

Dec. 22, 1964

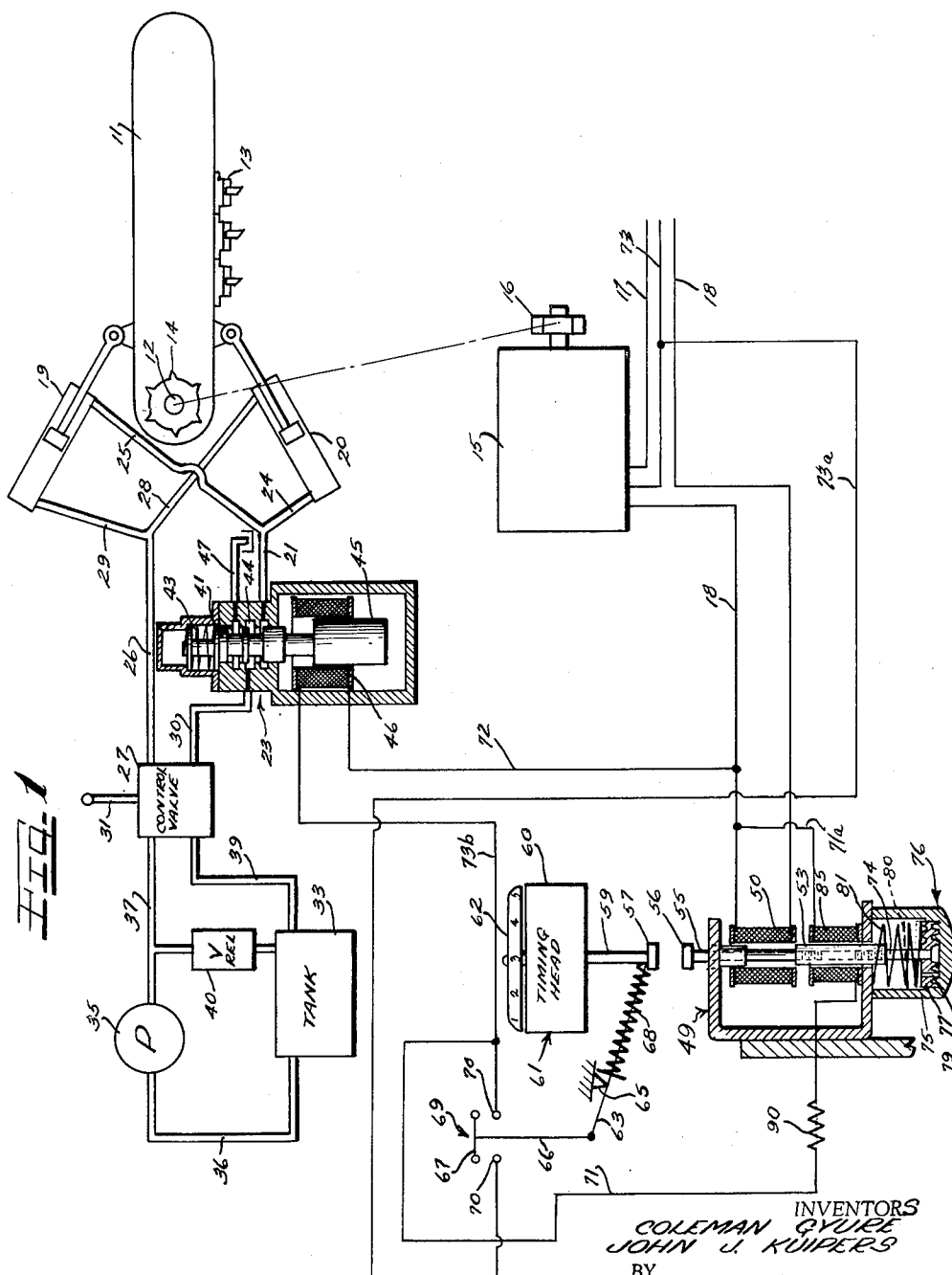
J. J. KUIPERS ETAL

3,162,249

LOAD CONTROL FOR CUTTING APPARATUS

Filed July 3, 1962

2 Sheets-Sheet 1



INVENTORS
COLEMAN CYLURE
JOHN J. KUIPERS
BY
Kelly, Herman, Merani, Chas. & Simpson
ATTORNEYS

Dec. 22, 1964

J. J. KUIPERS ETAL

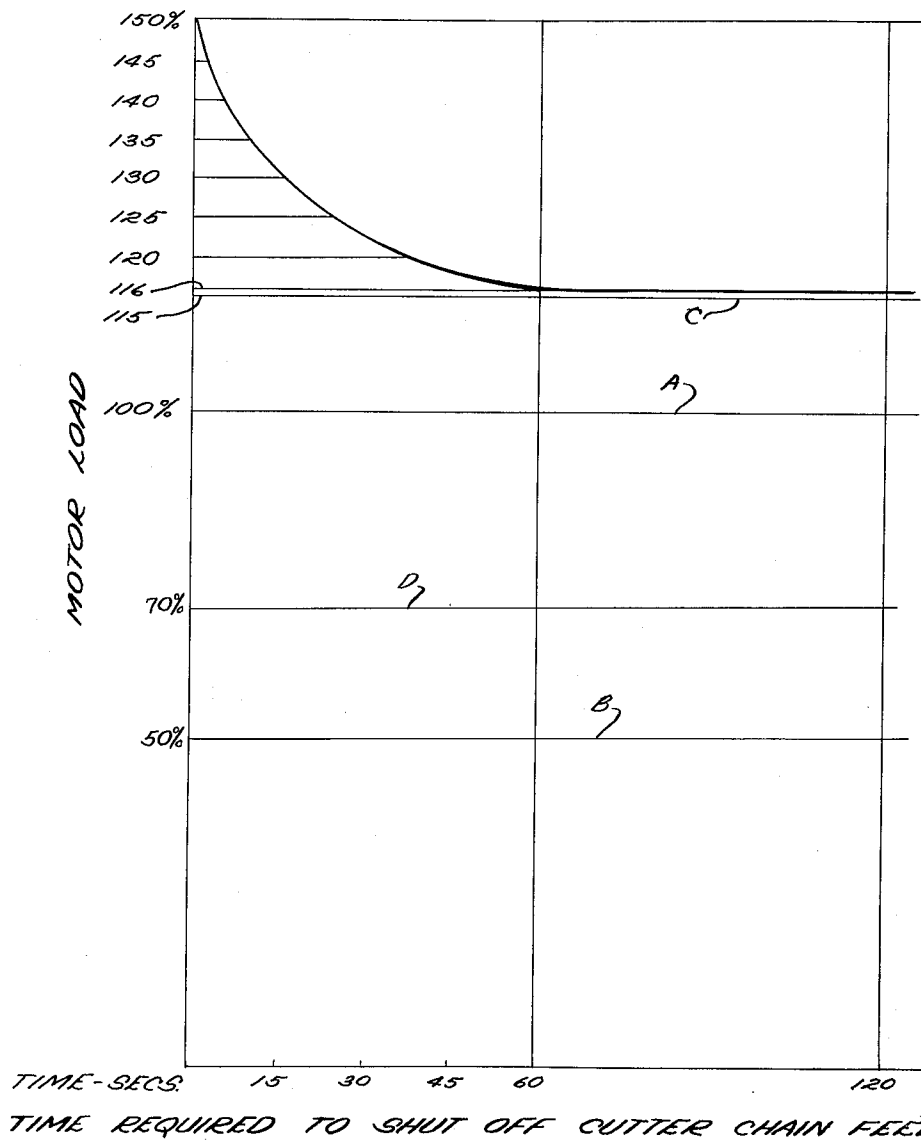
3,162,249

LOAD CONTROL FOR CUTTING APPARATUS

Filed July 3, 1962

2 Sheets-Sheet 2

FIG. 2



INVENTORS
COLEMAN GYURE
JOHN J. KUIPERS

BY

Niel, Sherman, Meene, Chas. & Simpson
ATTORNEYS

1

3,162,249

LOAD CONTROL FOR CUTTING APPARATUS

John J. Kuipers, Chicago, and Coleman Gyure, Riverdale, Ill., assignors to Goodman Manufacturing Company, Chicago, Ill., a corporation of Illinois
Filed July 3, 1962, Ser. No. 207,288
6 Claims. (Cl. 173-7)

This invention relates to improvements in load controls for cutting apparatus and more particularly relates to an improved form of load control stopping the advance or feed of the cutting apparatus upon predetermined overload conditions.

A principal object of the present invention is to provide a control for cutting apparatus, having an overload relay controlling the stopping of the cutting apparatus, so arranged that the influence of the coil on the armature for the relay is reduced upon operation of the relay, to accommodate the relay to drop out at a substantially higher amperage than the amperage required to drive the cutting apparatus at no load, and to thereby enable the relay to readily reset itself where the range between continuous operation and no load operation is relatively narrow.

A further object of the invention is to provide a load control for cutting apparatus allowing the cutting apparatus drive motor to operate at peak motor capacity during the entire cutting operation, and including a relay connected in series with the drive motor for the cutting apparatus, together with a control for the relay assuring the armature of the relay will always lift at the same amperage.

A further object of the invention is to provide an improved form of overload protection for a cutting apparatus so arranged as to accommodate operation of the cutting apparatus at maximum drive motor load during the entire cutting operation, in which the feed continues upon encountering small overloads of short duration, but is immediately discontinued upon maximum overload conditions.

A still further object of the invention is to improve upon the controls for feeding the cutter chains of mining machines and the like into and along a coal face, in which the cutter chain is driven by an electric motor and is fed into and along the face by hydraulic feeding means, by placing a relay in the motor circuit, sensing the load on the motor and by so arranging the relay that its armature will be extended at a preselected overload current rating and will drop out at a higher current rating than the no load current rating, and by delaying the time of opening of the relay switch when overload conditions are relieved, to assure that the amperage lifting the relay armature to pick up the relay will always be uniform.

These and other objects of the invention will appear from time to time as the following specification proceeds and with reference to the accompanying drawings wherein:

FIGURE 1 is a diagrammatic view diagrammatically illustrating a control circuit for carrying out the principles of the present invention; and

FIGURE 2 is a time load graph showing the time required to stop the feed of the cutting apparatus at various overload conditions on the cutting apparatus.

In the embodiment of the invention illustrated in the drawing, I have shown for illustrative purposes a cutter bar 11 of a bottom cutting or universal cutting machine. The cutter bar 11 is swingable by power about a vertical pivot 12 to advance the cutter bar and a cutter chain 13 orbitally driven thereabout across a working face of a coal seam to cut a kerf therein, in a conventional manner.

It should be understood, however, that the control of

2

the invention need not necessarily be applied to control feeding movement of a cutter bar, but may be applied to any form of cutting apparatus having a driven cutting surface and a separate power advance or feed for the cutting apparatus, such as the advancing means of a boring head of a continuous mining machine, a drill or saw or any other similar cutting apparatus.

A cutter chain sprocket 14 driven from a motor 15 through a geared reduction train 16 is provided to drive the cutter chain 13 about the cutter bar 11. The motor 15 may be a heavy duty electric motor either alternating or direct current and is herein diagrammatically shown as being an alternating current motor, energized through conductors 17, 18 and 73 under the control of a suitable controller (not shown) and no part of the present invention so not herein shown or described.

Double acting hydraulic jacks 19 and 20 are pivotally connected to opposite sides of the cutter bar 11 to feed or advance said cutter bar about the axis of the pivot 12 and thereby advance the cutter chain across a mine face to cut a kerf therein. As herein shown, a pressure line 21 leading from a stop or shut-off valve 23 is connected with the head end of the jack 20 and piston rod end of the jack 19 through pressure lines 24 and 25 respectively, leading from the pressure line 21, to effect pivotal movement of the cutter bar 11 about the pivotal axis 12 in a feeding direction.

A pressure line 26 leading from a control valve 27 is connected with the piston rod end of the hydraulic jack 20 and the head end of the hydraulic jack 19 through pressure lines 28 and 29 respectively to effect return movement of the cutter bar 11 to an initial cutting position after termination of a cutting operation.

The control valve 27 may be a conventional form of metering control valve selectively operable to supply fluid under pressure to the pressure line 26 or a pressure line 30 connected with the stop or shut off valve 23 to supply fluid under pressure to the pressure line 21 under the control of said stop valve by manual operation of an operating handle 31. The control valve 27 may also be operable to vary the volume of fluid under pressure supplied to either of the pressure lines 26 or 30 by operation of the operating handle 31 thereof.

The source of supply of fluid under pressure for advancing the cutter bar 11 includes a tank 33 connected with a pump 35 through a pressure line 36 and connected with the control valve 27 through a pressure line 37. Fluid is returned from the jacks 19 and 20 through the control valve 27 to the tank 33 through a return line 39.

A relief valve 40 is connected from the pressure line 37 to the tank 33 to return fluid to the tank 33 upon overload conditions and when the control valve 27 is in its "off" position and the pump 35 is operating.

The valve 23 is shown in the drawings as being a solenoid operated spool valve of a well known form including a valve spool 41 biased by a spring 43, to accommodate fluid under pressure to pass from the control valve 27 through the pressure line 30 to and through a valve chamber 44 of the stop valve 23 to the pressure line 21, to supply fluid under pressure to the hydraulic jacks 19 and 20 to advance the cutter bar 11 in a cutting direction. The valve spool 41 has an armature 45 extending from its end opposite the spring 43 through a solenoid coil 46. Upon energization of the coil 46 the armature 45 is moved along the coil to move the valve spool into position to block the passage of fluid through the pressure line 21 and to by pass fluid under pressure from the pressure line 30 through a return line 47 connected to tank. The advance of the cutter bar 11 will thus be stopped upon energization of the solenoid coil 46.

An overload relay 49 having a series coil 50, connected in series with the energizing circuit to the motor 15, is provided to sense the load exerted by the cutter bar 11 on the material being cut, such as a seam of coal, to energize the solenoid coil 46 and actuate the shut off or stop valve 23, following the sensing of an injurious overload condition on the motor 15. The series coil 50 is connected in the conductor 18 and is continually energized at the load of the motor 15.

The series coil 50 encircles an armature 53 having a stem 55 extending therefrom and having a button 56 on its outer or upper end, engageable with an aligned button 57 on the lower end of a plunger 59, depending from a casing 60 of a timing head 61 timing the opening of a switch 69, deenergizing the solenoid coil 46.

The timing head 60 may be a commercial form of timing head, such as, the Westinghouse type A-M Timer. The timer consists generally in an air bellows (not shown) delaying movement of the plunger 59 to the extended position shown in FIGURE 1 as the armature 53 drops out. A dial knob 62 is provided to select the time at which the plunger 59 moves to its extended position.

The plunger 59 is connected with a switch arm 63 of the switch 69. The switch 69 may be a snap action switch and is illustratively shown as including the switch arm 63 pivoted intermediate its ends on a fulcrum point 65 and a spring 68 diagrammatically shown in FIGURE 1 as encircling the switch arm 63 between the plunger 59 and fulcrum point 65, to snap the switch into its open and closed positions in a conventional manner. The free end of the switch arm 63 is pivotally connected with an arm 66 extending from a contact bar 67 of the switch 69. The contact bar 67 is moved by the switch arm 63 to engage stationary contacts 70, to complete a circuit from a conductor 73^a to a conductor 73^b through the solenoid coil 46 to the conductor 18 through a conductor 72. This will energize solenoid coil 46 and move the armature 45 through said coil. This will move the valve spool 41 against the spring 43 in position to shut off the flow of fluid under pressure to the pressure line 21 and to the head and piston rod ends of the respective hydraulic jacks 20 and 19, to thereby stop feeding movement of the cutter bar 11. A shunt coil 85 encircling the armature 53 is connected to the conductor 71^a. A conductor 71 having a resistor 90 connected therein leads from the shunt coil 85 and is connected with the conductor 73^b. The shunt coil 85 is, therefore, energized upon closing of the switch 69, through the contacts 70, contact bar 67 and conductor 73^a connected to the conductor 73.

The armature 53 has a rod 74 threaded in its lower end and depending therefrom within a cylinder 75 of a dashpot 76. The rod 74 has a piston 77 on its lower end having a series of bleeder passageways 79 leading axially therethrough.

Oil is filled in the cylinder 75 to a level indicated by reference character 80 and bleeds from one side of the piston 77 to the other upon movement of the armature 53 along the coil 50, as the current in said coil builds up to certain predetermined overload current conditions. The dashpot 76 thus forms a time delay means, delaying operation of the armature 53 for a time period that varies inversely with the overload on the motor 15, to thereby close the switch 69 in a delayed time interval after overload of the motor 15. A spring 81 is provided to facilitate the return of the piston 77, as the motor load drops to rated motor load.

During operation of the machine, the motor current passing through the series coil 50 will exert a continuing magnetic upward pull on the armature 53. The resistance to upward movement offered by the distance the armature 53 projects into the coil 50, the weight of the armature 53, stem 55, rod 74 and piston 77, and the transfer of oil from the top to the bottom of the piston

77 of the dashpot, in the form of the piston 77 and cylinder 75, will restrain the armature 53 from moving upwardly along the electromagnetic coil 50 under normal current conditions when the motor is operating at full load. Upon small overload conditions, however, the oil in the dashpot, which may be a silicone fluid, and which is forced through the bleed passages 79, as the armature 53 starts to lift, will create a time delay in upward movement of the armature 53. This will accommodate the motor 15 to continue to operate for short intervals of time under overload conditions. As, however, the overload conditions continue, the piston 77 will continue its upward movement along the cylinder 75 at a rate determined by the rate of transfer of oil from the top to the bottom of said piston and the upward force produced by overload in the coil 50, and will close the circuit between the contacts 70 and the contact bar 67, and thereby close the circuit to the electromagnet 46, and effect the energization of said electromagnet. This will move the valve spool 41 in position to block the passage of fluid under pressure through the pressure line 21 and into position to return fluid from the pressure line 30 back to tank through the return line 47.

It should here be understood that the piston 77 can only rise as fast as fluid transfers from its top to its bottom and that the length of the time delay interval before the contact bar 67 engages the contacts 70, to close the switch 69, varies inversely with the magnitude of the overcurrent. Thus, as the overcurrent increases, the time delay interval will decrease.

The shunt coil 85 is wound reversely to the winding of the series coil 50 and is energized upon the closing of the switch 69 as the armature 53 picks up. The shunt coil 85, therefore, is only energized upon overload conditions sufficient to cause the armature 53 to close the switch 69. Said shunt coil 85 when energized, therefore, opposes the series coil 50 and reduces the influence of the current in said series coil holding the armature 53 in its extended or pick up condition, and thereby raises the current point at which the armature 53 may drop out a substantial amount above the normal current load required to drive the cutting apparatus at no load. This assures resetting of the relay at current values substantially above the normal no load running current of the motor 15 and makes it unnecessary to shut off the motor 15 to reset the relay.

A resistor 90 is connected in the conductor 71 to regulate the influence of the shunt coil 85 on the series coil 50, by regulating the opposing flux of the shunt coil 85 and thereby regulating the influence of the coils 50 and 85 on the armature 53. Different value resistances may be connected in the line 71 in series with the shunt coil 85, to vary the opposing flux as desired and to allow the setting of the drop out point to a required current value and to thereby permit the relay contact closing and drop out points to be independently adjusted.

The plunger 74 is threaded in the end of the armature 53 to adjust the position of the armature 53 with respect to the series coil 50 and to thereby vary the value of the motor current which will cause the armature to lift, it being understood that the amperage required to lift the armature varies in accordance with the vertical position of the armature with respect to the series coil 50. The stem 55 is threaded in the opposite end of the armature 53 from the plunger 74, to enable the spacing between the buttons 56 and 57 to be adjusted in accordance with adjustment of the plunger 74, and to vary the spacing between said buttons where required.

The graph in FIGURE 2 is a time load curve illustrating the various load conditions on the motor 15 and the time required to shut off the supply of fluid under pressure to the feed jacks 19 and 20 for various cutter chain and motor overload conditions. Line "A" indicates the continuous rating of the motor 15. Line "B" indicates the load condition on the motor required to drive the

5

cutting apparatus at no load. Line "C" indicates an overload of 15%, at which time the motor will still run continuously at the selected setting of the armature 53 with respect to the bottom of the cylinder 75 shown in FIGURE 1. As, however, the motor load increases to an overload of over 16%, the motor current sensed by the series coil 50 will cause the armature 53 and the piston 77 to rise as fast as the dashpot fluid transfers from the top to the bottom of the piston, through the bleeder passageways 79, providing a time delay interval in closing of the switch 69, which varies inversely with the magnitude of the overcurrent. The time delay period as indicated in FIGURE 2 is one minute.

It may be seen from this figure that as the overload and overcurrent increases, the time delay interval will decrease and that when the overcurrent condition is a 50% overload condition, the armature 53 will rise instantaneously and close the switch 69 with no time delay interval.

Upon closing of the switch 69, the shunt coil 85 is energized to oppose the holding force of the series coil 50. As previously mentioned, this will raise the current point at which the armature drops out to reopen the relay contacts, above the no load motor current value, as indicated by line "D," and will thereby make it possible for the armature to reset itself at a current point far higher than would be possible without the shunt coil 85.

Therefore, as the motor current drops to a current value approximated by line D, the armature 53 will drop out and the button 56 will move away from the button 57. The timing head 61 will, however, hold the switch 69 closed for a time delay interval sufficient to permit the armature 53 and the piston 77 to drop to the bottom limit of the cylinder 75. The switch 69 will then open and the relay will be reset to again operate at the required overload conditions to energize the solenoid coil 46 and disconnect the hydraulic jacks 19 and 20 from their source of fluid under pressure.

It may here be seen that the shunt coil 85 makes it unnecessary to stop the motor 15 to reset the relay after an overload condition sufficient to pick up the armature 53 to close the switch 69, and thereby enables the motor 15 to operate continuously upon a relief in the overload thereon by operation of the valve 23.

It may also be seen that the shunt coil 85, resistor 90 and relay switch 69 make it possible to adjust the drop out point of the relay independently of the pick up point and vice versa.

While we have herein shown and described one form in which our invention may be embodied, it may readily be understood that various variations and modifications in the invention may be attained without departing from the spirit and scope of the novel concepts thereof, as defined by the claims appended hereto.

We claim as our invention:

1. In an automatic control for cutting apparatus and the like,
 - a motor,
 - a cutting member,
 - means driven by said motor for driving said cutting member,
 - feeding means for advancing said cutting member to effect a cutting operation,
 - electrically energizable stop means stopping operation of said feeding means and the advance of said cutting member upon overload of said motor,
 - an energizing circuit for said electrically energizable stop means including an overload relay having a switch in said energizing circuit,
 - a series coil connected in series with said motor,
 - an armature movable along said series coil and operable to close said switch upon a predetermined load on said motor and coil,
 - a shunt coil encircling said armature and wound reversely of said series coil and energized through the

6

energizing circuit to said electrically energizable stop means upon the closing of said switch,

said shunt coil opposing said series coil upon the closing of said switch and the energization of said electrically energizable stop means and raising the current value at which said armature will move to its inoperative position,

above the no load current value of said motor and thereby enabling said switch to open and effect the continued operation of said feeding means at a higher current value than the current value for effecting opening of said switch by the series coil alone.

2. An automatic control for cutting apparatus in accordance with claim 1 in which a resistor is placed in series with said shunt coil, to regulate the current passing through said shunt coil and the current value at which the armature will move to an inoperative position to accommodate opening of said switch and the continued operation of the feeding means.

3. In an automatic control for cutting apparatus and the like,

- a motor,

- a cutting member,

- means driven by said motor for driving said cutting member,

- feeding means for advancing said cutting member to effect the cutting operation,

- electrically energizable stop means operable to stop the operation of said feeding means and the advance of said cutting member including a solenoid,

- an energizing circuit to said solenoid,

- an overload relay having a switch in said energizing circuit closing upon predetermined overload conditions,

- a series coil connected in series with said motor,

- an armature movable along said series coil to close said switch upon a predetermined current load on said motor,

- a dashpot connected with said armature and delaying operation of said armature to close said switch for a time delay interval inversely proportional to the overload on said cutting member,

- and a timer controlling the opening of said switch upon a predetermined reduction in the overload current including a plunger operatively connected with said switch and an engaging connection between said armature and said plunger for actuating said plunger to close said switch upon movement of said armature along said series coil upon a predetermined current load,

- means moving said armature away from said plunger upon a predetermined reduction in the current load, and thereby accommodating opening of said switch by said timer in a time delay interval determined by the setting of said timer and sufficient to accommodate said armature to move to an extreme inoperative position prior to opening of said switch.

4. An automatic control for cutting apparatus and the like in accordance with claim 3 in which a shunt coil also encircles the armature and in which the shunt coil is wound reversely of the series coil and is energized through said energizing circuit to said solenoid upon the closing of said switch, to raise the current value at which said switch will open to deenergize said solenoid above the current value at which said series coil alone will accommodate opening of said switch.

5. In an overload cutout for cutting apparatus having a cutting member,

- an electric motor for driving said cutting member,

- a hydraulic motor for advancing said cutting member to effect a cutting operation,

- a source of fluid under pressure,

- a pressure line connected from said source of fluid under pressure to said hydraulic motor,

a valve in said pressure line shutting off the supply of fluid under pressure to said motor,
 a solenoid energizable to move said valve into position to stop the flow of fluid under pressure to said hydraulic motor and thereby to stop the advance of said cutting member to effect the cutting operation,
 an energizing circuit to said solenoid having a normally open switch therein,
 a series coil connected in series with said motor,
 an armature encircled by said series coil and movable along said series coil into a position to close said switch upon the building up of current in said series coil by predetermined overloads on said motor,
 and movable into an inoperative position to accommodate the opening of said switch upon a predetermined reduction in load on said motor,
 means accommodating the movement of said armature to an inoperative position to effect the opening of said switch at current values substantially greater than the current value required to drive said motor and cutting member at no load,
 comprising a shunt coil wound reversely of said series coil and encircling said armature and connected in the energizing circuit to said solenoid through said switch upon the closing of said switch,
 and means delaying the opening of said switch until said armature has moved to the full extent of its travel in a direction away from said switch comprising a timer having a plunger operatively connected with said switch to delay the opening of said switch and engaged by said armature to effect the closing of said switch upon the building up of a predetermined current value in said series coil.
 6. In an overload cutout for cutting apparatus having a cutting member,
 an electric motor for driving said cutting member,
 a hydraulic motor for advancing said cutting member to effect a cutting operation,
 a source of fluid under pressure,
 a pressure line connected from said source of fluid under pressure to said hydraulic motor,

a valve in said pressure line shutting off the supply of fluid under pressure to said motor,
 a solenoid energizable to move said valve into position to stop the flow of fluid under pressure to said hydraulic motor,
 an energizing circuit to said solenoid including a normally open switch,
 a series coil connected in said series with said motor,
 an armature encircled by and movable along said series coil upon the building up of the current value of said coil to a predetermined current value caused by overload conditions on said motor,
 into a position to close said switch and movable to an inoperative position to accommodate opening of said switch upon the reduction of the current value in said series coil,
 a dashpot connected with said armature and delaying operation of said armature to close said switch upon overload of said motor for a time delay interval varying inversely with the overload,
 means accommodating the movement of said armature to an inoperative position and thereby accommodating the closing of said switch at current values substantially greater than the current values required to drive said cutting member at no load,
 comprising a shunt coil encircling said armature and wound reversely of said series coil and connected in the energizing circuit to said solenoid through said switch and energized upon the closing of said switch,
 and means delaying the opening of said switch until said armature has moved to the full extent of travel to its inoperative position comprising a timer having a plunger operatively connected with said switch and controlling opening of said switch upon movement of said armature to its inoperative position and engaged by said armature upon movement of said armature along said series coil upon the building up of predetermined current loads in said series coil.

References Cited in the file of this patent

UNITED STATES PATENTS

3,107,903 Newton Oct. 22, 1963

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,162,249

December 22, 1964

John J. Kuipers et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 45, after "conductor" insert -- 18
through a conductor --.

Signed and sealed this 4th day of May 1965.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents