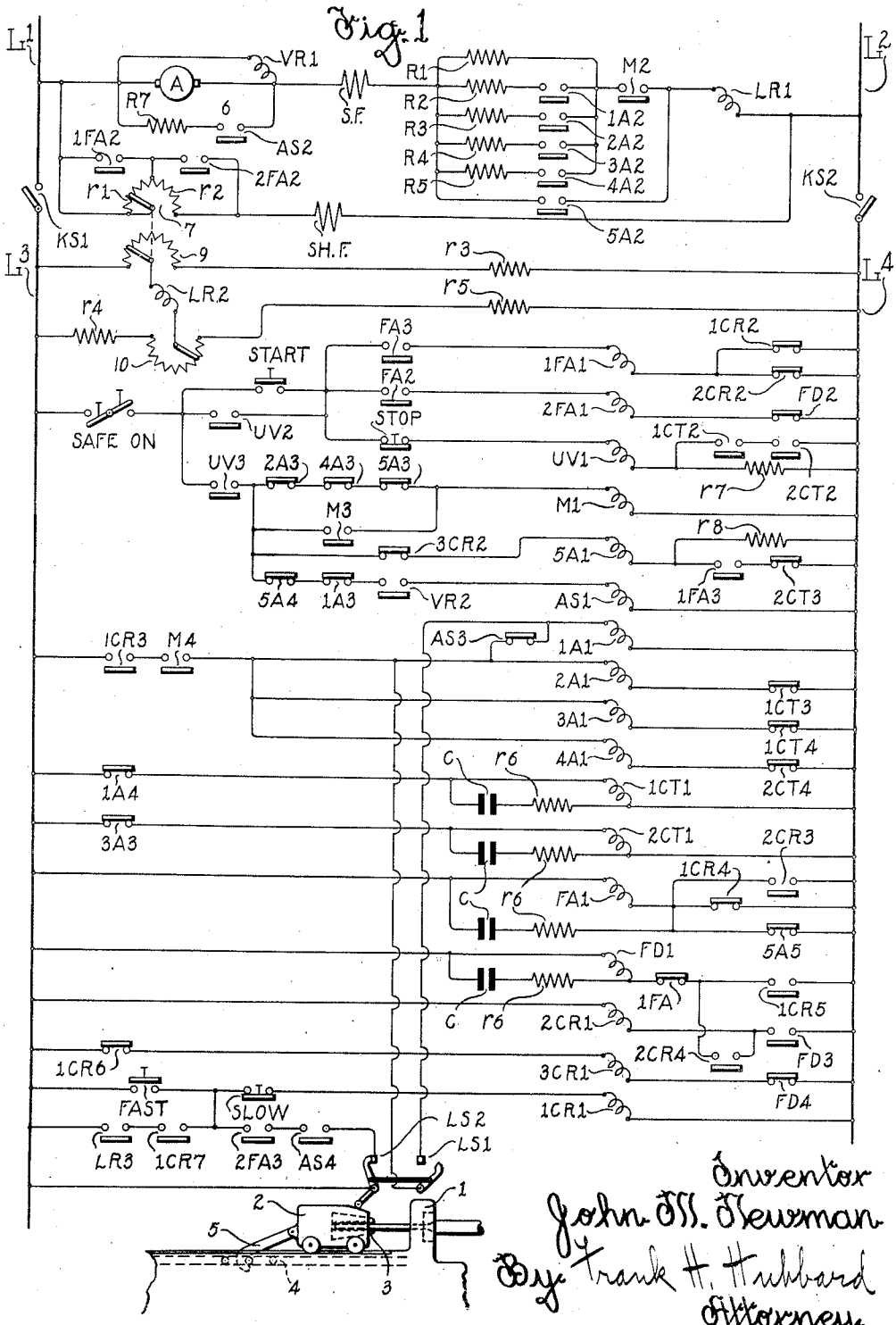
Aug. 8, 1944. J. M. NEWMAN 2,355,321

MOTOR CONTROLLER

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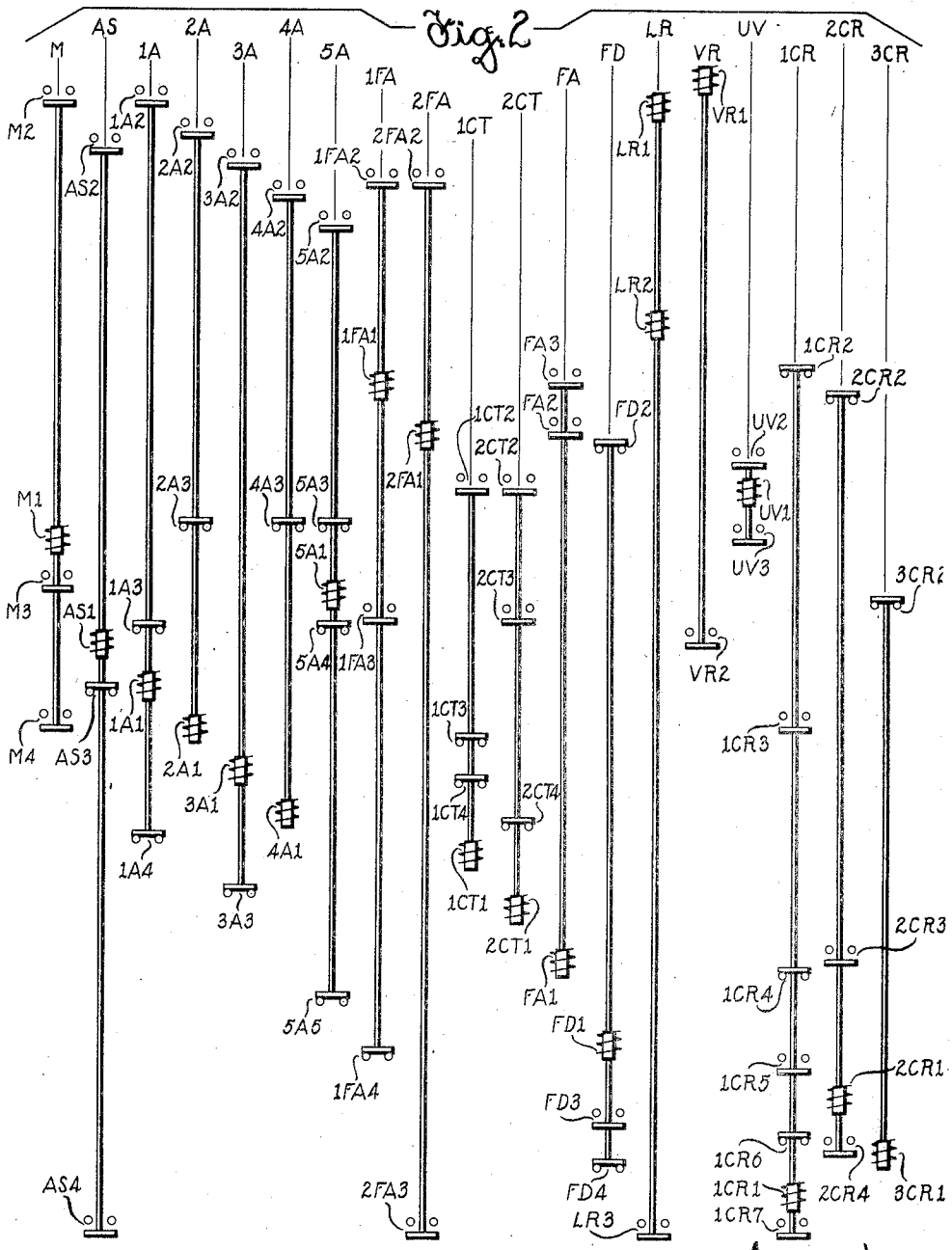
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Fig. 2



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2,355,321

MOTOR CONTROLLER

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Application October 14, 1942, Serial No. 461,961

9 Claims. (Cl. 205—3)

This invention relates to motor controllers and is particularly applicable to controllers for motor driven machines such as metal draw benches.

Draw benches are ordinarily provided with a stationary die, a traveling carriage having a plier associated therewith for gripping the stock to be drawn, and a motor driven chain to which the carriage is adapted to be hooked for operation in a direction to draw the stock through the die. It is common practice to employ a compound wound direct current motor for operating the chain and to operate such motor at its base speed or in other words, its full field speed when the carriage is disconnected from the chain. Thus when the carriage is hooked to the chain for a drawing operation the same is quickly accelerated, and in practice it has been found that with the chain motor operating at base speed the rate of acceleration of the carriage is such that the plier is frequently jerked loose from the stock at the beginning of the draw.

The present invention has among its objects to provide an improved controller for machines of the aforesaid character which overcomes the aforementioned objection.

Another object is to provide a controller for machines of the aforesaid character which provides for idling operation of the chain motor at a speed lower than base speed to thereby provide for cushioning of the shock which occurs at the beginning of a drawing operation.

Another object is to provide a controller of the aforesaid character having improved means for accelerating the chain motor to a predetermined maximum drawing speed upon starting of a drawing operation.

Various other objects and advantages of the invention will hereinafter appear.

The accompanying drawings illustrate an embodiment of the invention which will now be described, it being understood that the controller illustrated is adapted for use in connection with machines of various types other than that shown in the drawing, and that the same is susceptible of modification without departing from the spirit and scope of the appended claims.

In the drawings,

Figure 1 is a straight line diagrammatic representation of a controller embodying the invention, and

Fig. 2 is a key illustration of the switches and relays embodied in Fig. 1.

The illustration of the switches and relays in Fig. 2 shows them with their coils and contact members disposed in horizontal alignment with their positions in the straight line circuits of Fig. 1 so that the reader may readily determine the position of the coil and contact members of any switch or relay in the straight line circuit. The reference characters also serve as a guide to the relation between the operating coils of the switches and relays and their associated contacts. For example, switch M is provided with an operating coil M1 and contacts M2, M3 and M4.

The switches and relays are named as follows:

M—Main switch
AS—Armature shunt switch
1A, 2A, 3A, 4A, 5A } Armature accelerating switches
1FA, 2FA } Field accelerating switches
1CT, 2CT, FA, FD } Timing relays
LR—Load relay
VR—Voltage relay
UV—Under voltage relay
1CR, 2CR, 3CR } Control relays

Referring now to Fig. 1, the same illustrates a draw bench of a conventional type including a stationary die block 1, a traveling carriage 2 having a plier 3 associated therewith for gripping the stock to be drawn through the die, and a motor driven chain 4 which is adapted to be engaged by a releasable hook 5 associated with carriage 2 to move said carriage away from the die block 1 for a drawing operation. The draw bench is also provided with a motor drive (not shown) which is adapted upon disconnection of hook 5 from chain 4 to effect return of carriage 2 from the end of its stroke to starting position.

Chain 4 is driven by a direct current motor 6 having an armature A, a series field winding SF and a shunt field winding SH.F. The supply circuit for said motor is indicated by lines L1, L2 and main switch M provides for connection of armature A and series field winding F across said lines in series with a resistance R1. Accelerating switches 1A, 2A, 3A and 4A provide for connection of resistances R2, R3, R4 and R5, respectively, in parallel with resistance R1 and accelerating switch 5A provides for exclusion of all of the resistances R1 to R5, inclusive, from

the armature circuit of the motor. The armature shunt switch AS provides for connection of a resistance R7 across the terminals of armature A. The shunt field winding SH.F is permanently connected across lines L1, L2 in series with a speed regulating rheostat 7 and field accelerating switches 1FA and 2FA provide for shunting of resistance sections $r1$ and $r2$ of said rheostat.

Main switch 1 and certain other of the aforementioned switches are controlled by the under voltage relay UV which in turn is controlled by a snap switch marked "Safe On," a normally open push button switch marked "Start" and a normally closed push button switch marked "Stop." The armature shunt switch AS is controlled by the voltage relay VR and armature accelerating switches 2A to 5A and field accelerating switches 1FA and 2FA are controlled by the timing relays 1CT, 2CT, FA and FD, control relays 1CR, 2CR and 3CR and by the load relay LR. The controller also includes a normally open push button marked "Fast," a normally closed push button marked "Slow" and two limit switches LS1 and LS2 which are associated with the draw bench carriage 2.

The aforementioned switches and relays with the exception of voltage relay VR and load relay LR are operated by current from lines L3 and L4 which are energized from lines L1, L2 through the medium of knife switches KS1 and KS2. The voltage relay VR is provided with an operating winding VR1 which is permanently connected across the terminals of armature A. Load relay LR is provided with a series operating winding LR1 and a shunt operating winding LR2. The series operating winding LR1 is connected in the armature circuit of the motor and the current in the shunt operating winding LR2 is controlled by two adjustable rheostats 9 and 10 and a plurality of resistances $r3$, $r4$ and $r5$. The adjusting arm of rheostat 9 is mechanically connected to the adjusting arm of speed regulating rheostat 7 and winding LR2 is connected between the adjusting arms of rheostats 9 and 10. One terminal of rheostat 9 is connected to line L3 and the opposite terminal thereof is connected to line L4 through the medium of resistance $r3$. One terminal of rheostat 10 is connected to line L3 through the medium of resistance $r4$ and the other terminal thereof is connected to line L4 through the medium of resistance $r5$. Winding LR2, rheostats 9 and 10 and resistances $r3$, $r4$ and $r5$ form a Wheatstone bridge circuit by means of which winding LR2 is controlled to assist the series winding LR1 of the load relay upon setting of speed regulating rheostat 7 in low speed positions and to oppose said series winding upon setting of said speed regulating rheostat in high speed positions.

Each of the relays FA, FD, 1CT and 2CT has a condenser C and a resistance $r6$ connected in series across the terminals of its associated operating winding. Each of said condensers is charged upon establishment of the energizing circuit for its associated relay and each acts to delay dropping out of its associated relay upon interruption of the energizing circuit therefor.

The function and operation of the aforedescribed controller and the circuit connections thereof will now be more fully described.

Upon closure of knife switches KS1 and KS2 supply lines L3 and L4 are energized and field timing relay FA, armature timing relays 1CT and 2CT and control relay 3CR all respond, the operating windings thereof being energized from said supply lines by the following circuits. Operating winding FA1 of timing relay FA is energized by a circuit extending through control relay contacts 1CR4 and accelerating switch contacts 5A5. Operating winding 1CT1 of timing relay 1CT is energized by a circuit extending through accelerating switch contacts 1A4. Operating winding 2CT1 of timing relay 2CT is energized by a circuit extending through accelerating switch contacts 3A3. Operating winding 3CR1 of control relay 3CR is energized by a circuit extending through control relay contacts 1CR6 and timing relay contacts FD4.

Assuming now that motor 6 is to be started, hook 5 of the draw bench carriage 2 is disconnected from chain 4 and the "safe on" switch is moved into closed position. The "start" push button is then momentarily depressed and upon closure thereof field accelerating switches 1FA and 2FA and under voltage relay UV respond, the operating windings thereof being energized from lines L3, L4 by the following circuits. Operating winding 1FA1 of field accelerating switch 1FA is energized by a circuit extending through field timing relay contacts FA3 and control relay contacts 1CR2 and 2CR2. Operating winding 2FA1 of field accelerating switch 2FA is energized by a circuit extending through contacts FA2 and FD2 of timing relays FA and FD. Operating winding UV1 of under voltage relay UV is energized by a circuit extending through contacts 1CT2 and 2CT2 of timing relays 1CT and 2CT. Upon release of the "start" push button the aforedescribed energizing circuits for field switches 1FA and 2FA and under voltage relay UV are maintained through the medium of the under voltage relay contacts UV2. Upon response of the under voltage relay UV switch M responds, the same being energized by a circuit extending from line L3 through the "safe on" switch, through contacts UV3 of said under voltage relay, through accelerating switch contacts 2A3, 4A3 and 5A3 and through the operating winding M1 of said main switch to line L4.

Upon response of the field accelerating switches 1FA and 2FA the shunt field winding SH.F of the motor is connected directly across lines L1, L2 and upon response of main switch M, armature A and series field winding F are connected across lines L1, L2 in series with resistance R1. Motor 6 is thus started and at a predetermined low counter E. M. F. of the motor operating winding VR1 effects response of the voltage relay VR. Voltage relay VR in responding establishes an energizing circuit for the armature shunt switch AS extending from line L3 through the "safe on" switch, through under voltage relay contacts UV3, through contacts 5A4 and 1A3 of accelerating switches 5A and 1A, through the voltage relay contacts VR2, and through the operating winding AS1 of said accelerating switch to line L4. Upon response of armature shunt switch AS the contacts AS2 thereof connect resistance $r7$ across the terminals of armature A.

Upon starting of the motor, winding LR1 is energized to effect response of the load relay LR. With carriage 2 of the draw bench in starting position limit switch LS2 is closed, and upon response of the armature shunt switch AS control relay 1CR is energized by a circuit extending from line L3 through the limit switch LS2, through the armature shunt switch contacts AS4, through field accelerating switch contacts 2FA3, through the "slow" push button and through the operating winding 1CR1 of said control relay to line

L4. Upon response of control relay 1CR a maintaining circuit for its operating winding 1CR1 is established through the medium of its contacts 1CR7, the load relay contacts LR3 and the "slow" push button. Also control relay 1CR in responding interrupts the aforedescribed energizing circuit for control relay 3CR1 by opening of contacts 1CR6.

The resistances R1 and R7 are designed to provide for operation of motor 6 at a relatively low speed, as for example 50% of full field or base speed when the motor is merely idling to operate chain 4. These resistances are also designed to provide a steep torque characteristic so that even a relatively light load on the motor will cause an appreciable drop in the speed thereof.

Assuming now that hook 5 of carriage 3 is dropped into engagement with chain 4 to start a drawing operation. Carriage 3 is almost instantly jerked to a speed corresponding to the speed of the chain and when the stock is drawn into the die motor 6 is subjected to an increased load which reduces the speed thereof. If the load imposed on the motor at the start of the draw is extremely light the motor does not slow down appreciably, but for heavier loads there is a very considerable drop in the motor speed. As will now be set forth, the limit switch LS1 operates upon extremely light load conditions at the start of a draw to initiate acceleration of the motor and under heavier load conditions at the start of a draw voltage relay VR operates to initiate acceleration of the motor.

Voltage relay VR is calibrated to drop out upon a relatively small reduction in the speed of the motor at the start of a draw and upon dropping out of said relay the contacts VR2 thereof interrupt the aforedescribed energizing circuit for the armature shunt switch AS. Upon deenergization of the armature shunt switch AS the contacts AS2 thereof open to exclude resistance R7 from the motor circuit and the contacts AS3 thereof close to establish an energizing circuit for the armature accelerating switch 1A extending from line L3, through control relay contacts 1CR3, through main switch contacts M4, through shunt switch contacts AS3 and through the operating winding 1A1 of said accelerating switch to line L4.

If the load imposed on motor 6 at the start of a draw is extremely light, voltage relay VR remains in its attracted position and when the draw bench carriage 2 has moved a short distance away from die block 1 limit switch LS1 closes to establish an energizing circuit for the armature accelerating switch 1A extending from line L3, through control relay contacts 1C3, through main switch contacts M4, through the limit switch LS1 and through the operating winding 1A1 of said accelerating switch to line L4. Upon response of accelerating switch 1A the contacts 1A3 thereof open to interrupt the aforedescribed energizing circuit for armature shunt switch AS.

Thus under either extremely light or heavy load conditions at the start of a draw resistance R7 is excluded from the motor circuit and resistance R2 is connected in shunt with resistance R1 by accelerating switch contacts 1A2 to effect acceleration of the motor. As will now be set forth, upon response of accelerating switch 1A armature accelerating switches 2A, 3A, 4A and 5A close and field accelerating switches 1FA and 2FA open in the order named to accelerate the motor and bring the same up to a selected maximum drawing speed determined by the setting of rheostat 7. Upon response of accelerating switch 1A the contacts 1A4 thereof open to interrupt the aforedescribed energizing circuit for the operating winding 1CT1 of timing relay 1CT and said relay then drops out after a given period of delay caused by the discharge of its associated condenser C. Upon dropping out of relay 1CT contacts 1CT3 close prior to contacts 1CT4 and said contacts in closing establish energizing circuits for the operating windings 2A1 and 3A1 of accelerating switches 2A and 3A through the medium of control relay contacts 1CR3 and main switch contacts M4. Accelerating switch contacts 2A2 and 3A3 are thus closed sequentially to connect resistances R3 and R4 in parallel with resistances R1 and R2.

If voltage relay VR has dropped out the same recloses at some point during acceleration of the motor and upon reclosure thereof establishment of the aforedescribed energizing circuit for the operating winding AS1 of armature shunt switch AS is prevented by opening of contacts 1A3 of accelerating switch 1A. Upon response of accelerating switch 2A the aforedescribed energizing circuit for the operating winding M1 of main switch M is interrupted by opening of accelerating switch contacts 2A3 and said main switch operating winding is then maintained energized through the medium of main switch contacts M3.

Upon response of accelerating switch 3A the contacts 3A3 thereof interrupt the aforedescribed energizing circuit for timing relay 2CT and said relay then drops out after a given period of delay due to the discharge of its associated condenser C. Upon dropping out of relay 2CT contacts 2CT4 close prior to closure of contacts 2CT3. Closure of contacts 2CT4 establishes an energizing circuit for the operating winding 4A1 of accelerating switch 4A through the medium of control relay contacts 1CR3 and main switch contacts M4. Closure of timing relay contacts 2CT3 establishes an energizing circuit for the operating winding 5A1 of accelerating switch 5A through the medium of the "safe on" switch, under voltage relay contacts UV3, control relay contacts 3CR2 and field accelerating switch contacts 1FA3. Accelerating switch contacts 4A2 and 5A2 are thus closed in the order named to first connect resistance R5 in parallel with resistances R1, R2, R3 and R4 and to thereafter exclude all of said resistances from the armature circuit of the motor.

Upon starting of the drawing operation limit switch LS2 is opened by the carriage 2 and upon opening of said limit switch the operating winding 1CR1 of relay CR is maintained energized through the medium of load relay contacts LR3, control relay contacts 1CR7 and the "slow" push button. With relay 1CR energized the aforedescribed energizing circuit for timing relay FA is controlled by accelerating switch contacts 5A5. Thus upon response of accelerating switch 5A timing relay FA drops out after a given period of delay due to the discharge of its associated condenser C. Upon dropping out of timing relay FA the contacts FA2 and FA3 thereof open in the order named to interrupt the aforedescribed energizing circuits for the operating windings 2FA1 and 1FA1 of field accelerating switches 2FA and 1FA. Contacts 2FA2 and 1FA2 of the field accelerating switches are thus opened to include speed regulating rheostat 7 in the shunt field circuit of the motor.

From the foregoing it is apparent that upon starting of a drawing operation resistances R2,

R3, R4 and R5 are successively connected in parallel with resistance R1 and thereafter all of said resistances are excluded from the armature circuit for acceleration of the motor. Also upon exclusion of all of the armature resistances field regulating rheostat 7 is included in the shunt field circuit of the motor to bring the motor up to a selected maximum drawing speed determined by the setting of said rheostat.

Upon dropping out of timing relays 1CT and 2CT during acceleration of the motor the contacts 1CT2 and 2CT2 are opened and the operating winding UV1 is then maintained energized through the medium of a resistance r7 to hold under voltage relay UV in closed position. Upon dropping out of timing relay FA, during acceleration of the motor, contacts 1FA3 are opened and the operating winding 5A1 is then maintained energized through the medium of resistance r8 to prevent dropping out of accelerating switch 5A. Upon dropping out of field accelerating switch 1FA the contacts 1FA4 and control relay contacts 1CR5 establish an energizing circuit for the operating winding FD1 of timing relay FD. Timing relay FD in responding closes its contacts FD3 to establish an energizing circuit for the operating winding 2CR1 of control relay 2CR and upon response of said control relay the operating winding FA1 is energized through the medium of contacts 2CR3 to effect reclosure of timing relay FA. Upon reclosure of timing relay FA, control relay contacts 1CR2 and 2CR2 are in open position to prevent energization of the operating winding 1FA1 of accelerating switch 1FA and the timing relay contacts FD2 are in open position to prevent energization of the operating winding 2FA1 of accelerating switch 2FA.

Assuming now that the drawing operation is completed or that the stock breaks or slips out of engagement with pliers 3 during the drawing operation, the motor becomes unloaded and load relay LR drops out to interrupt the aforedescribed energizing circuit for control relay 1CR by opening of its associated contacts LR3. The current in the shunt operating winding LR2 of load relay LR is controlled as hereinbefore set forth and said winding acts in conjunction with the series winding LR1 to insure dropping out of said relay at various running speeds immediately upon unloading of the drawing mechanism and regardless of the fact that there may be only a slight reduction in load when the stock breaks or leaves the die. Depression of the "slow" push button also interrupts the aforedescribed energizing circuit for the operating winding 1CR1 of control relay 1CR. As will now be set forth, upon dropping out of relay 1CR resistance R1 is included in the armature circuit of the motor, speed regulating rheostat 7 is excluded from the shunt field circuit of the motor and resistance R7 is connected across the motor armature to provide for operation of the motor at its slow idling speed.

Upon dropping out of control relay 1CR the contacts 1CR2 thereof close to re-establish the aforedescribed energizing circuit for the operating winding 1FA1 of field accelerating switch 1FA and said switch in responding shunts resistance section r1 of speed regulating rheostat 7. Also upon dropping out of control relay 1CR the contacts 1CR3 thereof interrupt the aforedescribed energizing circuits for accelerating switches 1A, 2A, 3A and 4A to provide for dropping out of said switches. Upon dropping out of accelerating switch 1A contacts 1A4 reestablish the energizing circuit for the operating winding 1CT1 of control relay 1CT and upon dropping out of accelerating switch 3A contacts 3A3 re-establish the energizing circuit for the operating winding 2CT1 of control relay 2CT. Upon response of field accelerating switch 1FA the contacts 1FA4 thereof open to interrupt the energizing circuit for operating winding FD1 of timing relay FD and said timing relay then drops out subject to a given period of delay due to the discharge of its associated condenser C. Upon dropping out of timing relay FD contacts FD2 close prior to opening of the contacts FD3 thereof. Closure of contacts FD2 re-establishes the aforedescribed energizing circuit for the operating winding 2FA1 of field accelerating switch 2FA and said switch in responding closes its contacts 2FA2 to shunt resistance section r2 of speed regulating rheostat 7. Opening of timing relay contacts FD3 interrupts the energizing circuit of winding 2CR1 of control relay 2CR and closure of the timing relay contacts FD4 re-establishes the energizing circuit of operating winding 3CR1 of control relay 3CR. Control relay 3CR in responding opens its contacts 3CR2 to interrupt the aforedescribed energizing circuit for the operating winding 5A1 of accelerating switch 5A and upon dropping of said accelerating switch resistance R1 is re-included in the armature circuit of the motor. Upon dropping out of accelerating switch 5A the contacts 5A4 thereof re-establish the aforedescribed energizing circuit for the operating winding AS1 of armature shunt switch AS and said armature shunt switch in responding re-connects resistance R7 across the terminals of armature A. The motor is thus decelerated and brought to its low idling speed under no load conditions.

The controller also operates to effect automatic acceleration of the motor from its slow idling speed to its selected maximum drawing speed upon depression of the "fast" push button. Closure of the "fast" push button establishes an energizing circuit for the operating winding 1CR1 of control relay 1CR through the medium of the "slow" push button. With the motor operating at slow idling speed load relay LR is in closed position and upon release of the "fast" push button the operating winding 1CR1 of control relay 1CR is maintained energized through the medium of load relay contacts LR3 and control relay contacts 1CR1. Upon response of control relay 1CR contacts 1CR3 close to establish the aforedescribed energizing circuit for the operating winding 1A1 of accelerating switch 1A. Upon response of accelerating switch 1A the armature shunt switch AS is opened and the timing relays 1CT, 2CT and FA then operate as hereinbefore set forth to effect sequential response of armature accelerating switches 2A to 5A and field accelerating switches 1FA and 2FA for acceleration of the motor to the speed determined by the setting of rheostat 7.

Upon depression of the "stop" push button the aforedescribed maintaining circuit for the operating winding UV1 of the under voltage relay is interrupted and upon dropping out of said relay the contacts UV2 and UV3 thereof interrupt the aforedescribed energizing circuits for main switch M, accelerating switch 5A, armature shunt switch AS and field accelerating switches 1FA and 2FA. Upon dropping out of main switch M the contacts M2 thereof open to effect stopping of the motor and the contacts M4 thereof open to insure deenergization of accelerating switches 1A, 2A, 3A and 4A.

What I claim as new and desire to secure by Letters Patent is:

1. The combination with a direct current motor and a machine driven thereby, of means for starting said motor and for causing the same to normally operate at a predetermined slow speed below its base or full field speed with said machine in an unloaded condition, and means associated with said former means for accelerating said motor to a selected maximum speed when the load on said machine exceeds a predetermined value.

2. The combination with a direct current motor and a machine driven thereby, of means for starting said motor and for causing the same to normally operate at a predetermined slow speed below its base or full field speed with said machine in an unloaded condition, and means associated with said former means and responsive upon slowdown of said motor below said normal speed due to loading of said machine for effecting acceleration of said motor to a selected maximum speed.

3. The combination with a direct current motor and a machine driven thereby, of means for starting said motor and for causing the same to normally operate at a predetermined slow speed below its base or full field speed with said machine in an unloaded condition, and means associated with said former means for automatically accelerating said motor to a selected maximum speed upon loading of said machine and for automatically decelerating said motor to said predetermined slow speed upon unloading of said machine.

4. The combination with a direct current driving motor and a machine driven thereby, of a resistance to be connected in series in the armature circuit of said motor, a second resistance to be connected across the armature of said motor, means for establishing power connections for said motor and for including said resistances in the armature circuit thereof to provide for normal operation of said motor at a relatively slow speed below its base or full field speed with said machine in an unloaded condition, and accelerating means for automatically excluding said resistances from the armature circuit of said motor when the load on said machine exceeds a predetermined value.

5. The combination with a direct current motor and a machine driven thereby, of a resistance to be connected in series in the armature circuit of said motor, a second resistance to be connected across the armature of said motor, means for establishing power connections for said motor and for including said resistances in the armature circuit of said motor to provide for normal operation of said motor at a speed below its base or full field speed with said machine in an unloaded condition, accelerating means for automatically excluding said resistances from the armature circuit of said motor when the load on said machine exceeds a predetermined value and decelerating means for re-including said resistances in the armature circuit of said motor when the load on said machine drops below said predetermined value.

6. The combination with a direct current motor and a machine driven thereby, of a series resistance to be connected in the armature circuit of said motor, a shunt resistance to be connected across the armature of said motor, means for establishing power connections for said motor including said series resistance, means for including said shunt resistance in the motor circuit upon starting of said motor to provide for normal operation of said motor at a predetermined slow speed below its base or full field speed with said machine in an unloaded condition, and for excluding said shunt resistance from the motor circuit upon slowdown of said motor due to a loaded condition of said machine, and accelerating means responsive upon exclusion of said shunt resistance from the motor circuit for automatically excluding said series resistance from the motor circuit.

7. The combination with a direct current motor and a machine driven thereby, of a series resistance to be connected in the armature circuit of said motor, a shunt resistance to be connected across the armature of said motor, means for establishing power connections for said motor including said series resistance, control means for said shunt resistance including a relay responsive to counter E. M. F. conditions in the motor circuit, said relay acting upon starting of said motor to include said shunt resistance in the motor circuit for normal operation of said motor at a predetermined slow speed below its base or full field speed with said machine in an unloaded condition, said relay also providing for automatic exclusion of said shunt resistance from the motor circuit upon slowdown of said motor below said normal speed due to loading of said machine, and means acting upon exclusion of said shunt resistance from the motor circuit for automatically excluding said series resistance for acceleration of said motor.

8. The combination with a direct current motor and a machine driven thereby, of a series resistance to be connected in the armature circuit of said motor, a shunt resistance to be connected across the armature of said motor, means for establishing power connections for said motor including said series resistance, means acting upon starting of said motor for including said shunt resistance in the motor circuit to provide for normal operation of said motor at a predetermined slow speed below its base or full field speed with said machine in an unloaded condition and for excluding said shunt resistance from the motor circuit upon slowdown of said motor below said predetermined speed due to loading of said machine, means acting automatically upon exclusion of said shunt resistance from the motor circuit to exclude said series resistance from the motor circuit for acceleration of the motor and decelerating means responsive to load conditions in the motor circuit for including said series and shunt resistances in the motor circuit upon unloading of said machine.

9. The combination with a metal drawing machine and a driving motor therefor, of means for starting said motor and for causing the same to normally operate at a predetermined slow speed below its base or full field speed when said drawing mechanism is unloaded and in an initial position for starting of the drawing operation, means associated with said former means for accelerating said motor to a selected maximum speed when said drawing mechanism is started out of initial position and subjected to a load exceeding a predetermined value, and means acting under load conditions below said predetermined value for accelerating said motor to said selected maximum speed upon a given movement of said drawing mechanism out of initial position.

JOHN M. NEWMAN.