This invention relates to an inching control system for electric motors.

Electric motors employed to drive machine tools or other loads are usually provided with a well-known form of starting and interlocking holding circuits for controlling their operation. Initial operation of a start push button energizes a relay which operates to start the motor and which closes a holding contact for the purpose of maintaining itself energized when the start push button is released. When the motor is thus started, it will continue to run until its starting relay is deenergized by opening of a stop push button in the relay energizing circuit.

In many cases, it is desirable to operate the motor momentarily to effect an inching or jogging operation for the purpose of positioning the machine tool apparatus or other load driven thereby. Due to the holding contact for the purpose of maintaining the starting relay energized, conventional inching control systems require the use of a separate control relay and push button controlling the relay energization in order to effect the desired inching or jogging operation. The use of the separate control relay for jogging operations adds to the cost and space requirements of the control apparatus and often requires a special cabinet for mounting the starter.

In the absence of a special inching relay for the purpose of effecting jogging operations of an electric motor, it is possible to perform such operations by the use of the conventional start and stop push buttons. To do so, the stop push button is first opened, and the start push button is moved to its closed position. Thereafter, momentary closure of the stop push button will effect a momentary or jogging operation of the motor. However, this method requires knowledge or special training or skill on the part of the operator and consequently in some cases is impractical and dangerous.

One of the principal objects of this invention is to provide an inching control system for electric motors which is foolproof in operation and which does not require any control relay in addition to the normal starting relay for the motor.

A further object of this invention is to provide an inching control system in which there is provided an inching push button which is effective upon operation thereof to render the conventional start push button inoperative until such time as the start push button is positively operated by the operator.

A further object is to provide an inching control system for electric motors in which an inching push button is arranged to occupy a normal position, making the start push button operative, and which, upon movement out of its normal position to effect an inching operation of the electric motor is latched against return movement to its normal position.

A further object is to provide a latching apparatus capable of latching an inching push button in the manner referred to which is arranged to be unlatched upon operation of the start push button.

A further object of this invention is to provide a novel form of mechanical interlock for interlocking the operation of a pair of push buttons controlling common electrical apparatus.

Other objects and advantages of this invention will become apparent from the following description.

In the drawing, there is shown a preferred embodiment of the invention. In this showing:

Fig. 1 is a top plan view of a pair of push button switches constructed in accordance with the principles of this invention;

Fig. 2 is a vertical sectional view of the push button switches shown in Fig. 1;

Fig. 3 is a view similar to Fig. 2, with one of the push button switches shown in elevation, together with a diagrammatic sketch of a circuit controlled by the push buttons; and

Fig. 4 is a detail view of the movable contact operating member employed in each of the push button switches.

In Fig. 3, numeral 1 designates an alternating current motor connected to alternating supply leads L1, L2 and L3 by the contacts 2 of a relay 3 having an energizing winding 4. Energization of the winding 4 is normally effected by a starting circuit 5 which operates to connect the winding 4 across alternating current supply leads L1 and L2 through the contacts 6 of a start push button switch 7 and the contacts 8 of an inching push button switch 8 and a stop push button switch 10. The relay 3 is provided with a holding contact 11 which operates to close a holding circuit 12 for the coil 4. The holding circuit 12 is connected in parallel with the contacts 6 of the start push button switch 7 so that the coil 4 will be maintained energized when the start push button switch 7 is opened after closure thereof.

Inching or jogging operations of the motor 1 are effected through an inching circuit 13 which may be connected in series with the alternating
current supply leads L1, L2 and the energizing coil 4 through contacts 14 on the inching push button switch 9 in a manner to be described.

Each of the switches 1 and 3 comprises upper and lower insulating structure 15 and 16 which are clamped together and secured to a supporting structure 17 by threaded fastening elements 18. A push button 15 is movably mounted for vertical rectilinear movement in the upper insulating structure 15 and is provided with a spring 23 for biasing it to its upper position, as shown in Fig. 2, and an operating member 21 secured thereto for movement therewith. Each of the operating members 21 is provided with a rectangular opening 22, as shown in Fig. 4, in which is mounted a conductive contactor element 23 having a biasing spring 24 for biasing the contactor element 23 in a direction toward the lower end of the slot 22. As far as described, the design of the individual push button switches 1 and 3 is conventional and not part of the invention proper. This, however, does not apply to the features described presently.

The push button switch 9 is provided with a latching element 25 which is pivotally connected to the stationary supporting structure 15. A biasing spring 26 is provided for pivotally moving the latching element 25 in a counterclockwise direction, as viewed in Figs. 2 and 3. The latching element 25 has a latching part 27 which engages with a surface 28 on the push button 19 of the switch 9 when it is in the position shown in Fig. 2. When the push button switch 9 is operated, the surface 28 will be moved downwardly and out of restraining engagement with the latching part 27 which will then move inwardly to a position overlying the notched ledge 29, as shown in Fig. 3. Return movement of the push button 19 on the surface 9 by its biasing spring 28 to the position shown in Fig. 3 will be prevented by the latching part 27.

To release the latching part 27 from engagement with the ledge 25, an actuating part 33 is secured to the push button 19 of the switch 7. When the push button 19 of the switch 7 is moved downwardly against the action of its biasing spring 28, the actuating part 33 will move downwardly against engagement with an arm 31 on the latching element 25 which will then be pivoted in a clockwise direction against the action of its biasing spring 28 to move the latching part 27 out of engagement with the ledge 25 and to thereby release the push button 19 of the switch 7 to movement by its biasing spring 28 to the position shown in Fig. 2.

The normal position of the push button switches 1 and 3 is shown in Fig. 2. In this normal position, the conducting contactor element 23 of the switch 9 is operable to electrically interconnect the contacts 8. Referring to Fig. 3, it will be noted that operation of the switch 7 by downward movement of its push button 19 will be effective through its conducting contactor element 23 to electrically interconnect the contacts 8 to thereby energize the starting circuit 5 for the coil 4 of the relay 3. Energization of the relay 3 will cause the holding contact 11 to close and thereby set up a holding circuit for the coil 4 around the contacts 8 so that when the switch 7 moves to its open position the coil 4 will remain energized. The energization of both starting circuit 5 and holding circuit 12 is dependent upon electrical connection of the contacts 8 through the conducting contactor element 23 of the switch 9. Subsequent deenergization of the coil 4 to stop the motor 1 may be effected by either operation of the stop push button 18 or operation of the push button switch 9 to disengage its contactor element 23 from the contacts 8.

To effect a momentary inching or jogging operation of the motor 1 at any time, it is merely necessary to move the push button 19 of the inching switch 9 downwardly against the action of its biasing spring 20. The first action that takes place in such downward movement is the electrical disconnection of the contacts 8. When the contactor element 23 of the switch 9 moves to a position substantially midway between the contacts 8 and 12, the latching element 25 will pivot in a counterclockwise direction to prevent return movement of the push button switch 9 to its normal position. Thereafter, operation of the push button 19 on the switch 9 will be effective only to move its contactor element 23 to and out of engagement with the contacts 14. Engagement of the contact element 23 with the contacts 14 will effect momentary energization of the inching circuit 13 and starting coil 4 for the motor 1. As long as the latching element 25 is in the position shown in Fig. 3, energization of the relay 3 through its normal starting circuit 5 and its holding circuit 12 will be prevented since the energization of these circuits is dependent upon the electrical connection of the contact elements 8 by the contactor element 23 of the switch 9. When the switch 9 is thus latched to prevent electrical connection of the contact elements 8, it will be seen that the motor 1 will only operate as long as the inching switch 9 is operated to maintain its contact element 23 positively engaged with the contacts 14. As soon as the apparatus driven by the motor 1 is properly positioned and it is desired to operate the motor 1 continuously, it is merely necessary to operate the push button switch 7 manually by pushing its push button 19 downwardly and to electrically connect the starting contacts 6. This downward movement will first effect an unlatching operation of the latch 25, as explained above, to release the switch 9 which will automatically operate by reason of its biasing spring 28 to 20 to electrically connect the contacts 8 to the connection of the starting contacts 6 by the start push button 17 after electrical connection of the contacts 8 will then be effective to energize the relay 3 through the starting circuit 5, and the relay 3 will operate to seal itself in through its holding contact 11.

The latching of the inching push button switch 9 against a return movement of its conductor element 23 beyond a position in which it is out of engagement with the contacts 8 is necessary for safety purposes when effecting jogging operations of the motor 1. This requirement will be better understood by considering the action that would take place if the latching operation were omitted. When the push button switch 9 is operated to connect the contacts 14, the relay 3 operates to start the motor 1, and in addition, closes the holding contact 11 for the holding circuit 12. As long as the circuit 12 is opened through the contacts 8, no damage can be done. However, if the switch 9 is permitted to move quickly to its normal position, the contacts 8 may be connected before the relay 3 drops out to open the interlocking holding contact 11. In such case, an energizing circuit...
would be completed through the holding contact 11, and the motor 1 would continue to run with the possibility of injury to operators working on the apparatus driven by the motor. By interlocking the operation of the switches 6 and 7 so as to prevent continued operation of the motor in the absence of positive actuation of the start push button 7, it will be seen that accidental operation of the motor 1 is prevented during jogging operations thereof for positioning purposes. It will also be noted that inching or jogging operations can be accomplished without the use of a relay additional to that of the normal starting relay 3 as required in conventional controls.

Since numerous changes may be made in the above-described construction and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all the matter contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. An inching control system for an electric motor, comprising a relay having a control coil, a starting circuit and a holding circuit connected with said coil, an inching circuit connected with said coil in parallel relation to said starting and holding circuits for energizing said coil independently of said starting and holding circuits, a push button having a first contact structure in said starting and holding circuits and a second contact structure in said inching circuit, said push button having a bias for moving it to a normal position in which said first contact structure is closed and said second contact structure is open, a latch responsive to movement of said push button out of said normal position to close said second contact structure for latching said push button against return movement by its bias to said normal position, and a start push button for said starting circuit effective upon operation thereof to actuate said latch and release said first named push button for movement by its bias into its normal position to render said starting and holding circuits operative.

2. An inching control system for an electric motor, comprising a relay having a control coil, a starting circuit and a holding circuit connected with said coil, an inching circuit connected with said coil in parallel relation to said starting and holding circuits for energizing said coil independently of said starting and holding circuits, a push button having a first contact structure in said starting and holding circuits and a second contact structure in said inching circuit, said push button having a bias for moving it to a normal position in which said first contact structure is closed and said second contact structure is open, a latch responsive to movement of said push button out of said normal position to close said second contact structure for latching said push button against return movement by its bias to said normal position, a start push button for said starting circuit effective upon operation thereof to actuate said latch and release said first named push button for movement by its bias into its normal position to render said starting and holding circuits operative, and a latch actuator for operating said latch to release said start push button for movement by its bias from said mid-position to said normal position to render said start push button operative to start said motor.

3. In an inching control for an electric motor, the combination of a start push button for operating said motor, an inching push button for operating said motor independently of said start push button, said inching push button being movable from a normal position rendering said start push button operative to a second position in which it operates said motor and said start push button is rendered inoperative, said inching push button having a bias for moving it to and maintaining it in said normal position, a latch responsive to movement of said inching push button to a mid-position between said normal and second positions for latching it against movement by its bias from said mid-position to said normal position, said inching push button when latched being movable back and forth between said mid-position and said normal position, and a part responsive to operation of said start push button for actuating said latch to release said inching push button for movement by its bias to said normal position to render said start push button operative to start said motor.

4. In an inching control for an electric motor, the combination of a start push button for operating said motor, an inching push button having a first contact structure operable upon closure thereof to render said start push button operative and a second contact structure operable upon closure thereof to operate said motor independently of said start push button, said inching push button being movable from a normal position in which said first contact structure is closed through a mid-position in which both of said contact structures are open to a second position in which said second contact structure is closed and having a bias for moving it to said normal position, a latch responsive to movement of said inching push button to said mid-position for latching it against return movement by its bias to said normal position, said inching push button when latched being movable back and forth between said mid-position and said normal position, and a part operative in response to operation of said start push button for actuating said latch to release said inching push button for movement by its bias from said mid-position to said normal position to render said start push button operative to start said motor.

5. The combination with a pair of push buttons respectively movable in parallel paths between two positions and having a bias to one of said positions, of a latch responsive to movement of one of said push buttons against its bias to a mid-position between said two positions for latching said push button against return movement by its bias from said mid-position to said one position, said one push button when latched being movable back and forth between said mid-position and the other of said two positions, and a latch actuator for operating said latch to release said one push button for movement from said mid-position by its bias in response to movement of the other of said push buttons against its bias.

6. The combination with a pair of operating members respectively movable in parallel paths between two positions and having a bias to one of said positions, of a pair of push buttons respectively operable to actuate one of said operating members against its bias, a latch responsive to movement of one of said operating members against its bias to a mid-position between said two positions for latching said one operating member against return movement by its bias from said mid-position to said one position, said operating member when latched being movable back and forth between said mid-position and the other of said two positions, and a latch actuator for operating said latch to release said one operating member for movement from said
7. The combination with a pair of operating members respectively movable in parallel paths between two positions and having a bias to one of said positions, of a supporting structure for said members, a latching member mounted for movement on said structure and having a bias for moving it toward one of said operating members, said one member having a part providing engageable with said latching member for preventing movement thereof during its movement from said one position to a second position spaced from the other of said two positions, movement of said one operating member to said second position being operative to disengage said surface from said latch to release it for movement by its bias to a latching position overlying said part, said latch when in latching position being operative to engage said part to prevent return movement of said one operating member from its second to its said one position and to thereby confine said one operating member for movement back and forth between said second position and the other of said two positions, and a part responsive to movement of the other of said operating members against its bias for moving said latch to release said one operating member for movement from said second position to said one position.

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