Aug. 29, 1961 O. L. BARDES ET AL 2,998,124

DRAW BENCH

Filed June 17, 1958 2 Sheets-Sheet 1

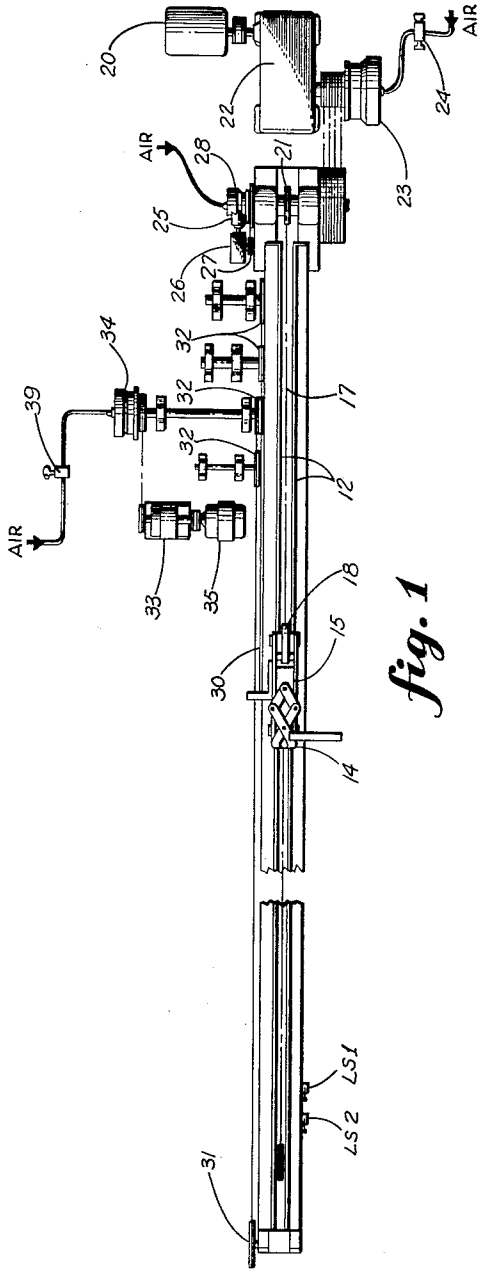


fig. 1

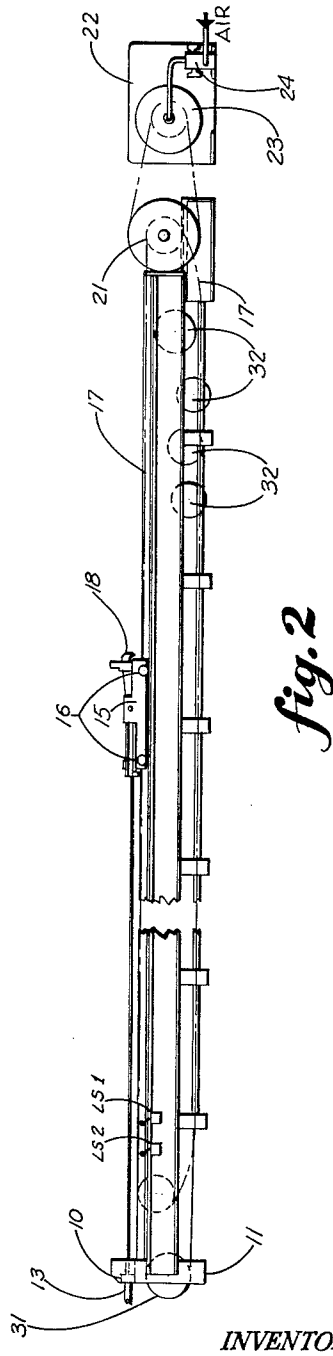


fig. 2

INVENTORS.
OLIVER L. BARDES
ERNEST A. HUND
BY
Wood, Herron & Evans.
ATTORNEYS

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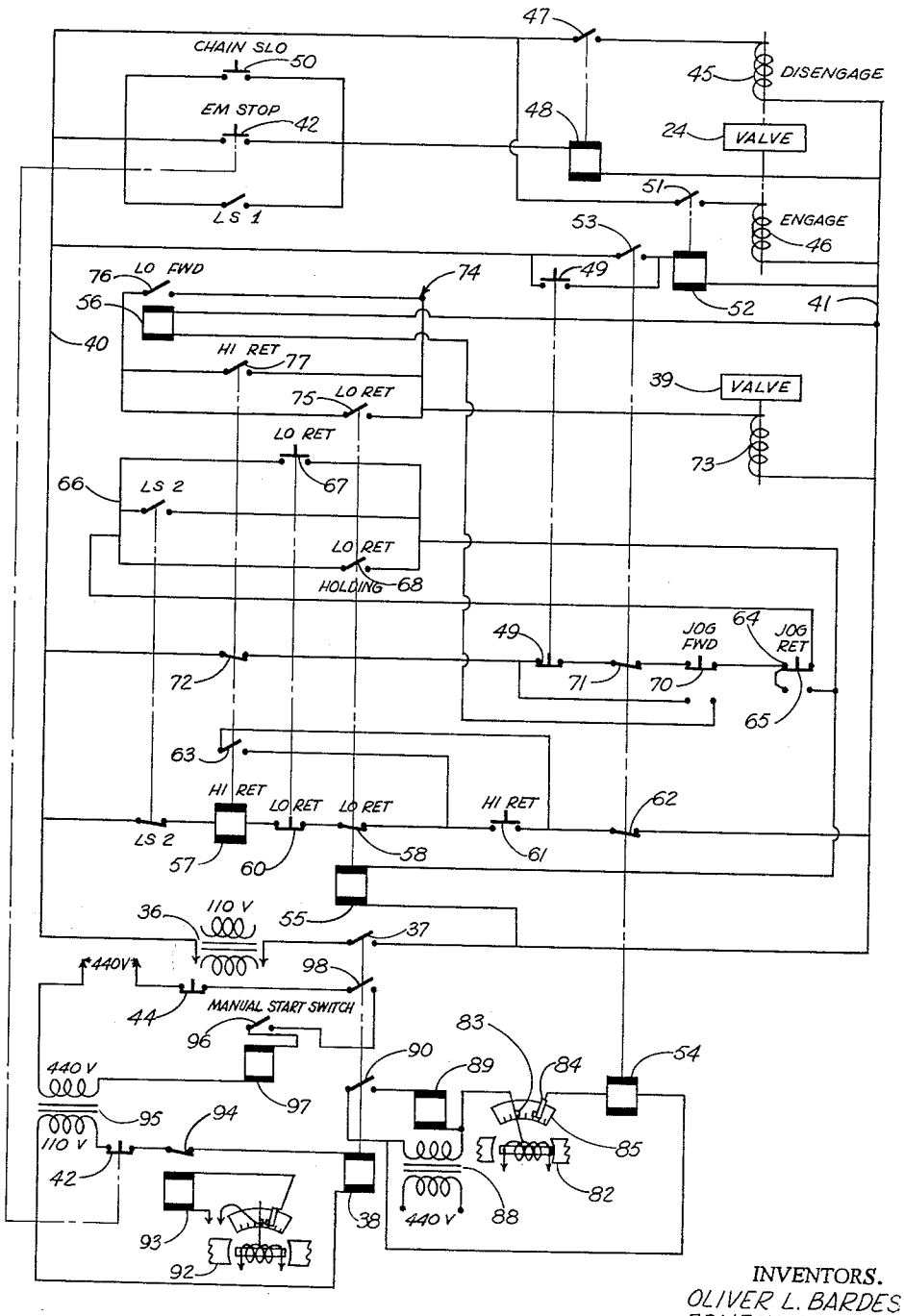


fig. 3

INVENTORS.
OLIVER L. BARDES
ERNEST A. HUND

BY

Wood, Herron & Evans.
ATTORNEYS

United States Patent Office 2,998,124 Patented Aug. 29, 1961

2,998,124

DRAW BENCH

Oliver L. Bardes, Cincinnati, Ohio, and Ernest A. Hund, Fort Thomas, Ky., assignors to Bardes Corporation, Cincinnati, Ohio, a corporation of Ohio

Filed June 17, 1958, Ser. No. 742,577
4 Claims. (Cl. 205—3)

This invention relates to a draw bench and more particularly to an exclusively alternating current motor drive for the draw bench carriage, and a system for substantially automatically controlling the operation of the alternating current motor drive.

The draw bench to which the invention is directed is generally of known construction and includes a die adjacent to one end of trackways, the trackways having a carriage movably mounted thereon. The carriage has jaws which grip one end of tubing or solid bar to be drawn through the die. An endless draw chain is mounted between the trackways and is adapted to receive a hook pivoted on the carriage, the hook being caused to drop into the draw chain when the carriage jaws grip the end of the tubing, or solid bar. Means are provided for driving the draw chain to pull the carriage during the drawing stroke and means are provided for returning the carriage to the die after the tubing or solid bar has been drawn and released from the jaws of the carriage.

It is necessary to drive the carriage rapidly and with considerable power during the drawing stroke in order to have an effective drawing operation. However, the speed of the draw chain driven at drawing speed is too great to permit the carriage mounted hook to drop into the draw chain immediately prior to the drawing stroke. Accordingly, the practice has been to provide a variable speed direct current motor with means for driving the motor at high speed during the drawing stroke and at low speed after the drawing stroke in order to permit the introduction of the carriage mounted hook into the draw chain. Similarly, it has been the practice to use a variable speed direct current motor to return the carriage to the die after the draw stroke so that the carriage initially can be driven at a high speed and immediately before reaching the die can be braked and driven at a low speed.

The known system utilizing variable speed direct current motors is disadvantageous particularly in view of the cost of the direct current motors and motor controls as well as the cost of a convertor to provide the direct current power. Additionally, the high cost of maintenance of direct current machinery and controls increases the cost of operating known draw benches.

The present invention avoids the disadvantages of the prior practices by providing a large alternating current motor of sufficient horse power for the main drive or drawing stroke, a small auxiliary alternating current motor of approximately three horse power for driving the draw chain at a low speed during the engagement of the carriage jaws with the tubing to be drawn and a control system by which the main drive and auxiliary alternating current motors are selectively connected for driving engagement with the draw chain. A third alternating current motor having high and low speed windings is connected through a cable to drive the carriage during the return travel.

It has been an objective of the invention to provide a control system for selectively causing the engagement and disengagement of a main drive alternating current motor; the engagement of the main drive motor being dependent upon the predetermined overload current drawn by the alternating current auxiliary motor.

It has been another objective of the invention to provide control means for selectively causing the shifting of a draw chain drive from a main drive alternating current motor to an auxiliary alternating current motor, the shift being initiated by the tripping of a limit switch by the carriage on its return travel toward the drawing die.

It has been another objective of the invention to provide a control system as described above in which the auxiliary motor is running constantly at low speed and is connected to the draw chain through an over-running clutch so that it will take over the driving of the draw chain when the main drive alternating current motor has been disengaged from driving the draw chain at high speed; and which will not be an additional load on the large alternating current motor when the large motor is in driving engagement with the draw chain.

It has been another objective of the invention to provide a system as described above which will further include an air clutch between the auxiliary motor over-running clutch and the draw chain. The air clutch will be under pressure just sufficient to permit the auxiliary motor to drive the draw chain. Thus, if the main drive motor should fail for any reason to drive the chain during the draw stroke, the auxiliary motor and its mounting will not be damaged through an extraordinary load on the auxiliary motor.

It has been another objective of the invention to provide an alternating current carriage drive motor having high and low speed windings for the return of the carriage to the drawing die. Such a motor is commonly called a multispeed type motor, and in the preferred embodiment has windings to provide a 4:1 speed ratio. A control system is provided for such carriage return motor having cooperative inter-relation with the control system for the two draw chain drive motors. The control system will disconnect the carriage return motor when the main drive motor is driving the chain on the draw stroke. The control system for the carriage return motor includes a relay contact, whose operation is dependent upon overload on the auxiliary motor, the contact being effective to disconnect both the high speed carriage return and the low speed carriage return windings in the carriage return motor. The shift of the carriage return motor from high speed to low speed is effective immediately to brake the high speed of the carriage just prior to its reaching the die.

It is another objective of the invention to provide a control system including an overload relay device in the auxiliary motor circuit, the relay device having a galvanometer movement with visual indicators for the tripping current and the instantaneous motor current. The visual indicators increase the effectiveness of the system in that they permit the trip current setting to be varied in accordance with the varying conditions of the operation. The relay device also includes a time delay which permits the auxiliary motor to be started with the attendant overload starting current without closing the relay contacts.

These and other objectives of the invention will become more readily apparent in the following detailed description taken in conjunction with the drawings in which:

FIG. 1 is a top plan view of a draw bench;

FIG. 2 is a side elevational view of a draw bench; and

FIG. 3 is a circuit diagram of the control system for the draw bench.

The draw bench, in general, follows known design except insofar as the invention has been applied to the draw bench.

The drawing die **10** is mounted in a die block on a support **11** at one end of trackways **12** on the draw bench. Tubing or bar **13**, having a tapered end, is grasped by the jaws **14** of a carriage **15** mounted by rollers or wheels **16** for movement along the trackways.

The carriage is drawn by a draw chain **17** which is adapted to receive between the links thereof, a hook **18** pivotally mounted on the carriage.

Engagement of a trigger on the carriage with the die

block on the return travel releases a latching mechanism holding the hook 18 in the elevated position shown in FIG. 2 so that the hook can drop toward the draw chain. The dropping of the hook causes the jaws of the carriage to grip the tapered end of the tube or bar projecting through the die. If the draw chain is moving slowly enough, the hook will engage the draw chain so that the carriage can be pulled on the draw stroke by the draw chain. Tension of the draw chain pulling on the hook relatches the hook 18 as the carriage begins the draw stroke so that the hook 18 remains in the elevated position until the carriage is once again returned to the die.

On the draw stroke the carriage is pulled by the draw chain which is powered by a large alternating current motor 20 of, say, 125 horsepower. The large main drive motor 20 is connected to a draw chain drive sprocket 21 through suitable reduction gearing 22 and an air pressure operated clutch 23. The air pressure operated clutch 23 is controlled by a two position non-self centering valve 24 operated by double solenoids to be described in connection with the circuit diagram.

An auxiliary alternating current motor 25 of, say, three horse power is connected to the sprocket 21 through suitable reduction gearing 26, an overrunning clutch 27 and an air clutch 28 which is under just sufficient pressure to permit the motor to drive the chain. The overrunning clutch permits the motor 25 to drive the draw chain at the low speed provided through the reduction gearing when the main motor 20 is disengaged. The draw chain is overrunning with respect to the auxiliary drive motor when the main drive motor is driving the draw chain at high speed.

Alternative types of clutches such as electrically operated plate clutches, may be used in place of the air pressure clutches 23 and 28 providing that they perform substantially the same functions as the air pressure operated clutches.

The carriage is driven on the return stroke by a cable 30, both ends of which are fastened to the carriage. The cable is wrapped at the die block end of the bench on groove pulley 31 and at the head end of the bench by a series of groove pulleys 32, providing a tandem wrap drive. The pulleys 32 are driven through reduction gearing 33 and an air clutch 34 by an alternating current motor 35 having a high speed winding and a low speed winding controlled by a reversing starter in a manner to be described in the circuit diagram. A solenoid operated valve 39 controls the engagement and disengagement of the air clutch 34.

A first limit switch LS1 and a second limit switch LS2 are mounted in spaced relation in proximity to the drawing die 10 and partially control the carriage return motor and the draw chain drive motors. The limit switches are designed to be operated only when they are engaged by the carriage on its return travel.

Electrical control system

The electrical control system can best be understood by a preliminary explanation of the sequence of steps. Thereafter the manner in which the sequence of steps is initiated will become apparent through a description of the circuit diagram.

Assuming that a drawing operation has just been completed, the tension imparted to the carriage by a tube or bar being drawn is released and the draw chain which has been maintained in engagement with the hook 18 by virtue of the tension on the carriage, drops away from the hook 18. The carriage coasts to a standstill with the hook 18 remaining in elevated position and the draw chain continues to run at high speed through the engagement of the draw chain by the main drive motor.

The operator inserts a stock tube or bar into the die and presses a carriage return button. The carriage return button connects the high speed winding of carriage return motor 35 and operates the air clutch 34 to drive the carriage on the return stroke at high speed.

On the return stroke, the carriage will first engage limit switch LS1 which will effect the operation of the valve 24 to disengage the clutch 23 between the main drive motor and the draw chain sprocket. The draw chain will immediately slow down until it reaches the speed imparted by the auxiliary motor 25. The auxiliary motor will drive the draw chain at a speed low enough to permit the hook 18 to engage the draw chain when it is unlatched.

The carriage continues to move toward the die 10 under the drive imparted by the carriage return motor 35 and trips limit switch LS2 approximately four feet from the die, which shifts the winding on the carriage return motor from high speed to low speed. The shift effectively brakes the movement of the carriage toward the die so that the carriage engages the tube or bar and die support at a comparatively low speed.

The tube is gripped by the jaws 14 of the carriage and the hook 18 drops into the now slowly moving draw chain. The resistance of the draw chain, carriage and tube or bar being drawn is obviously too great for the three horse power auxiliary motor, and accordingly the auxiliary motor 25 is rapidly overloaded. An overload current of approximately full load current will cause the operation of a relay which in turn causes the engagement of clutch 23 to main drive motor 20 and simultaneously de-energizes the return carriage motor 35 and disengages its associated clutch 34. Thereafter the drawing operation proceeds until the tube or bar is drawn.

The control system is illustrated in the circuit diagram of FIG. 3. Energy for the control system comes from a source 36 which is controlled by a contact 37 which is closed when the main drive starter coil indicated at 38 is energized. The voltage source 36 feeds the system through the main lines 40 and 41.

Motor control

The main drive motor 20 operates continuously unless disconnected by either the emergency stop button 42 or an overload relay 43 operated by the current in the auxiliary motor which de-energizes the starter for the main motor, or through operation of a stop button 44 which drops out a holding coil for the main starter switch. Throughout the normal operation of the draw bench the connection of the main drive motor to the draw chain is controlled by the valve 24 which is in turn operated by a solenoid 45 for "disengage" and a solenoid 46 for "engage." The circuit to the solenoid 45 is closed by a contact 47 on a relay 48, the relay 48 being energized through a circuit which is closed by a limit switch LS1. Additionally, the circuit for relay 48 can be closed by a chain "slo" contact 50 and the emergency stop contact 42.

The "engage" solenoid 46 is controlled by the contact 51 and which is part of relay 52. The circuit of relay 52 is controlled by contact 53 which is part of the small motor overload relay 54, whose operation is described below. Alternatively the "engage" relay 52 may be energized by operation of a manual button 49, in the event that the overload relay 54 fails to operate properly.

Carriage return control

The carriage return motor 35 is operated through a reversing starter diagrammatically illustrated by coils 55 for low speed return and coil 56 for low speed forward. Additionally, the carriage return motor 35 has a control to shift to the high speed winding, the control being illustrated diagrammatically as coil 57, all coils having associated contacts, to be described. The circuit for energizing the high speed return coil 57 is principally a series circuit including the coil 57, limit switch LS2 (normally closed) contact 58 (normally closed) and opened by low speed return coil 55, low speed carriage return switch 60 (normally closed) high speed carriage

return switch 61 (normally open) and contact 62 (normally closed) and operated by small motor overload relay 54. A holding contact 63 is connected across the high speed return switch 61 and is maintained closed when the coil 57 is energized.

Low speed carriage return circuit

The coil 55 which, when energized, shifts the carriage return motor 35 to the low speed return winding is controlled through a series parallel circuits. One side of the coil 55 is maintained directly connected to the main line 41. The other side of the coil is connectable to the junction 64 which is connected to the other side 40 of the circuit. Closing the circuit from coil 55 is effected either through a "jog return" switch, when it is depressed to close the lower contacts; or a parallel circuit 66 including limit switch LS2. The "jog return" switch 65 is spring biased to maintain a position closing the upper of the two sets of contacts. In the upper position the switch connects the parallel circuit 66 to the line 40 through junction 64. Included in the parallel circuit 66 is a low speed carriage return switch 67 and a contact 68 (normally opened) operated by the low speed return coil 55 to hold the circuit to coil 55 closed after the release of the limit switch LS2. Thus when the circuit is in the condition illustrated in the circuit diagram operation of limit switch LS2, switch 67 or contact 68 will cause the carriage to move slowly on the return stroke.

A "jog forward" switch 70 (normally closed) is connected in series with the "jog return" button 65. It can be seen that if the "jog forward" button is depressed, the circuit to the low speed return coil 55 will be interrupted and a circuit to the coil 56 operating the motor at low speed forward will be closed.

A contact 71 (normally closed) operated by the small motor overload relay 54 is in series with the low speed return circuit. Also in series with the low speed circuit is a contact 72 (normally closed) which is opened when the coil 57 associated with the high speed return starter is energized.

Carriage return clutch valve circuit

The carriage return motor 35 is connected through an air pressure clutch 34 controlled by a valve 39. The valve 39 is operated by a solenoid 73 energized through the circuit which includes the parallel circuit 74. Circuit 74 includes a contact 76 (normally open) operated by the coil in the low forward starter, a contact 77 (normally open) operated by the high speed return starter coil 57 and a contact 75 (normally open) operated by the low speed return starter coil 55.

It will be seen that if the carriage return is energized for low speed return (coil 55) or low speed forward (coil 56) or high speed return (coil 57) the clutch will be engaged through the closing of contacts 75, 76, and 77 respectively. It can also be seen that none of the contacts 75 to 77 can close automatically when the contacts 62 and 71, operated by the small motor overload relay 54, are open. Thus the overload relay 54 exercises complete control over the carriage return motor.

The overload relay 54 device is in a series circuit including a contact which is closed by means 82, which is a current responsive relay device, the details of which per se form no part of the present invention except as they are embodied in the draw bench combination. In the particular embodiment illustrated, the relay 54 is controlled by an ammeter type device 82 having a galvanometer movement connected into the auxiliary motor circuit. A movable contact 83 fixed to the movable coil is connected to one side of the circuit of relay 54 and an adjustable contact 84 is connected to the other side of the circuit. Both the movable member 83 and the adjustable member 84 are mounted on a scale 85 so as to be visible to the operator of the draw bench.

The combination of an adjustable contact cooperating with the visible calibrated scale 85 is particularly useful in the draw bench circuit. The daily conditions of operation have an effect on the operation of the overload relay system. In order to provide substantially instantaneous response upon the engagement of hook 18 with the chain, the adjustable contact 84 is set quite close to the position of the movable contact 83 when the auxiliary motor is drawing a normal current to pull the draw bench at low speed. Accordingly, if conditions cause a greater resistance to movement on the part of the draw chain, the normal load position of contact 83 will be farther to the right as viewed in FIG. 3 and probably will trip the relay 54 before the hook 18 has been engaged.

Consequently, adjustment of the setting of contact 84 is on occasions necessary.

The circuit of relay 54 is fed by a source indicated as a transformer 88. A transformer 88 feeds a coil 89 in the auxiliary motor starter, the coil being controlled by contact 90 operated by the main drive motor starting coil 38.

A second ammeter type relay device similar to the device 82 is indicated at 92. Adjustable and movable contacts close a circuit to a relay 93 having a normally closed contact 94. The contact 94 is in series with the circuit to the main drive motor starting coil 38 which is fed by the transformer indicated at 95. The second ammeter device 92 is also in the auxiliary motor circuit and is set to trip at, say, two times normal load whereas the ammeter device 82 is set for slightly greater than normal load. The ammeter device 92 therefore acts as an emergency overload relay which will close down the complete operation by opening the circuit to main drive motor starter coil 38 when it is tripped. An instance in which emergency tripping is desirable is in the event that the solenoid 46 which effects the engagement of the main drive motor clutch fails for some reason to operate. If the emergency control were not provided, the auxiliary motor in attempting to pull the tube or bar drawing load would burn out, would pull loose from its mounting, or would damage its coupling to the draw chain.

Both ammeters 82 and 92 are provided with time delay means not shown which are sufficient to prevent tripping during starting of the auxiliary motor when, of course, the current drawn by the auxiliary motor will be several times the normal load.

The transformer 95 is energized from a 440 volt source, for example, controlled by a manual start switch 96 having an associated hold coil 97. An additional holding contact 98 is operated by the coil 38 in the main drive motor starter so that de-energization of coil 38 will open the feeder circuit to the transformer 95.

It should be understood that mechanisms other than the ammeter 82 can be provided for automatically switching to the main motor after the small motor has driven the draw chain slow enough for the engagement of the hook 18. However, the system utilizing the relay 54 whose operation is dependent upon the overload of the auxiliary motor is the preferred form of the invention because of the surety of its operation. An example of an alternative switching mechanism would be to provide a limit switch engageable by the hook 18 which switch would be tripped when the hook drops into the draw chain. The switch would operate to close a relay having contacts similarly arranged in the circuit as the contacts 53, 62, and 71 associated with the relay 54.

It will also be possible to employ a third limit switch to drop out the carriage return motor 35 and the associated clutch 34.

Having described our invention, we claim:

1. In a draw bench, the combination comprising, a draw chain, a carriage, a hook mounted on said carriage to connect said carriage to said draw chain, a carriage return system connected to said carriage, an electrical circuit for operating said carriage return system, a chain drive system comprising, a main drive alternating current

motor, an auxiliary alternating current motor, means connecting said auxiliary motor to drive said draw chain at least during the time that said hook moves into engagement with said draw chain, means for connecting said main drive motor to drive said draw chain immediately after said hook has engaged said draw chain, said last named means including relay means for detecting engagement of said hook in said draw chain, and contacts in said electrical circuit and operated by said relay means for simultaneously disconnecting said carriage return system.

2. In a draw bench, a carriage control system comprising, a draw chain, a hook mounted on said carriage and connectable to said draw chain, a main drive alternating current motor, means including a main clutch connecting said main motor to said draw chain, an auxiliary alternating current motor to drive said draw chain at a slow speed to permit said hook to connect said carriage to said draw chain, means including an auxiliary clutch connecting said auxiliary motor to said draw chain, an auxiliary motor circuit for energizing said auxiliary motor, an overload relay device connected in said auxiliary motor circuit and operable to engage said main drive motor clutch when said auxiliary motor reaches predetermined overload, a carriage return cable connected to said carriage, a two-speed alternating current motor, means including a return clutch connecting said two-speed motor to said carriage to drive said carriage, at least on the return travel, at high speed and at low speed, means connecting said overload relay device to deenergize said two-speed motor and disconnect said return clutch at the end of the return travel, a first limit switch operable by said carriage to disconnect said main drive motor clutch prior to the end of the return travel, and a second limit switch operable by said carriage to switch said two-speed motor from high to low speed.

3. In a draw bench, a carriage control system comprising, a draw chain, a hook mounted on said carriage and connectable to said draw chain, a main drive alternating current motor, means including a main clutch for connecting said main motor to said draw chain, an auxiliary alternating current motor to drive said draw chain at a slow speed to permit said hook to connect said carriage to said draw chain, means including an auxiliary clutch for connecting said auxiliary motor to said draw chain, an auxiliary motor circuit for energizing said auxiliary motor, an overload relay device connected in said auxiliary motor circuit and operable to engage said main drive motor clutch when said auxiliary motor reaches predetermined overload, a carriage return cable connected to said carriage, a two-speed alternating current motor, means including a return clutch for connecting said two-speed motor to said carriage to drive said carriage, at least on the return travel, at high sped and at low speed, and means connecting said overload relay device to de-energize said two-speed motor and disconnect said return clutch at the end of the return travel.

4. In a draw bench, a carriage control system comprising, a draw chain, a hook mounted on said carriage and connectable to said draw chain, a main drive alternating current motor, means including a main clutch for connecting said draw chain to said main motor to drive said draw chain, an auxiliary alternating current motor to drive said draw chain at a slow speed to permit said hook to connect said carriage to said draw chain, means including an auxiliary clutch for connecting said draw chain to said auxiliary motor, an auxiliary motor circuit for energizing said auxiliary motor, an overload relay device connected in said auxiliary motor circuit and operable to engage said main drive motor clutch when said auxiliary motor reaches predetermined overload, a carriage return cable connected to said carriage, a two-speed alternating current motor to drive said carriage, at least on the return carriage travel, at high speed and at low speed, means including a return clutch for connecting said two-speed motor to said cable, means connecting said overload relay device to de-energize said two-speed motor and disconnect said return clutch at the end of the carriage travel, and a limit switch operable by said carriage to disconnect said main clutch prior to the end of said return carriage travel.

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