

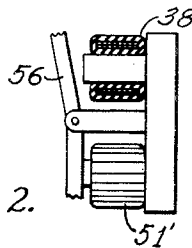
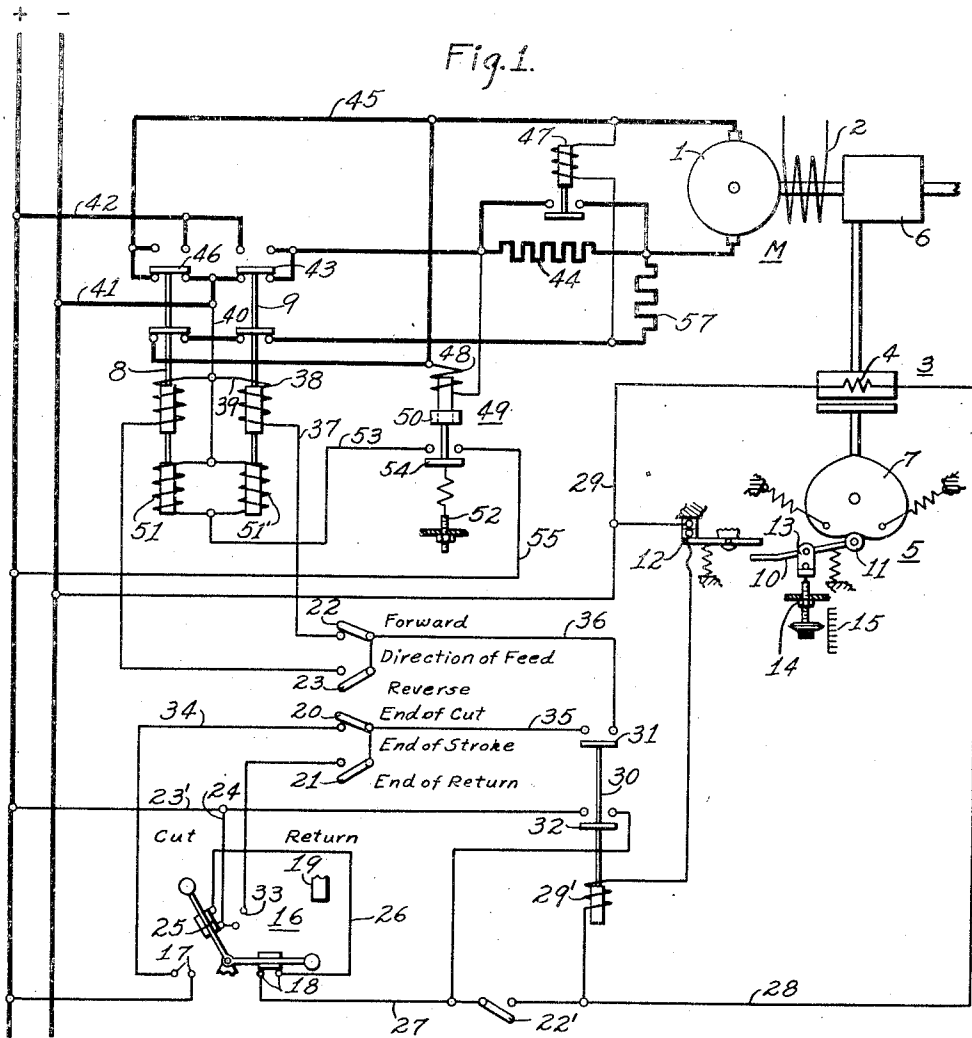
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2,285,666

FEED DRIVE MOTOR CONTROL

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FEED DRIVE MOTOR CONTROL

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My invention relates to a control system for effecting a predetermined amount of rotation of a feed motor in either of two directions, and is particularly suitable for planer control systems and the like.

Motor operated incremental feed is used quite extensively on planers, drawcut and pushcut shapers, etc. The measuring means used to obtain the feed may be a dashpot relay, a geared limit switch or any similar device. This system of control has already been covered by my earlier filed Patent No. 2,100,745, issued November 30, 1937.

Briefly, this method of control employs the use of a limit switch geared directly to the feed motor through a magnetic clutch. The limit switch is reset by a spring when the clutch is de-energized. A dial is provided calibrated in fractions of an inch for setting the amount of feed. The gearing is usually designed, for example, so that one-quarter revolution of the motor is equal to one-sixty-fourth of an inch feed or 16 motor revolutions equal one inch of feed.

To start the feed motor and stop it in one-quarter of a revolution requires fast operating contactors. For this reason it is better practice to use two contractors, each having one make contact and two back contacts for reversing contactors rather than to use single pole contactors which require sequencing. These two contactors each have two coils, one for closing the make contacts and one coil for sealing the back contacts.

The conventional method of connecting the back contact coils is across the armature and dynamic braking resistor. This connection provides full voltage on the make coils when the dissectional contacts are closed and provides counter voltage of the motor on the back contact coils to hold their back contacts closed during dynamic braking. This method of connecting the back contact coils gives satisfactory operation when the motor is allowed to reach a reasonable speed and develop sufficient counter voltage to hold the back contacts closed. On small feeds where the motor operates only a fraction of a revolution at a time the motor does not develop much counter voltage, causing the back contacts to bounce and open the dynamic braking circuit. This results in poor contact life and causes variations in the accuracy of the feed.

An object of my invention is to overcome the aforementioned difficulties by connecting the back contact coils across the line so that they

will be energized on full voltage during dynamic braking and by providing an inductive time relay also across full line voltage, as will appear more clearly hereinafter.

5 Another object of my invention is to provide a motor operated incremental feed system which will be devoid of pitting or arcing of the contact members and thereby which will have long contact life.

10 Another object of my invention is to provide a feed motor control system which is simple and which will provide highly accurate feed.

Other objects and advantages will become more apparent from a study of the following specification when considered in conjunction with the accompanying drawing, in which:

Figure 1 is a schematic showing of a control system embodying the principles of my invention; and

20 Fig. 2 is a side view of a portion of one of the reversing contactors shown in Fig. 1.

Referring more particularly to the figures, M denotes a feed motor having an armature 1, which motor is excited by a suitable field winding 2 from a source of potential (not shown). Geared to armature 1 is an electro-magnetic clutch 3 having an operating coil 4 which when energized effects engagement of said clutch. The purpose of the clutch is to couple or uncouple a measuring means or geared limit switch 5 from the feed motor through suitable reduction gearing indicated by numeral 6, which measuring means is old in the art and is described in my earlier filed patent previously mentioned. It may be briefly described as comprising a spring biased heart-shaped cam 7, which is rotated either clockwise or counter-clockwise, depending upon whether reversing contactor 8 or reversing contactor 9 is energized and having a spring biased pivoted arm 10, the roller 11 on one end which moves along the periphery of cam 7 and which is adapted after predetermined movement of the cam to open spring biased contact members 12, so as to effect deenergization of clutch coil 4, hence uncoupling thereof and to effect deenergization of contactor 30 so as to effect deenergization of the reversing contactor (8 or 9), thereby interrupting the feed circuit of the motor. For simplicity, means for predetermining the necessary angular rotation of cam 7 for effecting opening of switch 12 is represented as a vertically movable pivot 13, which is moved by an adjustable screw 14 alongside a calibrated scale 15. However, since the specific measuring means described above forms no part of my invention,

more detailed explanation thereof is not deemed necessary since such can be found in the previously mentioned patent.

Since my invention is particularly suitable in a control system for effecting reciprocating motion between a cutting tool, such as a planer and a work piece, it is shown as being associated with such device. However, such planer control systems are quite common, and have been described in my previous patents, such as my earlier filed patent mentioned above, and it is felt that for the sake of simplicity, it will be necessary merely to show the limit switch 16 thereof which is moved counter-clockwise at the end of the cut stroke by the reciprocating work piece (or in some cases the reciprocating cutting tool, that is, when the work piece is stationary), so as to close contact members 17 thereof and which limit switch is moved clockwise at the end of the return stroke so as to close contact members 18 thereof. A portion of the reciprocating member is denoted generally by numeral 19 and which alternately effects counter-clockwise and clockwise movement of the limit switch 16. Feed motion is sometimes desirable only at the end of the cut stroke and sometimes is desirable only at the end of the return stroke, and at other times desirable at the end of both strokes. "End of stroke" selector switches 20 and 21 are provided for effecting feed at the end of the cut stroke and at the end of the return stroke respectively. It will thus be evident that either or both of switches 20 and 21 may be closed to secure feed at the end of either or both strokes, if desired. In addition, a pair of "direction of feed" selector switches 22 and 23 are provided for effecting either forward or reverse lateral movement of said feed motor, that is, either rotation in one direction or in an opposite direction of said feed motor.

The operation of the control system embodying my invention is as follows: A source of electric potential indicated by plus and minus may be applied to the clutch coil 4 by the closing of a suitable feed switch 22. With limit switch 16 in the position shown, such energizing circuit extends from the plus terminal through conductors 23', 24, contact members 25, conductor 26, contact members 18, conductor 27, switch 22', conductor 28, clutch coil 4, conductor 29 to the minus terminal. A parallel energizing circuit will extend from switch 22' through the control relay coil 29' and contact members 12, as will be readily apparent, thereby effecting upward movement of contactor 30 and the closing of contact members 31 and 32 thereof. Contact members 32 parallel the closed contact members 25 and 18 of the limit switch 16 in the position shown, that is, at the end of the return stroke. (However, had the limit switch been in the counter-clockwise position representative of the end of the cut strike contacts 32 would have paralleled closed contact members 17 and 33 of the limit switch.) Contact members 31 of contactor 30 set up a feed circuit. When the reciprocating element of the planer 19 reaches the end of the cut stroke, a circuit is completed extending from the plus terminal to the contact members 17, conductor 34, selector switch 20, conductor 35, contact members 31, conductor 36 (and assuming switch 22 only is closed), switch 22, conductor 37, operating or make coil 38 of contactor 9, conductor 39, 40 and 41 to the minus terminal.

Contactor 9 will be operated and a motor energizing circuit will thus be completed extending from the plus terminal through conductor 42, contact members 43, accelerating resistor 44, motor armature 1, conductor 45, contact members 46, conductors 40 and 41 to the minus terminal. It will be readily apparent that in a similar manner armature 1 of feed motor M could be energized in an opposite direction, if switch 23 instead of switch 22 were closed, for in this instance contactor 8 instead of contactor 9 would be energized.

In going back to the previously traced circuit through operating coil 38, it will be apparent that upon the moment of energization of the motor armature, accelerating contactor 47 will be closed, thereby shunting the accelerating resistor 44 and at the same time operating coil 48 of a time limit relay 49 will be energized by the full value of the line potential. Time limit relay 49 is well known in the art and comprises essentially a non-magnetic ring or sleeve 50, a main operating coil 48 and an adjustable spring arrangement 52.

The theory of operation of the time limit contactor 49 is well known in the art, but to eliminate any possible misunderstanding of the function of contactor 49, it should be noted that this contactor is provided with a non-magnetic metal ring or sleeve 50, preferably copper, about a portion of its magnetic circuit, which copper ring acts as a secondary for the coil 48 when that coil becomes deenergized, so that there may be a definite inductive time constant for the time limit relay 49. To further adjust and fix the time constant the adjustable spring arrangement 52 is shown.

Shortly after the circuit for the operation coil 48 of the time limit relay 49 is closed, an auxiliary energizing circuit will be established, which circuit extends from the plus terminal through conductor 55, contact members 54, conductor 53, parallel connected coils 51 and 51', conductors 40 and 41 to the minus terminal. However, since contactor 9 is already in the make position, the energization of the back coils will have no effect because of the added reluctance of the air gap between the back contact coil 51' and the armature. This will be more readily understood from an inspection of Fig. 2 which shows the general arrangement of the armature 56 with respect to coils 38 and 51'.

After a predetermined time period, depending upon the setting of adjusting screw 14, contact members 12 open, thereby deenergizing relay coil 29' and effecting interruptions of said previously traced circuits through coil 38 and back contact coil 51'. Armature 56 (Fig. 3) will then drop to its normal position as indicated in the drawing by virtue of gravity or a suitable spring (not shown). In order however, to avoid bouncing of the back contacts of contactor 9, the back contact coil 51' is energized, by virtue of maintenance, for a predetermined time of a circuit extending from the plus terminal to conductor 55, contact members 54, conductor 53, coils 51 and 51', conductors 40 and 41 to the minus terminal. The back contact members of contactor 9 will be firmly held closed for a short period of time following deenergization of the feed motor circuit, hence bouncing is prevented.

When contact 9 is in its lower position, as shown, a braking circuit is completed through the lower back contact members of contactors 8

and 9 and through a dynamic braking resistor 57, as will be readily apparent.

In older schemes, such as indicated in the above mentioned patent, the back contact coils were connected in series with the dynamic braking resistor 57 and the armature 1 so that the counter voltage developed would effect holding of the back contact members in the closed position. While this scheme was suitable for cases wherein said motor 1 developed a reasonably fast speed, it was entirely unsuitable for a condition in which the feed motion was so small that the feed motor did not come up to appreciable speed. In such a case, the counter voltage was insufficient to effect closure of the back contact elements. For this reason, according to my invention I energize time relay 49 by the full extent of the line voltage for a predetermined time following deenergization of the feed motor so that closing of the back contact members is fully insured, even for extremely small amounts of feeding. In this manner arcing or pitting of the back contacts is entirely avoided and the accuracy of the feed measuring is maintained, which features are highly important in the planer art where switches are operated at the end of each stroke, thereby being operated a great number of times during the course of an hour.

While the above description has been given with respect to the forward operation of motor M, it will be readily apparent that substantially the same operation occurs if reverse operation of motor 1 is desired, that is, switch 23 instead of switch 22 is closed, in which case contactor 2 instead of contactor 9 will be operated.

I am, of course, aware that others, particularly after having had the benefit of the teachings of my invention, may devise other devices and systems of control embodying my invention, and I, therefore, do not wish to be limited to the specific showings made in the drawing and the descriptive disclosure hereinbefore made, but wish to be limited only by the scope of the appended claims and such prior art that may be pertinent.

I claim as my invention:

1. In a control system for effecting relative reciprocating movement between a machine tool element and a work piece, in combination, a feed motor for effecting lateral incremental feed motions of one of said relatively movable elements at the end of its reciprocating movement, a constant supply source of electric potential therefor, circuit means including a time delay relay, a limit switch and a reversing contactor, operable by said limit switch having make and back contact members for selectively effecting said lateral feed motion in either one lateral direction or another for controlling the direction of rotation of said motor, said reversing contactor having a main operating coil which, when energized, effects closing of said make contact members and having an additional back contact coil which is energized through said time delay relay, said back contact coil being effective only when said main operating coil is deenergized, said time delay relay having an operating coil connected across said source of potential and effective to interrupt the circuit through said back contact coil a predetermined period of time following interruption of said circuit means so as to effect sealing of said back contact members by the residual magnetic effect on said time delay relay by said source of electric potential.

2. In a control system for effecting relative re-

ciprocating movement between a machine tool element and a work piece, in combination, a feed motor for effecting lateral incremental feed motions of one of said relatively movable elements at the end of its reciprocating movement, a constant supply source of electric potential therefor, circuit means including a time delay relay, a limit switch and a reversing contactor, operable by said limit switch having make and back contact members for selectively effecting said lateral feed motion in either one lateral direction or another for controlling the direction of rotation of said motor, said reversing contactor having a main operating coil which, when energized, effects closing of said make contact members and having an additional back contact coil which is energized through said time delay relay, said back contact coil being effective only when said main operating coil is deenergized, said time delay relay having an operating coil connected across said source of potential and effective to interrupt the circuit through said back contact coil a predetermined period of time following interruption of said circuit means so as to effect sealing of said back contact members by the residual magnetic effect on said time delay relay by said source of electric potential, said reversing contactor comprising a substantially E-shaped core having a make coil on one end leg and a break or sealing coil on the other end leg and having an angular shaped armature pivoted of said central leg and adapted for rocking movement under alternate influence of said make and break coils, but being normally biased towards said break coil.

3. In a control system for effecting relative reciprocating movement between a machine tool element and a work piece, in combination, a feed motor for effecting lateral incremental feed motions of one of said relatively movable elements at the end of its reciprocating movement, a constant supply source of electric potential therefor, circuit means including a time delay relay, a limit switch and a reversing contactor, operable by said limit switch having make and back contact members for selectively effecting said lateral feed motion in either one lateral direction or another for controlling the direction of rotation of said motor, said reversing contactor having a main operating coil which, when energized, effects closing of said make contact members and having an additional back contact coil which is energized through said time delay relay, said back contact coil being effective only when said main operating coil is deenergized, said time delay relay having an operating coil connected across said source of potential and effective to interrupt the circuit through said back contact coil a predetermined period of time following interruption of said circuit means so as to effect sealing of said back contact members by the residual magnetic effect on said time delay relay by said source of electric potential, a dynamic braking circuit, including a dynamic braking resistor, which is closed by said back contact members, said dynamic braking circuit being in parallel with a dynamic braking circuit through said time limit relay coil, said last-mentioned dynamic braking circuit being exclusive of said dynamic braking resistor.

4. In a control system for effecting relative reciprocating movement between a machine tool element and a work piece, in combination, a feed motor for effecting lateral incremental feed motions of one of said relatively movable elements at the end of its reciprocating movement, a constant supply source of electric potential

therefor, circuit means including a time delay relay, a limit switch and a reversing contactor, operable by said limit switch having make and back contact members for selectively effecting said lateral feed motion in either one lateral direction or another for controlling the direction of rotation of said motor, said reversing contactor having a main operating coil which, when energized, effects closing of said make contact members and having an additional back contact coil which is energized through said time delay relay, said back contact coil being effective only when said main operating coil is deenergized, said time delay relay having an operating coil connected across said source of potential and effective to interrupt the circuit through said back contact coil a predetermined period of time following interruption of said circuit means so as to effect sealing of said back contact members by the residual magnetic effect on said time delay relay by said source of electric potential, said reversing contactor comprising a substantially E-shaped core having a make coil on one end leg and a break or sealing coil on the other end leg and having an angular shaped armature pivoted of said central leg and adapted for rocking movement under alternate influence of said make and break coils, but being normally biased towards said break coil, a dynamic braking circuit, including a dynamic braking resistor, which is closed by said back contact members, said dynamic braking circuit being in parallel with a dynamic braking circuit through said time limit relay coil, said last-mentioned dynamic braking circuit being exclusive of said dynamic braking resistor.

5. In a control system for effecting relative reciprocating movement between a machine tool element and a work piece, in combination, a feed motor for effecting lateral incremental feed motions of one of said relatively movable elements at the end of its reciprocating movement, a constant supply source of electric potential therefor, adjustable means for predetermining the extent of angular rotation of said feed motor, an electromagnetic clutch interposed between the feed motor and said adjustable switch means and having a magnetic coil, the energization of which is controlled by said adjustable switching means, circuit means including a time delay relay, a limit switch and a reversing contactor, operable by said limit switch having make and back contact members for selectively effecting said lateral feed motion in either one lateral direction or another for controlling the direction of rotation of said motor, said reversing contactor having a main operating coil which, when energized, effects closing of said make contact members and having an additional back contact coil which is energized through said time delay relay, said back contact coil being effective only when said main operating coil is deenergized, said time delay relay having an operating coil connected across said source of potential and effective to interrupt the circuit through said back contact coil a predetermined period of time following interruption of said circuit means so as to effect sealing of said back contact members by the residual magnetic effect on said time delay relay by said source of electric potential.

6. In a control system for effecting relative reciprocating movement between a machine tool element and a work piece, in combination, a feed motor for effecting lateral incremental feed motions of one of said relatively movable ele-

ments at the end of its reciprocating movement, a constant supply source of electric potential therefor, adjustable means for predetermining the extent of angular rotation of said feed motor, an electromagnetic clutch interposed between the feed motor and said adjustable switch means and having a magnetic coil, the energization of which is controlled by said adjustable switching means, circuit means including a time delay relay, a limit switch and a reversing contactor, operable by said limit switch having make and back contact members for selectively effecting said lateral feed motion in either one lateral direction or another for controlling the direction of rotation of said motor, said reversing contactor having a main operating coil which, when energized, effects closing of said make contact members and having an additional back contact coil which is energized through said time delay relay, said back contact coil being effective only when said main operating coil is deenergized, said time delay relay having an operating coil connected across said source of potential and effective to interrupt the circuit through said back contact coil a predetermined period of time following interruption of said circuit means so as to effect sealing of said back contact members by the residual magnetic effect on said time delay relay by said source of electric potential, said reversing contactor comprising a substantially E-shaped core having a make coil on one end leg and a break or sealing coil on the other end leg and having an angular shaped armature pivoted of said central leg and adapted for rocking movement under alternate influence of said make and break coils, but being normally biased towards said break coil.

7. In a control system for effecting relative reciprocating movement between a machine tool element and a work piece, in combination, a feed motor for effecting lateral incremental feed motions of one of said relatively movable elements at the end of its reciprocating movement, a constant supply source of electric potential therefor, adjustable switching means for predetermining the extent of angular rotation of said feed motor, an electromagnetic clutch interposed between the feed motor and said adjustable switching means and having a magnetic coil, the energization of which is controlled by said adjustable switching means, circuit means including a time delay relay, a limit switch and a reversing contactor, operable by said limit switch having make and back contact members for selectively effecting said lateral feed motion in either one lateral direction or another for controlling the direction of rotation of said motor, said reversing contactor having a main operating coil which, when energized, effects closing of said make contact members and having an additional back contact coil which is energized through said time delay relay, said back contact coil being effective only when said main operating coil is deenergized, said time delay relay having an operating coil connected across said source of potential and effective to interrupt the circuit through said back contact coil a predetermined period of time following interruption of said circuit means so as to effect sealing of said back contact members by the residual magnetic effect on said time delay relay by said source of electric potential, a dynamic braking circuit, including a dynamic braking resistor, which is closed by said back contact mem-

bers, said dynamic braking circuit being in parallel with a dynamic braking circuit through said time limit relay coil, said last-mentioned dynamic braking circuit being exclusive of said dynamic braking resistor.

8. In a control system for effecting relative reciprocating movement between a machine tool element and a work piece, in combination, a feed motor for effecting lateral incremental feed motions of one of said relatively movable elements at the end of its reciprocating movement, a constant supply source of electric potential therefor, adjustable switching means for predetermining the extent of angular rotation of said feed motor, an electromagnetic clutch interposed between the feed motor and said adjustable switching means and having a magnetic coil, the energization of which is controlled by said adjustable switching means, circuit means including a time delay relay, a limit switch and a reversing contactor, operable by said limit switch having make and back contact members for selectively effecting said lateral feed motion in either one lateral direction or another for controlling the direction of rotation of said motor, said reversing contactor having a main operating coil which, when energized effects closing of said make contact members and having an additional back contact coil which is energized through said time delay relay, said back contact coil being effective only when said main operating coil is deenergized, said time delay relay having an operating coil connected across said source of potential and effective to interrupt the circuit through said back contact coil a predetermined period of time following interruption of said circuit means so as to effect sealing of said back contact members by the residual magnetic effect on said time delay relay by said source of electric potential, said reversing contactor comprising a substantially E-shaped core having a make coil on one end leg and a break or sealing coil on the other end leg and having an angular shaped armature pivoted of said central leg and adapted for rocking movement under alternate influence of said make and break coils, but being normally biased towards said break coil, a dynamic braking circuit, including a dynamic braking resistor, which is closed by said back contact members, said dynamic braking circuit being in parallel with a dynamic braking circuit through said time limit relay coil, said last-mentioned dynamic braking circuit being exclusive of said dynamic braking resistor.

9. A control system comprising, in combination, a feed motor, a constant supply source of electric potential therefor, adjustable switching means for predetermining the extent of angular rotation of said feed motor, an electromagnetic clutch interposed between the feed motor and said adjustable switching means and having a magnetic coil, the energization of which is controlled by said adjustable switching means, a reversing switch having make and back contact members for controlling the direction of rotation of said motor, a time delay relay, means for normally biasing said contactor in the "back

contact closed" position, said reversing switch having a main operating coil which, when energized, effects closing of said make contact members and having an additional back contact coil which is energized through said time delay relay, said back contact coil being effective only when said main operating coil is deenergized, said time delay relay having an operating coil connected across said source of potential and effective to interrupt the circuit through said back contact coil a predetermined period of time following interruption of said circuit means so as to effect sealing of said back contact members by the residual magnetic effect on said time delay relay by said source of electric potential.

10. A control system comprising, in combination, a feed motor, a constant supply source of electric potential therefor, a reversing switch having make and back contact members for controlling the direction of rotation of said motor, a time delay relay, means for normally biasing said contactor in the "back contact closed" position, said reversing switch having a main operating coil which, when energized, effects closing of said make contact members and having an additional back contact coil which is energized through said time delay relay, said back contact coil being effective only when said main operating coil is deenergized, said time delay relay having an operating coil connected across said source of potential and effective to interrupt the circuit through said back contact coil a predetermined period of time following interruption of said circuit means so as to effect sealing of said back contact members by the residual magnetic effect on said time delay relay by said source of electric potential.

11. A control system comprising, in combination, a feed motor, a constant supply source of electric potential therefor, a reversing switch having make and back contact members for controlling the direction of rotation of said motor, a time delay relay, means for normally biasing said contactor in the "back contact closed" position, said reversing switch having a main operating coil which, when energized, effects closing of said make contact members and having an additional back contact coil, which is energized through said time delay relay, said back contact coil being effective only when said main operating coil is deenergized, said time delay relay having an operating coil connected across said source of potential and effective to interrupt the circuit through said back contact coil a predetermined period of time following interruption of said circuit means so as to effect sealing of said back contact members by the residual magnetic effect on said time delay relay by said source of electric potential, a dynamic braking circuit including a dynamic braking resistor, which is closed by said back contact members, said dynamic braking circuit being in parallel with a dynamic braking circuit through said time limit relay coil, said last-mentioned dynamic braking circuit being exclusive of said dynamic braking resistor.

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