Dec. 23, 1941. W. L. BUTLER 2,267,394

SWITCH OPERATING MEANS

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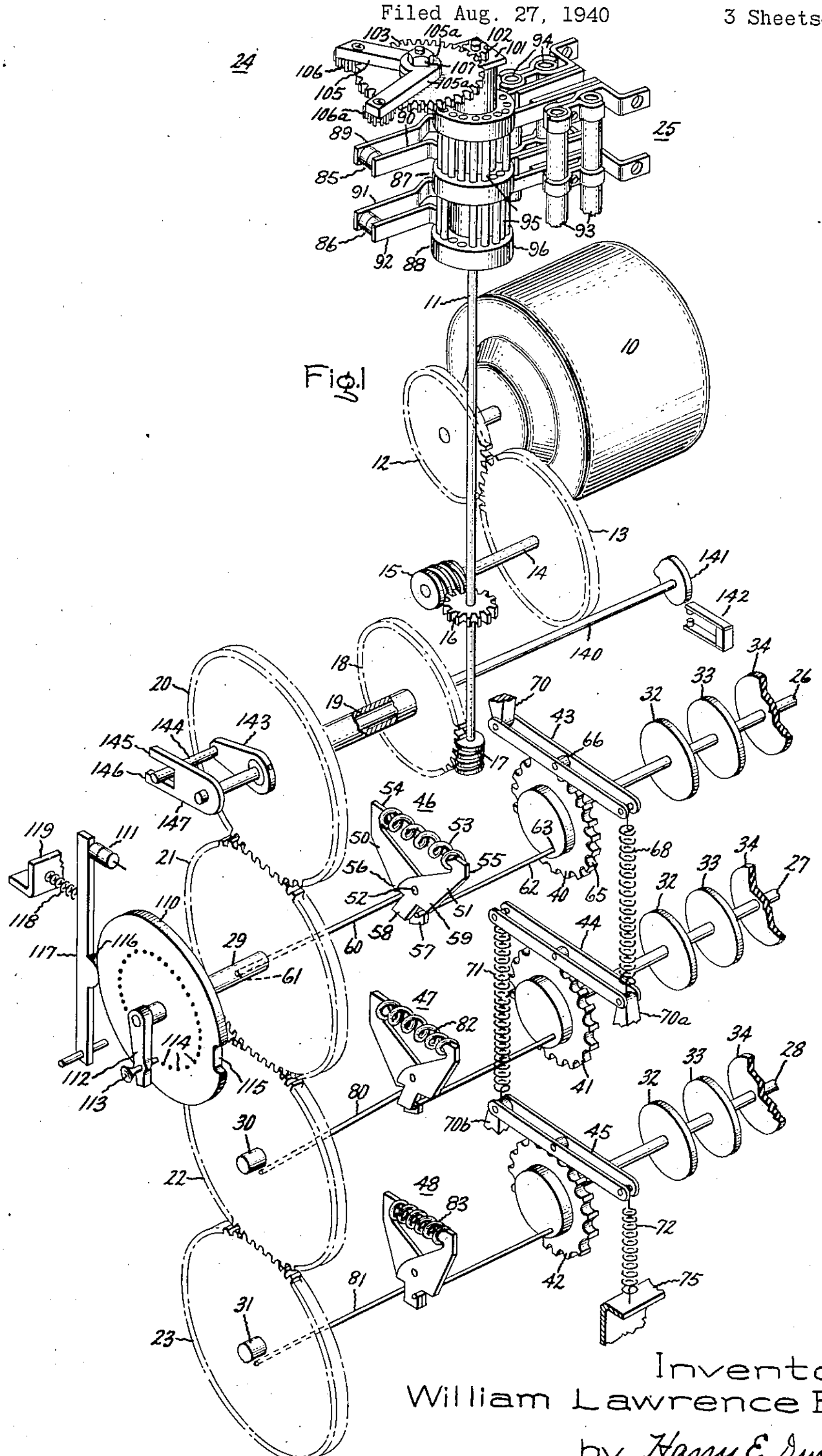

Fig. 1

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Fig.2

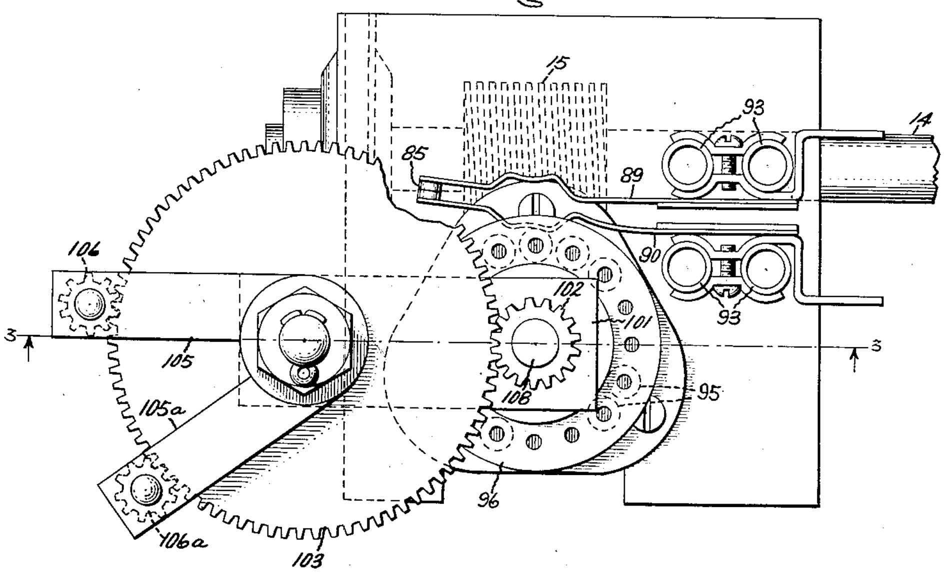

Fig.3

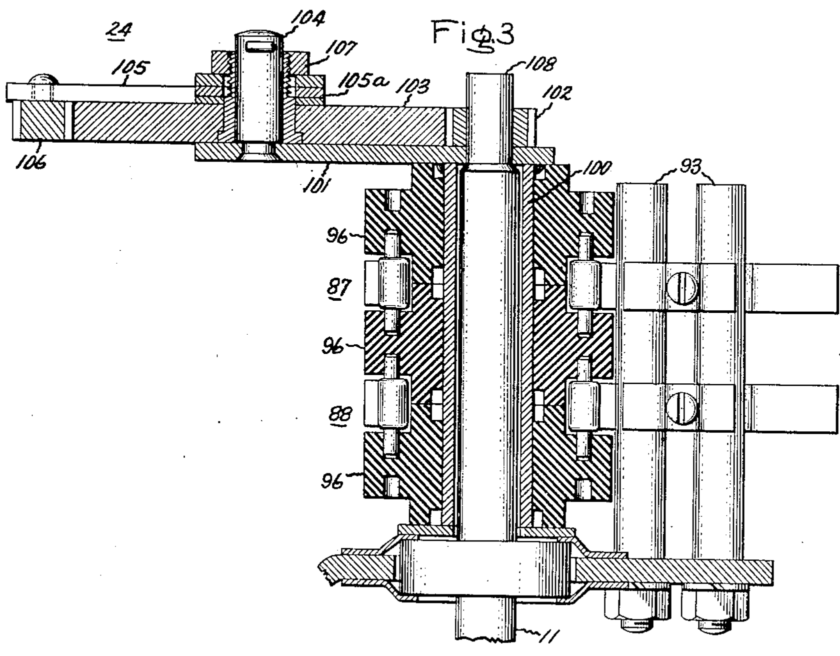

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Fig. 4

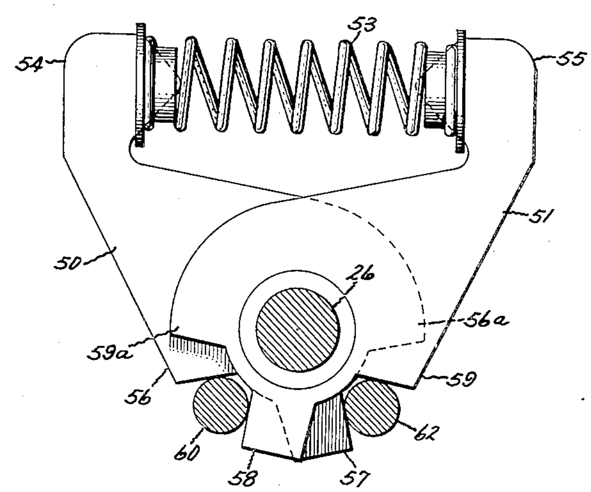
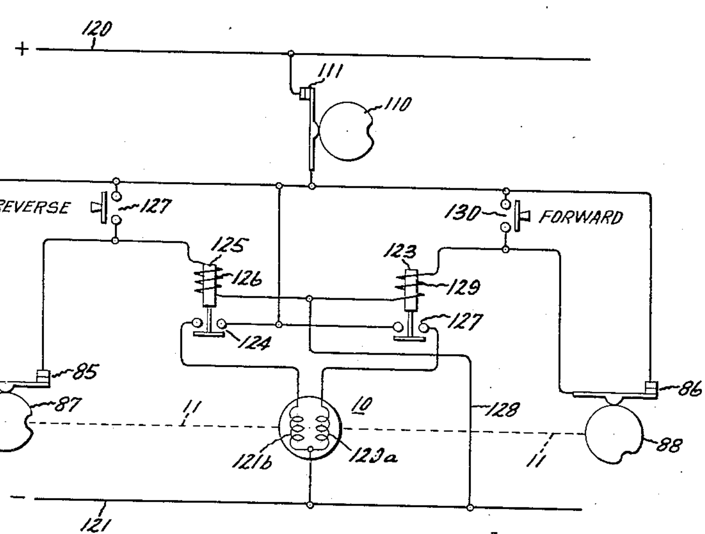


Fig. 5



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Patented Dec. 23, 1941

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UNITED STATES PATENT OFFICE

2,267,394

SWITCH OPERATING MEANS

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18 Claims. (Cl. 74—100)

My invention relates to switch-operating means and particularly to means for sequentially and intermittently operating a plurality of switches.

In the application of electric motors to various machinery, and particularly to printing press drives, it is desirable to provide control means capable of controlling the motor speed in very small increments. For this purpose, wound-rotor induction motors have been used in the manner illustrated in Patent 2,083,531, Jones, filed November 28, 1936, and assigned to the same assignee as the present application. In the arrangement illustrated in the Jones patent, corresponding sections of the three-phase resistor are simultaneously controlled by the switch-operating mechanism. It has been found that control of speed in even smaller increments may be obtained if corresponding sections of resistance in the three-phase resistor are removed or inserted sequentially rather than simultaneously. In prior arrangements, it has also been customary to control the motor resistance by means of relays energized through a switch of small capacity. It has been found more desirable to control the resistance directly through the contacts of the speed-regulating switch wherever this is possible.

It is, therefore, an object of my invention to provide sequentially operating snap-acting means for driving a plurality of switch-operating members.

It is a further object of my invention to provide such a snap-acting sequentially operating drive means with self-operated disabling means effective after a predetermined number of switching operations.

It is also an object of my invention to provide a lost-motion connection operable upon each reversal of direction of switch operation in order to permit the switch last operated in the time sequence to operate first in reversed sequence.

In carrying out my invention, I provide a notching mechanism for controlling each switch-operating shaft. Each notching mechanism includes a spring biased pawl cooperating with a star wheel. A pair of spring-biased levers are crossed at their pivot point and are biased apart by a compression spring. A driving gear driven from a source of energy through a geared transmission is provided with a pin for engaging one of the spring-biased levers. A second pin attached to the star wheel engages the other spring-biased lever. In operation, the driving gear, through its pin, stores energy in the compression spring while the star wheel and its pin are temporarily held in position by the cooperating pawl to prevent movement of the other pivoted lever. When the pin on the driving wheel has compressed the spring to such an extent that the pivoted levers are in alignment at their points of engagement with the pins, a positive driving connection is formed between the driving pin and the pin on the star wheel. Through this positive driving connection, the pawl is forced to release the star wheel and allow it to rotate to its next notching position.

For a more complete understanding of my invention, reference may now be had to the accompanying drawings illustrating one embodiment of my invention, in which Fig. 1 is an exploded perspective view of a switch-operating mechanism embodying my invention; Fig. 2 is a plan view of the lost-motion mechanism and limit switch shown at the top of Fig. 1; Fig. 3 is a side view taken in section along the line 3—3 of Fig. 2; Fig. 4 is an enlarged side elevation of the spring-biased snap-acting arms shown in perspective in Fig. 1, and Fig. 5 is a simplified circuit diagram of the electrical connections for the pilot motor.

Referring now to the drawings and particularly to Fig. 1, a reversible pilot motor **10** is permanently connected to a drive shaft **11** through gears **12** and **13**, a shaft **14**, a worm **15**, and a worm wheel **16**. The shaft **11** is provided at one end with a worm **17** meshing with a worm wheel **18** for driving, through a hollow shaft **19**, a plurality of gears **20**, **21**, **22**, and **23**. The upper end of the shaft **11** is connected through a lost-motion mechanism **24** to a limit switch assembly **25**. The lost-motion mechanism **24** and the limit switch assembly **25** will be more fully described hereinafter. A plurality of switch-operating shafts **26**, **27**, and **28** are located in alignment with driving shafts **29**, **30**, and **31** which carry the gears **21**, **22**, and **23**, respectively. The shafts **26**, **27**, and **28** are each provided with a plurality of cams **32**, **33**, and **34** for operating motor-controlling switches in any desired timed sequence. A notching mechanism is associated with each switch-operating shaft **26**, **27**, and **28**. The notching mechanism comprises star wheels **40**, **41**, and **42** fixedly attached to the shafts **26**, **27**, and **28**, respectively, and spring-biased pawls **43**, **44** and **45**. Spring-biased energy-storing means **46**, **47**, and **48** are arranged intermittently to connect the shafts **29** and **26**, and **30** and **27**, and **31** and **28**, respectively.

For purposes of simplicity and clarity, only one of three similar switch-operating mechanisms will be described in detail. By way of illustration, the snap-acting mechanism connecting shafts 29 and 26 will be described. The energy-storing means 46 is located between the gear 21 and the star wheel 40 and comprises a pair of crossed levers 50 and 51 loosely mounted upon the shaft 26 at a pivot point 52. A compression spring 53 engages the abutments 54 and 55 of the levers 50 and 51, respectively to bias the levers to a normal position of angular separation. The lever 50 is provided with lugs 56, 56*a* and 57, while the lever 51 carries lugs 58, 59 and 59*a*. A pin 60 is fixed in the gear 21 at 61 and engages the lugs 56 and 58, while a pin 62 is fixed to the star wheel 40 at 63 and engages the lugs 57 and 59. The star wheel 40 has a serrated periphery 65 adapted to engage an antifriction member 66 pivotally mounted upon the pawl 43. The antifriction member 66 is biased to a normal position in engagement with the serrated periphery 65 of the star wheel 40 by the spring 68. The pawl 43 is pivoted at one end to a portion 70 of the frame or base upon which the switch is mounted, while the spring 68 resiliently connects the other end of the pawl 43 to a portion 70*a* of the frame. Similarly one end of the pawl 44 is pivoted to the frame at 70*a* while the other end of the pawl is biased into engagement with the star wheel 41 by a spring 71. The spring 71 and one end of the pawl 45 are pivotally connected to the frame at 70*b*, while a spring 72, fastened to the frame at 75, biases the pawl 45 into engagement with the periphery of the star wheel 42.

In operation, when the pilot motor 10 is started, it rotates the gear 21 through the geared transmission comprising the gears 12 and 13, the shaft 14, the worm 15, the worm wheel 16, the shaft 11, the worm 17, the worm wheel 18, the hollow shaft 19, and the gears 20 and 21. Assuming a counterclockwise rotation of the gear 21, the pin 60 engages the lug 58 and rotates the arm 51 counterclockwise about the pivot point 52 and against the force of the spring 53. At this time, movement of the lever 50 and its spring abutment 54 is prevented by engagement of the lug 57 with the pin 62, which is fixed in the star wheel 40. The star wheel 40 is prevented from moving while the spring 53 is compressed due to the spring-pressed engagement of the antifriction member 66 with the serrated periphery 65 of the star wheel. As the spring 53 is compressed by the movement of the lug 58 in the counterclockwise direction, a point is reached where the lugs 57 and 58 come into alignment. In this condition, the spring 53 is fully wound, and a positive driving connection is formed between the pin 60 and the pin 62 through the stop formed by the now aligned lugs 57 and 58. An energy-storing mechanism in this wound-up condition is illustrated at 48. When such positive driving connection is formed, continued rotation of the gear 21 and the pin 60 forces the pin 62 to move the star wheel 40. The movement of the star wheel 40 forces the antifriction member 66 out of its notch in the star wheel. As soon as the antifriction member 66 is free of the star wheel, the spring 53 expands and releases its energy to move the lever 50 and the lug 57 in a counterclockwise direction. At this time, movement of the lever 51 and the lug 58 in a clockwise direction is prevented by positive engagement of the lug 58 with the pin 60. Counterclockwise movement of the lug 57 under the influence of the spring 53 takes place at a greater rate than the continuing counterclockwise movement of the lever 51 and the lug 58 under the influence of the pin 60. The energy-storing mechanism 46, therefore, again assumes its deenergized position in which the lugs 57 and 58 are angularly displaced. The movement of the lug 57 under the influence of the spring 53 causes continued rotation of the star wheel 40 until the spring-biased antifriction member 66 comes into engagement with the next notch of the serrated periphery 65.

By the means described above, the shaft 26 has been moved through one step of its switch-operating sequence in one direction. The operation of the shaft 26 in the other direction takes place in response to the reversal of the pilot motor 10. The reverse operation of the shaft 26 is analogous to the forward operation just described except that the lugs 56, 59*a* and 59, 56*a* come into operation in place of the lugs 57 and 58, respectively.

While the operation of the shaft 26 as described above has been taking place, the shaft 29 has also been rotating the gears 22 and 23. These latter gears through their attached pins 80 and 81, respectively, have been winding their associated springs 82 and 83. The angular location in which the pins 60, 80, and 81 are set in the gears 21, 22, and 23, respectively, is such that the energy-storing means 46, 47, and 48 are caused to act successively. The energy-storing means 46, 47, and 48, therefore, have been shown in Fig. 1 in successive stages of their operating sequence. As shown, the energy-storing means 48 is just about to be released to rotate the shaft 28, the energy-storing means 47 is in an intermediate stage of compression, and the energy-storing means 46 is shown completely deenergized.

The gear ratio between the shafts 11 and 19 is such that three revolutions of the shaft 11 are required to operate any one energy-storing means through a complete cycle, for instance, from the deenergized position of 46 back to that same deenergized position. It will, therefore, be apparent that one of the energy-storing means 46, 47, or 48 will be released at each single revolution of the shaft 11. A limit switch assembly 25 is provided to stop the rotation of the motor 10 after the shaft 11 has completed one revolution. Referring to Figs. 1, 2, and 3, the assembly 25 consists of two separate limit switches 85 and 86 associated with cams 87 and 88, respectively. The switch 85 controls the pilot motor 10 in one direction of its rotation independently of the switch 86, while the switch 86 independently controls the pilot motor 10 in the other direction of its rotation. The switches 85 and 86 comprise resilient contact members 89, 90, 91, and 92 mounted upon supporting posts 93 and 94. The members 90 and 92 are biased toward the cams 87 and 88 respectively. The cams 87 and 88 are shown as consisting of a plurality of cylinders 95 mounted between disks 96. The cylinder assembly of each cam is provided with a single depression into which resilient members 90 or 92 may fall once each revolution of the cams to open switches 85 and 86, respectively. To form the depression two adjacent cylinders on each cam are omitted.

As previously mentioned, the cams 87 and 88 are driven from the shaft 11 through a lost-motion connection 24. Referring particularly to

Figs. 1 and 3, a sleeve 100 is loosely mounted on the shaft 11 and carries an arm 101 fixedly attached thereto. The cams 87 and 88 are fixedly attached to the sleeve 100 by means of disks 96 which are rigidly secured to the sleeve 100. The disks 96 are preferably made of a suitable welded electrically insulating material, such as a phenolic condensation product. A gear 102 is keyed upon the shaft 11 and meshes with a gear 103 rotatably mounted upon a pivot pin 104 set in the arm 101. A lug 105 fixedly attached to a small gear 106 is mounted upon pivot pin 104 and held in position by a nut 107. A second lug 105*a*, similar in construction to the lug 105, and having a second small gear 106*a* fixed thereto may also be mounted upon the pin 104. The provision of the two lugs 105 and 105*a* permits adjustment of the angle between them and thereby the selection of a desired degree of lost motion. In operation shaft 11 may rotate gear 103 with respect to arm 101 until the lug 105 or the lug 105*a* comes in contact with projection 108 of shaft 11. Engagement of the projection 108 with the lug 105 or the lug 105*a* prevents further relative rotation of gears 102 and 103. A positive driving connection is thus formed between shaft 11 and sleeve 100. This driving connection may be followed from the shaft 11 through the gear 102, the gear 103, the pivot pin 104, the lug 105 or the lug 105*a* to the sleeve 100 and thus to the cams 87 and 88. So long as the shaft 11 continues to rotate in the same direction, the driving connection remains positive. Upon reversal of direction of rotation of the shaft 11, however, the arm 101 remains stationary for such time as is required to rotate the gear 103 and the lugs 105 and 105*a* until one of the lugs engages the other side of the projection 108. In the embodiment of my invention shown in the drawings, two revolutions of the shaft 11 will be permitted upon reversal before the arm 101 begins to rotate the sleeve 100. The shaft 11 then makes one more complete revolution before it is stopped by the cam switch 25.

The lost-motion connection described above is necessary upon the reversal of direction of operation of my sequentially operating switch in order to avoid the necessity of starting the pilot motor 10 three times before any switch will operate. When a sequentially operating switch of the type disclosed in the present embodiment of my invention is reversed, it is necessary that the switch last operated in the forward direction be the first to operate in the reverse direction. Referring to Fig. 2 the switch last operated is that driven by the shaft 26 and the energy-storing means 46. Assuming that the energy-storing means 46 has just been operated in the counterclockwise direction and it is now desired to reverse the direction of operation, it will be recalled that it required three revolutions of the shaft 11 to bring any energy-storing means from its completely deenergized position through a single operating sequence and back to its deenergized position. During these three revolutions of the shaft 11, the completely wound spring 83 and the partially wound spring 82 are being gradually unwound while the spring 53 is being wound. When the spring 53 is completely wound in the reverse direction, the spring 82 will be partially wound in this direction, and the spring 83 will be completely deenergized. However, without the lost-motion connection 24 described above, it would have been necessary to start the motor 10 three times before any switch would operate in the reverse direction. This would be due to the fact that the limit switches 85 and 86 are arranged to stop the motor 10 after each single revolution of the shaft 11. Through the lost-motion connection 24, however, reverse operation of the shaft 11 through two revolutions is permitted before the cams 87 and 88 begin to rotate. Once the cams 87 and 88 begin to rotate in the reverse direction, operation proceeds in the normal manner without any lost motion.

My invention also provides means for limiting to any predetermined extent the degree of rotation of the shafts 26, 27, and 28. The extent of the rotation of shafts 26, 27, and 28 determines the extent to which the speed of the main control motor is changed. The maximum speed of the main motor may be limited by limiting the degree of rotation of the shafts 26, 27, and 28 in one direction, while the minimum speed of the main motor may be predetermined by limiting the degree of rotation of these shafts in the other direction. In order to predetermine the extent to which switch-operating shafts 26, 27, and 28 are rotated, one of the shafts 29, 30, or 31, for example shaft 29, is provided with a loosely mounted cam 110 which engages a limit switch 111. The limit switch 11 is connected in circuit with the pilot motor 10 in such a manner that the pilot motor 10 is completely disabled upon the opening of the switch 111. The circuit connections of the motor 10 will be more fully described hereinafter with reference to Fig. 5. In the assembly for the limit switch 111, an arm 112 is fixedly attached to the shaft 29 and provided with a removable pin 113. The pin 113 is adapted to engage any one of a plurality of holes 114 in the cam 110. Since the cam 110 is loosely mounted upon the shaft 29, it will be apparent that the cam may be fixed to the shaft in any desired angular position by means of the arm 112 and the pin 113. The cam surface 115 on the cam 110 is adapted to engage a lug 116 upon an operating arm 117 of the switch 111. The operating arm 117 is biased into engagement with the surface of cam 110 by means of a spring 118, one end of which abuts a portion 119 of the frame upon which the switch is mounted. The cam surface 115 is of such configuration that the switch 111 is opened once during each revolution of the cam. Since the cam 110 may be adjusted on the shaft 29, the angle through which the shaft 29 and consequently the shafts 26, 27, and 28 rotate, may be predetermined.

Referring now to Fig. 5, I have shown by way of example one possible arrangement for the control circuits and limit switches associated with the pilot motor 10. A pair of field coils 120*a* and 120*b* of the motor 10 are adapted to drive the motor in forward and reverse directions respectively. The circuit for coil 120*a* may be traced from the wire 120 through the limit switch 111, the contacts 122 of a relay 123 and the coil 120*a* to the wire 121. The circuit for the coil 120*b* may be traced from the wire 120 through the limit switch 111, the contacts 124 of a relay 125 and the coil 120*b* to the wire 121. An operating coil 126 of the relay 125 is connected across the supply wires 120 and 121 through a circuit which may be followed from the supply wire 120 through the limit switch 111, the push button 127, the coil 126, and the wire 128 to the wire 121. The push button 127 is shunted by a limit switch 85. The coil 129 of relay 123 is connected across the supply wires 120 and 121 through a circuit which may be followed from the supply wire 120 through the limit switch 111, the push button 130, the coil 129, and the wire 128 to the wire 121. The push button 130 is shunted by a limit switch 86. In operation, any desired direction of rotation of the motor 10 may be selected by depressing one or the other of the push buttons 127 and 130. If the push button 130, for example, is depressed, a circuit is completed for the operating coil 129 of the relay 123. The relay 123 thereupon picks up and completes an operating circuit for the motor 10 through contacts 122 and limit switch 111. As soon as motor 10 begins to rotate, the cam 88 closes the limit switch 86 to complete a shunt circuit for the push button 130. Only momentary closure of the push button 130 is, therefore, necessary to set the motor 10 into operation. As previously pointed out, after the motor 10 has rotated the shaft 11 through one complete revolution, the cam 88 opens the circuit of the pilot motor 10 at the contacts 122. For operation of the motor 10 in the reverse direction, the push button 127, the limit switch 85, and the relay 125 operate in a manner analogous to that of the push button 130, the limit switch 86, and the relay 123 previously described.

Referring now to Fig. 1, I have shown means for performing any desired number of controlling operations independently of the lost motion in shafts 19, 29, 30 and 31. Passing through the hollow shaft 19 I provide a shaft 140 carrying a cam 141 arranged to operate a cam switch 142. The shaft 140 is actuated by the hollow shaft 19 through a lost motion mechanism which may comprise an arm 143 attached to the hollow shaft 19 and carrying a pin 144 which cooperates with a slot formed between two lugs 145 and 146 on an arm 147 carried by the shaft 140. A small angular displacement of the pin 144 between the lugs 145 and 146 is permitted. Preferably the angular displacement between the lugs 145 and 146 is such that the shaft 140 moves in synchronism with the sleeve 100 bearing the cams 87 and 88. The angle between the lugs will therefore depend upon the gear ratio between the shaft 11 and the hollow shaft 19 and upon the setting of the lugs 105 and 105*a* and may obviously be made adjustable. The shaft 140 may carry any desired number of switch operating cams similar to the cam 141. These cams may be used for any desired controlling operations in connection with any system in which my switch operating mechanism may be applied. For example, the switch 142 may be used to control the primary circuit of the motor whose secondary is being controlled by the cam shafts 26, 27, and 28 or it may be used to effect further controlling operations in connection with the pilot motor 10.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto. For example, while I have shown my invention as applied to the control of three operating shafts for the three phases of a wound rotor induction motor, it will be understood, of course, that my invention has a broad application wherever it is desired to obtain rapid and intermittent action of a switch-operating shaft, and wherever it is desired to obtain sequential operation of any desired number of such shafts. Furthermore, the particular gear ratios specified are for purpose of illustration only. It will be understood that any desired gear ratios may be used, so long as the various elements of the apparatus are coordinated for proper sequential operation. I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

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

1. In combination with a driving shaft, a driven shaft in alignment therewith, notching mechanism for controlling movement of the driven shaft, and resilient driving means disposed between said shafts comprising a pair of cross pivoted levers biased to a position of angular separation, said levers being provided with lugs arranged to be driven into alignment to form a positive driving connection between said shafts.

2. In a driving mechanism, the combination of a driving shaft, a driven shaft in alignment therewith, a notching mechanism for controlling movement of the driven shaft, a pin attached to each of said shafts and spaced from the centers thereof, a pair of crossed pivoted levers engaging said pins, and a spring for biasing said levers to a normal position of relative angular separation.

3. In combination with a driving shaft, a driven shaft in alignment therewith, a pawl for controlling movement of the driven shaft, a laterally extending pin attached to each of said shafts spaced radially from the centers thereof, and a pair of crossed levers pivoted about the axis of said shafts, each lever having a lug for engaging said pins, and a compression spring for biasing said levers to a normal position of relative angular separation.

4. In combination, a driving shaft and a driven shaft having aligned centers, a spring pressed pawl for controlling movement of the driven shaft, a pair of crossed levers pivoted about an axis aligned with said shaft centers, each lever being provided with a lug, means for biasing said lugs to a normal position of spaced angular relation, a pin attached to each shaft spaced from the centers thereof and engaging said lugs, the pin on the driving shaft being adapted first to drive the lugs into alignment and then positively to drive the pin on the driven shaft.

5. In combination, a first shaft and a second shaft having a radial arm attached thereto, a driving means attached to the first shaft for rotating the arm, and means loosely mounted on said arm permitting limited reverse movement of said driving means while said arm remains stationary.

6. In combination, a first shaft having a first gear fastened thereto, driving means connected to said first shaft, a second shaft having an arm fastened thereto, a second gear pivotally mounted on said arm and engaging said first gear, and stop means for limiting movement of the second gear about its pivot upon reversal of rotation of said driving means.

7. The combination of a driving shaft having a first gear fastened thereto, a driven shaft in alignment with the driving shaft having a radial arm attached thereto, a gear rotatably mounted on said arm and meshing with said first gear, and stop means limiting relative rotation of said gears upon reversal of rotation of said driving shaft.

8. In combination, a first shaft having a first gear fastened thereto, a second shaft concentric with said first shaft and having a radial arm attached thereto, a second gear pivotally mounted upon said arm, and means for limiting relative rotation of said second gear and said arm.

9. In combination, a first shaft, a second shaft concentric therewith, a radially projecting arm on said second shaft, driving means attached to said first shaft for rotating said arm, said driving means including elements relatively rotatable through a predetermined limited angle whenever the direction of rotation of said first shaft is reversed.

10. In combination, a first shaft, a second shaft concentric therewith, a radially projecting arm on said second shaft, a gear pivotally mounted on said arm, a plurality of relatively adjustable lugs detachably secured to said gear, driving means attached to said first shaft and engaging said gear, and a projection on said first shaft arranged to engage said lugs.

11. In combination, a first shaft having a first gear attached thereto, a second shaft concentric with the first shaft and having a radial arm mounted thereon, a second gear pivotally mounted upon said arm in meshing relationship with said first gear, a projecting lug fixed upon said second gear, and stop means associated with said arm for engaging said lug.

12. In a switch operating mechanism, a plurality of switch operating shafts, a separate snap-acting energy storing means for driving each shaft, means for sequentially releasing said energy storing means, a common reversible driving means for said energy storing means, disabling means for said driving means, and a lost motion mechanism disposed between said driving means and said disabling means and arranged to delay the operation of said disabling means upon reversal of rotation of said driving means.

13. In a switch operating mechanism, a plurality of switch operating shafts, a spring pressed pawl for controlling movement of each of said switch operating shafts, a driving shaft aligned with each of said switch operating shafts, a pair of crossed levers pivoted about the axis of each of said switch operating shafts, each lever being provided with a lug, a compression spring associated with each pair of crossed pivoted levers for biasing said lugs to normal positions of angular separation, a pin attached to each driving shaft and to each switch operating shaft, said pins being spaced from the centers of said shafts and engaging said lugs, the pins on said driving shafts being angularly displaced with respect to each other to sequentially drive each pair of lugs into alignment with each other and then positively to drive the associated switch operating shaft, a common source of energy connected to said driving shafts, a rotatable limit switch also driven by said source of energy and arranged to disable said source of energy after each operation of a single switch operating shaft, and a lost motion mechanism disposed between said source of energy and said limit switch, said lost motion mechanism comprising a pair of concentric shafts, a radially projecting arm on the outer concentric shaft, a gear attached to the inner concentric shaft, a second gear pivotally mounted on said arm in meshing relationship with said first gear, a projecting lug fixed upon said second gear, and stop means associated with said arm for engaging said lug, whereby limited reverse rotation of said inner concentric shaft may occur while said outer concentric shaft remains stationary.

14. In a switch-operating mechanism, a plurality of switch-operating shafts, separate intermittently operating energy-storing means for the shafts, a common source of energy associated with the energy-storing means, means for sequentially releasing the energy of the separate energy-storing means, and means for disabling said source of energy after the release of each energy-storing means.

15. In a switch operating mechanism, a plurality of sequentially and intermittently operating energy-storing means, a common source of energy associated with said energy-storing means, a releasing means for each of the energy-storing means, and means for disabling said source of energy after each operation of any releasing means.

16. In a switch-operating mechanism, a plurality of sequentially and intermittently operating energy-storing means, a common reversible source of energy associated with the energy-storing means, releasing means for each of said energy-storing means, means for disabling said source of energy and a lost-motion connection between said source of energy and said disabling means.

17. In a switch-operating mechanism, a plurality of sequentially and intermittently operating energy-storing means, a common reversible source of energy associated with said energy-storing means, energy-releasing means also associated with each of said energy-storing means, means for disabling said source of energy, and means for driving said disabling means and each of said energy-storing means from said source of energy, said driving means including a lost-motion mechanism between the source of energy and the disabling means operative upon each reversal of the source of energy.

18. In a switch operating mechanism, the combination of the continuously rotating reversible shaft, a second shaft geared thereto having a predetermined relative rate of rotation, driving means connected to said first shaft, rotatable control means for said driving means, an adjustable lost motion mechanism operable upon reversal of said first shaft and connected between said control means and said first shaft, a second rotatable control means, and a second lost motion mechanism connected between said second control means and said second shaft and arranged to drive said second control means in synchronism with said first control means.

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