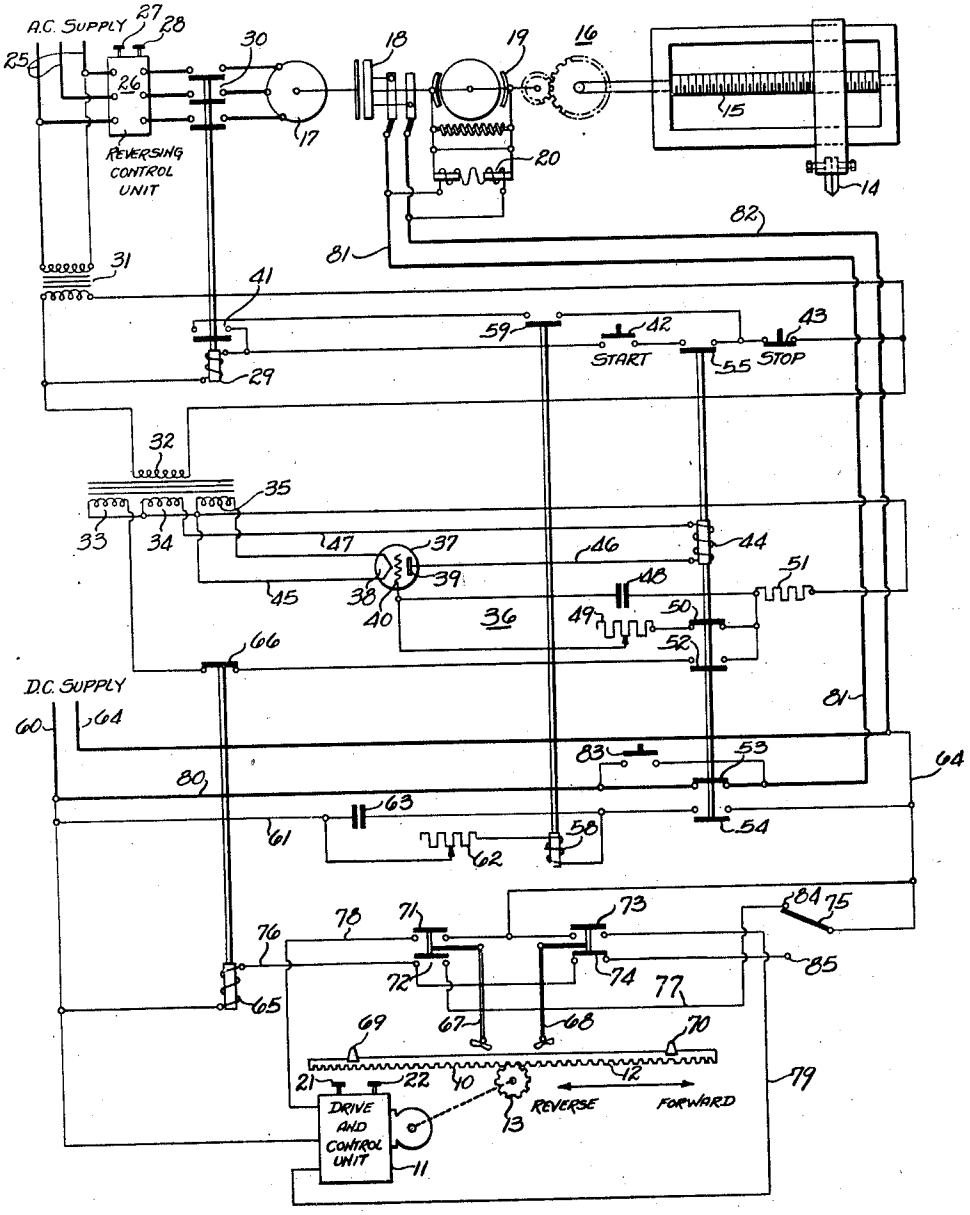
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ELECTRICAL CONTROL SYSTEM

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INVENTORS

George H. Pardey

BY Cornelius L. Johnson.

Hoadley and Kirat attys

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ELECTRICAL CONTROL SYSTEM

George H. Pardey and Cornelius L. Johnson, Cleveland, Ohio, assignors to The Motor Repair and Manufacturing Company, a corporation of Ohio

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Our invention relates in general to electrical control systems and more particularly to an electrical control system for controlling an intermittent drive.

In this application we are illustrating the use of our invention as being applied to control the traverse of a tool device with reference to a reciprocal work table upon which the work piece is mounted that is to be cut by the tool. Although we are showing the use of our invention as being applied to the machine tool as described, it is to be understood that our invention may be applied to other machinery having intermittent driving operations.

An object of our invention is to provide for intermittently energizing a magnetic clutch which interconnects a driving shaft and a driven shaft, whereby the driven shaft is operated through substantially a predetermined number of revolutions.

Another object of our invention is the provision of an electrical timing circuit which governs the duration during which the magnetic clutch is energized to transmit power from one shaft to another.

Another object of our invention is the provision of energizing the magnetic clutch for a predetermined length of time which governs the amount that the driven shaft is turned.

Another object of our invention is the provision of intermittently operating a driven shaft, wherein the intermittent operation is governed by an electrical timing circuit which may be adjusted to vary the duration of each intermittent operation.

Another object of our invention is to provide for intermittently operating a tool device with reference to a reciprocal work table, in which the movement of the tool device is governed by an electrical timing circuit which is set into operation in accordance with the reciprocal movements of the work table.

Another object of our invention is the provision of operating or moving the tool device with reference to the reciprocal work table during the interval or substantially at the same time that the reciprocal work table is being reversed.

Another object of our invention is to provide for electrically energizing the intermittent drive for the movement of the tool device substantially simultaneously at the same time that the electrical circuits are established for reversing the drive of the reciprocal work table.

Another object of our invention is to provide for using the tripping arrangement which reverses the direction of the drive for the reciprocal work table for also controlling the initiation of the electrical timing circuit which governs the amount of energization supplied to the electrical intermittent drive which moves the tool device with reference to the reciprocal work table.

Another object of our invention is to provide for arresting the movement of the tool device with reference to the reciprocal work table in the event that the electrical timing circuit fails to operate.

Other objects and a fuller understanding of our invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing, in which the figure represents a diagrammatic illustration of a control system embodying the features of our invention.

As hereinbefore mentioned, our invention is shown as being applied to a reciprocal work table identified by the reference character 10 which may be suitably driven by a drive and control unit indicated by the reference character 11. As diagrammatically illustrated, the drive and control unit may be operated in one direction by manually depressing the push button 21 and may be manually operated in the reverse direction by depressing the push button 22. Any suitable means may be employed to reciprocally operate the work table 10 and as illustrated we employ rack and pinion arrangement 12 and 13. The movement of the reciprocal work table to the right is designated as the forward direction and the movement of the reciprocal work table to the left is designated as the reverse direction. When the reciprocal work table 10 reaches the end of its forward movement, a projection 69 engages a toggle arrangement 67 which functions to close the contacts 71 and 72. The closure of the contacts 71 establishes a circuit through conductor 78 for reversing the drive and control unit 11 to reciprocate the work table 10 in the reverse direction. The work table moves in the reverse direction until the projection 70 engages the toggle arrangement 68 which operates to close the contacts 73 and 74. The closure of the contacts 73 establishes a circuit through conductor 79 for reversing the operation of the drive and control unit 11 to reciprocate the work table 10 in the forward direction. As the projections 69 and 70 pass back underneath their respective toggle arrangements, the operation is such that the contacts controlled thereby are restored to their open position as illustrated in the drawing. The toggle arrangements 67 and 68 are misaligned with

respect to each other so that the projections 69 and 70 only engage their respective toggles. The showing and the operation of the reciprocal movements of the work table by the drive and control unit 11 is abbreviated and condensed for the reason that this constitutes no portion of our invention, except only that our invention is associated with the particular diagrammatic arrangement as illustrated.

The tool device is illustrated by the reference character 14 and is arranged to be moved laterally with respect to the work table as each cut is made upon the work piece. As diagrammatically illustrated, the tool device may be moved in a transverse arrangement with respect to the work table by means of a screw traverse assembly 15 which may be driven by an electric motor 17 through means of an electric magnetic clutch 18 and reducing speed gears 16. An electric brake 19 is associated with the magnetic clutch so that when the magnetic clutch is energized to transmit power the electric brake 19 is released through the energization of the brake windings 20.

The electric motor 17 may be energized from a suitable alternating current supply indicated by the reference character 25. The starting and stopping of the electric motor 17 may be accomplished by a relay 29 having contacts 30 and the direction of rotation of the electric motor 17 may be controlled by the reversing control unit 26 which when the push button 27 is depressed operates the motor in one direction and when the push button 28 is depressed the motor operates in the reverse direction. The motor 17 is continuously driven and the magnetic clutch 18 is operated intermittently to intermittently move the tool device 14 with reference to the reciprocal work table upon actuation of the toggle arrangement 67 or 68 depending upon the direction of travel of the reciprocal work table and upon whether the transfer switch 75 is engaging contact 84 or 85. The duration through which the magnetic clutch is energized is governed by an electrical timing circuit indicated generally by the reference character 36 which comprises a grid controlled rectifying tube 37, a condenser 48, an adjustable resistor 49, a fixed resistor 51, and the secondary windings 33, 34 and 35 of a transformer 32, which in turn is energized by a transformer 31 connected to the alternating current supply 25. The grid controlled rectifying tube comprises a heated cathode 38, a plate 39 and a control grid 40. The cathode 38 is heated by the secondary winding 35 of the transformer 32. The plate circuit of the rectifying tube is energized by the secondary winding 34 and may be traced from the left-hand terminal of the secondary winding 34 through conductor 45 to the cathode 38, the plate 39, a conductor 46 to the winding of a relay 44 and through a conductor 47 to the opposite terminal of the secondary winding 34. When the tube 37 is conducting current the relay 44 is energized, and closes the contacts 52, 54 and 55 and opens the contacts 50 and 53. The closure of the contact 52 connects the secondary winding 33 in electrical circuit connection with the condenser 48 which electrically charges the condenser 48 preparatory to discharging same through the adjustable resistor 49 upon the reclosure of the contact 50 which connects the adjustable resistor 49 in closed circuit relation with the condenser 48. During the discharging of the condenser 48 through the adjustable resistor 49, the tube 37 becomes non-conducting until the condenser has been discharged to a predetermined condition, after which it again becomes conducting to resume the cycle of operation.

The operation of the complete circuit arrangement may be described as follows: assuming that the work table 10 is moving to the right as shown in the drawing, and that the rectifying tube 37 is conducting, in which event the relays 44 and 58 are energized, the motor 17 may then be started by depressing the start push button 42 which establishes a circuit for energizing the relay 29 for closing the contacts 30 which connect the motor 17 to the alternating current supply conductor 25. The relay 29 when once energized by depressing the push button 42 is continuously energized through the contacts 41 which are closed when the relay is once energized. Consequently, the motor 17 continues to run even though the contacts 55 of the relay 44 are open and even though the start push button 42 is open. The rectifying tube 37 continues to be conducting and the relay 44 continues to be energized until the projection 69 engages the toggle arrangement 67 at which time the contacts 71 and 72 are closed. The closure of the contacts 71 provides for reversing the direction of the drive and control unit for reversing the movement of the reciprocal work table 10 to the left. The closure of the contacts 72 establishes a circuit for energizing the relay 65 which circuit extends from the direct current supply conductor 60, the winding of the relay 65, a conductor 76, the contacts 72, a conductor 77 and a transfer switch 75 to the opposite side 64 of the supply source. The energization of the relay 65 opens the contact 66 for disconnecting the condenser 48 from circuit relation with the secondary transformer winding 33. Interruption of the circuit by the opening of the contact 66 causes the condenser 48 to affect the control grid 40 such that the tube 37 becomes non-conducting at which point the relay 44 is de-energized. The de-energization of the relay 44 closes the contact 53 which establishes a circuit for energizing the magnetic clutch 18 and the windings 20 of the brake 19. The circuit for energizing the magnetic clutch 18 and the brake winding 20 may be traced as follows: beginning with the direct current supply conductor 60, current flows through conductor 80, the contacts 53, conductor 81, the magnetic clutch 18 and the brake winding 20, and conductor 82 to the opposite side of the direct current supply source 64. The relay 44 remains de-energized for supplying current to the magnetic clutch for a short interval of time as determined by the rate at which the condenser 48 is discharged through the adjustable resistor 49 which is connected in closed circuit relation with the condenser 48 through the closed contacts 50. As previously explained, when the condenser 48 is discharged to a predetermined condition the tube 37 again becomes conducting at which point the relay 44 is again energized which interrupts the circuit for supplying the current to the magnetic clutch. During the interval that the magnetic clutch is energized, the motor 17 drives the gears 16 and the screw traverse assembly 15 for moving the tool device 14 a small distance with reference to the reciprocal work table for taking another cut upon the work piece carried by the work table. Accordingly, our invention provides for moving the tool device a small distance, upon the projection 69 tripping the toggle arrangement 67. The movement of the tool 14 is substantially concurrent with the tripping of the toggle arrangement so that the projection 69 need not move much be-

yond the toggle arrangement for effecting the proper movement of the tool 14. The operation of the timing circuit 36 upon the projection 70 engaging the toggle 68, is substantially the same as that described for the projection 69 engaging the toggle arrangement 67 except that the contacts 73 and 74 are operated instead of the contacts 71 and 72. The transverse switch 75 is arranged such that the movement of the tool device 14 may be moved either at the beginning of the stroke or at the end of the stroke of the reciprocal work table. Thus, in the position shown, the tool device is operated when the projection 69 engages the toggle arrangement 67. Upon the transfer of the switch 75 to the opposite contact 85, the movement of the tool 14 is effected when the projection 70 engages the toggle arrangement 68. When the toggle arrangement 67 or 68 as the case may be are restored to their normal position upon the reversal of the work table, the relay 65 is again de-energized which closes the relay contacts 66 for re-establishing the timing circuit by connecting the secondary transformer winding 33 in circuit relation with the condenser 48 and the fixed resistor 51 through the closed contacts 52 for again recharging the condenser 48 preparatory to another cyclic operation. The tube 37 remains conducting and the relay 44 remains energized until the relay 65 is again re-energized for interrupting the contact 66. Consequently, the relay 44 remains energized throughout the period that the movable work table 10 travels before the projection 69 or 70, as the case might be, engages the respective toggle arrangement, and momentarily remains de-energized during the time that the electrical timing circuit 36 causes the tube 37 to be non-conductive.

Accordingly, in our control system the magnetic clutch is energized momentarily through the closure of the contacts 53 during the period that the relay 44 is de-energized which is determined by the discharging of the condenser 48 through the adjustable resistor 49. The distance that the tool 14 is moved may be accordingly varied by adjusting the adjustable resistor 49 which varies the discharge rate of the condenser 48. In the event that the tube should fail for any other reason so that the relay 44 remains de-energized for too long a period, we provide for de-energizing the motor 17 through means of a relay 58 which is energized through a circuit including the contacts 54 of the relay 44. The circuit for energizing the relay 58 may be traced from the direct current supply conductor 60 through conductor 61, the adjustable resistor 62, the winding of the relay 58, and the contact 54 to the opposite side of the direct current supply source 64. The condenser 63 is connected in parallel with the adjustable resistor 62 and the winding 58 which tends to hold the relay 58 energized for a predetermined length of time after the contacts 54 are open upon the de-energization of the relay 44. Thus, the relay 58 is set for a longer period of time than the setting of the electrical timing circuit 36 so that in the ordinary operation of the electrical timing circuit 36 the relay 58 always remains closed. However, in the event that the relay 44 remains open for a longer period of time than that determined by the discharge of the condenser 48, such for example, as upon the failure of the tube 37, the relay 58 becomes de-energized and opens the contacts 59 for energizing the relay 29 which disconnects the motor 17 from the alternating current supply 25. The relay 58 may thus be characterised as a safety relay to prevent the motor 17 from driving the tool 14 in the event of failure of the electrical timing circuit 36. A push button 83 is connected in parallel with the contacts 53 so that upon depressing the push button 83 the magnetic clutch 18 may be energized separately from the electrical timing circuit for continuously moving the tool 14. The push button 83 may be used for setting the tool 14 for the initial setting operation.

We find from actual experience that the arrangement provides for giving very accurate control over the movements of the tool device 14 with reference to the reciprocal work table and that the movement of the tool with respect to the work piece is substantially concurrent with the tipping of the toggle arrangement for reversing the direction of the movement of the reciprocal work table. The entire system for operating the tool device may be arrested by depressing the stop button 43.

Although we have described our invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

We claim as our invention:

1. In a control system having a driving shaft, a driven shaft, a magnetic clutch between the two shafts, and a source of electrical current, the improvement of circuit means for momentarily energizing the magnetic clutch for transmitting power from the driving shaft to the driven shaft, said improvement comprising circuit connection means for connecting the magnetic clutch to the source of electric current, and an electrical timing circuit including a grid-controlled tube and a capacitor for governing the circuit connection means.

2. In a control system having a driving shaft, a driven shaft, a magnetic clutch between the two shafts, and a source of electrical current, the improvement of circuit means for momentarily energizing the magnetic clutch for transmitting power from the driving shaft to the driven shaft, said improvement comprising circuit connection means for connecting the magnetic clutch to the source of electric current, and an electrical timing circuit including a grid-controlled tube and a capacitor for governing the circuit connection means, said circuit connection means controlling the electrical timing circuit.

3. In a control system having a driving shaft, a driven shaft, a magnetic clutch between the two shafts, and a source of electrical current, the improvement of circuit means for momentarily energizing the magnetic clutch for transmitting power from the driving shaft to the driven shaft, said improvement comprising circuit connection means for connecting the magnetic clutch to the source of electric current, an electrical timing circuit including a grid-controlled tube and a capacitor for governing the circuit connection means, said circuit connection means controlling the electrical timing circuit, and means for arresting the rotation of the driving shaft upon failure of the electrical timing circuit.

4. In a control system having a movable work table, a movable tool device, and a source of electrical current, the improvement of circuit means for moving the tool device with respect to the work table, said circuit means comprising, driving means for the tool device, magnetic clutch

means for governing the driving means, circuit connection means for connecting the magnetic clutch to the source of electric current, an electrical timing circuit for governing the circuit connection means, said circuit connection means controlling the electric timing circuit, and means responsive to the movements of the work table for governing the electrical timing circuit.

5. In a control system having a movable work table, a movable tool device, and a source of electrical current, the improvement of circuit means for moving the tool device with respect to the work table, said circuit means comprising, driving means for the tool device, magnetic clutch means for governing the driving means, circuit connection means for connecting the magnetic clutch to the source of electric current, an electrical timing circuit including a grid-controlled tube and a capacitor for governing the circuit connection means, and means responsive to the movements of the work table for governing the electrical timing circuit.

6. In a control system having a movable work table, a movable tool device, and a source of electric current, the improvement of circuit means for moving the tool device with respect to the work table, said circuit means comprising, electric means for controlling the movements of the movable tool device, circuit connection means for connecting the electric means to the source of electric current, an electrical timing circuit including a grid-controlled tube and a capacitor for governing the circuit connection means, and means responsive to the movements of the work table for governing the electrical timing circuit.

7. In a control system having a movable work table, a movable tool device, and a source of electric current, the improvement of circuit means for moving the tool device with respect to the work table, said circuit means comprising, electric means for controlling the movements of the movable tool device, circuit connection means for connecting the electric means to the source of electric current, an electrical timing circuit for governing the circuit connection means, means responsive to the movements of the work table for governing the electrical timing circuit, and means for arresting the movements of the tool device upon failure of the electrical timing circuit.

8. In a control system having a movable work table, a movable tool device, and a source of electric current, the improvement of circuit means for moving the tool device with respect to the work table, said circuit means comprising, an electric motor for driving the tool device, a magnetic clutch between the electric motor and the tool device, means for energizing the electric motor, circuit connection means for connecting the magnetic clutch to the source of electric current, an electrical timing circuit for governing the circuit connection means, and means responsive to the movements of the work table for governing the electrical timing circuit.

9. In a control system having a movable work table, a movable tool device, and a source of electric current, the improvement of circuit means for moving the tool device with respect to the work table, said circuit means comprising, an electric motor for driving the tool device, a magnetic clutch between the electric motor and the tool device, means for energizing the electric motor, circuit connection means for connecting the magnetic clutch to the source of electric current, an electrical timing circuit for governing the circuit connection means, means responsive to the movements of the work table for governing the electrical timing circuit, and means for de-energizing the electric motor upon failure of the electrical timing circuit.

10. In a control system having a movable work table, a movable tool device, and a source of electric current, the improvement of circuit means for moving the tool device with respect to the work table, said circuit means comprising, an electric motor for driving the tool device, a magnetic clutch between the electric motor and the tool device, means for energizing the electric motor, circuit connection means for connecting the magnetic clutch to the source of electric current, an electrical timing circuit for governing the circuit connection means, said circuit connection means controlling the electrical timing circuit, means responsive to the movements of the work table for governing the electrical timing circuit, and means for de-energizing the electric motor upon failure of the electrical timing circuit.

GEORGE H. PARDEY.
CORNELIUS L. JOHNSON.