchronism due to the type of motor used in the counter.

In placing this system in operation through agreement between the operators at these stations reached over the telephone apparatus represented by the transmitter 19 and the receiver 20, the keys 13 and 16 are both operated whereby the two sources 7 and 8 are alternately applied to the radio set 14 and cause the operation of relay 6 at the observation station. Both motors 2 and 3 are operating and hence the signal lamps 24 and 25 will operate to indicate synchronism or lack of synchronism between the two motors. Let it be assumed that as the contact spring 27 moves to the right and to the left, the armature of relay 6 is caused to move exactly in step therewith. In this case neither lamp 24 or 25 would light and would therefore indicate that the desired state of synchronism between the motors 2 and 3 is present. If these lamps flicker, an adjustment may be made by slowing down motor 3 by a hand brake 44 or a differential gear (not shown) until the exact state of synchronism has been reached.

Thereafter the operator at the observation station will await the signal for starting from the control station. The key 16 is restored so that the receiver 20 is connected to the radio set 15. The operator at the control station will restore key 13 and then operate key 29. This applies the oscillator 7 to the communication channel steadily. When the operator at the observation station hears this 600-cycle tone he operates the non-locking key 31. This operates relay 23 and switches the contacts of relay 6 from the lamps 24 and 25 to armature 2 of relay 32 and the winding of relay 32 respectively. Since relay 6 now rests its armature steadily on its right-hand contact, relay 32 will operate and cause the signal lamp 34 to operate. Only a momentary operation of key 31 is necessary as relay 23 in operating locks over its armature 2 to the back contact of relay 33 and by its armature 1 transfers the communication channel from the radio set 15 to the filters 17 and 18.

After an appropriate interval the operator at the control station operates the start key 35. If at that instant the spring 38 is in contact with spring 39 no result will be obtained. However, as soon as the spring 38 moves into contact with spring 37, the pick-up relay 36 will be operated to prepare a circuit for the operation of relay 30 on the movement of spring 38 into contact with spring 39. When this circuit becomes effective, relay 30 operates and switches over from oscillator 7 to oscillator 8. Relay 30 locks, with relay 36, to ground through key 42. As relay 30 at the control station operates, relay 6 at the observation station operates to its left-hand contact, thus releasing the pick-up relay 32 and causing the operation of relay 33. Relay 33 locks over its armature 2 to the back contact and armature 1 of relay 32 and by the movement of its armature 1 unlocks relay 23.

Thus relays 30 and 33 are both operated simultaneously as the synchronized motors 2 and 3 move their controlled contacts toward the left. At the control station a circuit is established from ground, armature 3 and front contact of relay 30, contact springs 41 and 40 through the winding of counter 4 to battery. At the observation station a circuit is established from ground, armature 1 and front contact of relay 33, contact springs 42 and 43, winding of counter 5 to battery. Thus the two counters are started simultaneously and will continue to step simultaneously, so long as the motors 2 and 3 both continue to operate.

As the relay 32 is released at the start of the operation of counter 5, the signal lamp 34 will go dark, as a signal to the operator at the observation station that the counting operation has started.

The locked relays 30 and 36 may be released by the release key 42. At the observation station, the operation of key 31 will operate relay 23 and unlock relay 33 when it is desired to synchronize the motors and restart the counting.

What is claimed is:

1. In a control system, equal speed motors at points remote from each other, a common source of current for driving said motors, a communication channel between said points, a plurality of different sources of signals at the transmitting end of said channel, contacts controlled by one of said motors at the transmitting end of said channel for alternately connecting said different sources of signals to said communication channel, means at the receiving end of said communication channel responsive to signals from said sources transmitted over said channel, another set of contacts controlled by that motor which is at the receiving end of said communication channel, indicators jointly controlled by said signal responsive means and said contacts to indicate exact synchronism of said motor at the said receiving end of said communication channel with said motor at the said transmitting end of said communication channel and means for temporarily altering the speed of said receiving end motor to bring it into exact synchronism with said transmitting end motor.

2. In a control system, equal speed synchronous motors at points remote from each other, a communication channel between said points, means including said communication channel for bringing said motors into synchronous operation with each other and means comprising a common alternating current source independent of said communication channel for keeping said motors in synchronous operation with each other.

3. In a control system, equal speed motors and apparatus operated thereby at points remote from each other, a communication channel between said points, means including said communication channel for bringing said motors into synchronous operation with each other, means including said communication channel for simultaneously placing said apparatus under control of said motors and means independent of said communication channel for thereafter keeping said motors and said apparatus in synchronous operation.

4. In a control system, synchronous alternating

current motors at points remote from each other, a common source of alternating current for driving said motors, apparatus operated by said motors, a communication channel between said points, means at one of said points for bringing the said motor thereat into synchronism with the other of said motors, means controlled over said communication channel for indicating synchronism between said motors and means under control of said motors and operated over said communication channel for simultaneously starting and for thereafter controlling the operation of said apparatus at said points.

5. In a control system, synchronous alternating current motors at points remote from each other, a common source of alternating current for driving said motors, a communication channel between said points, a plurality of different sources of current at the transmitting end of said channel, means at the other end of said channel differently responsive to currents from said different sources transmitted over said channel, means for alternately and periodically applying said sources to said channel for synchronizing purposes, a pick-up circuit for applying first one and then another of said sources of current to said channel in a predetermined sequence, apparatus operated by said motors and means responsive to said pick-up circuit for simultaneously starting the said apparatus at both ends of said communication channel into operation, said pick-up circuit including a relay and a locking circuit therefor for extending the control of its associated motor to its associated operated apparatus, said locking circuits being independent of further control over said communication channel.

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