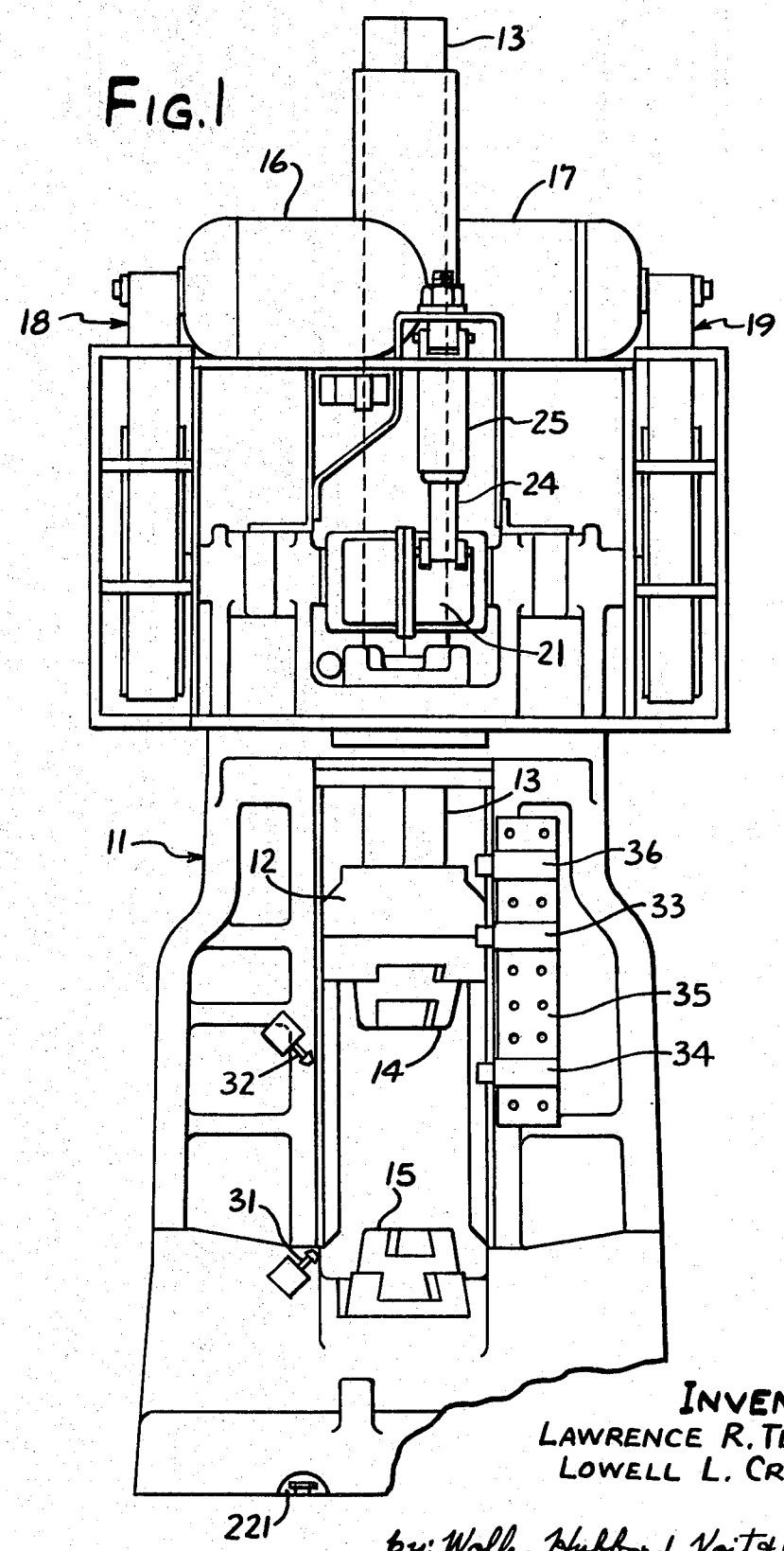
Feb. 9, 1971 L. R. TETZLOFF ET AL 3,561,238

AUTOMATIC DIE LUBRICATOR FOR DROP HAMMERS

Filed May 22, 1968 4 Sheets-Sheet 1

FIG. 1



INVENTORS
LAWRENCE R. TETZLOFF
LOWELL L. CROM

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

AUTOMATIC DIE LUBRICATOR FOR DROP HAMMERS

Filed May 22, 1968 4 Sheets-Sheet 2

FIG. 2

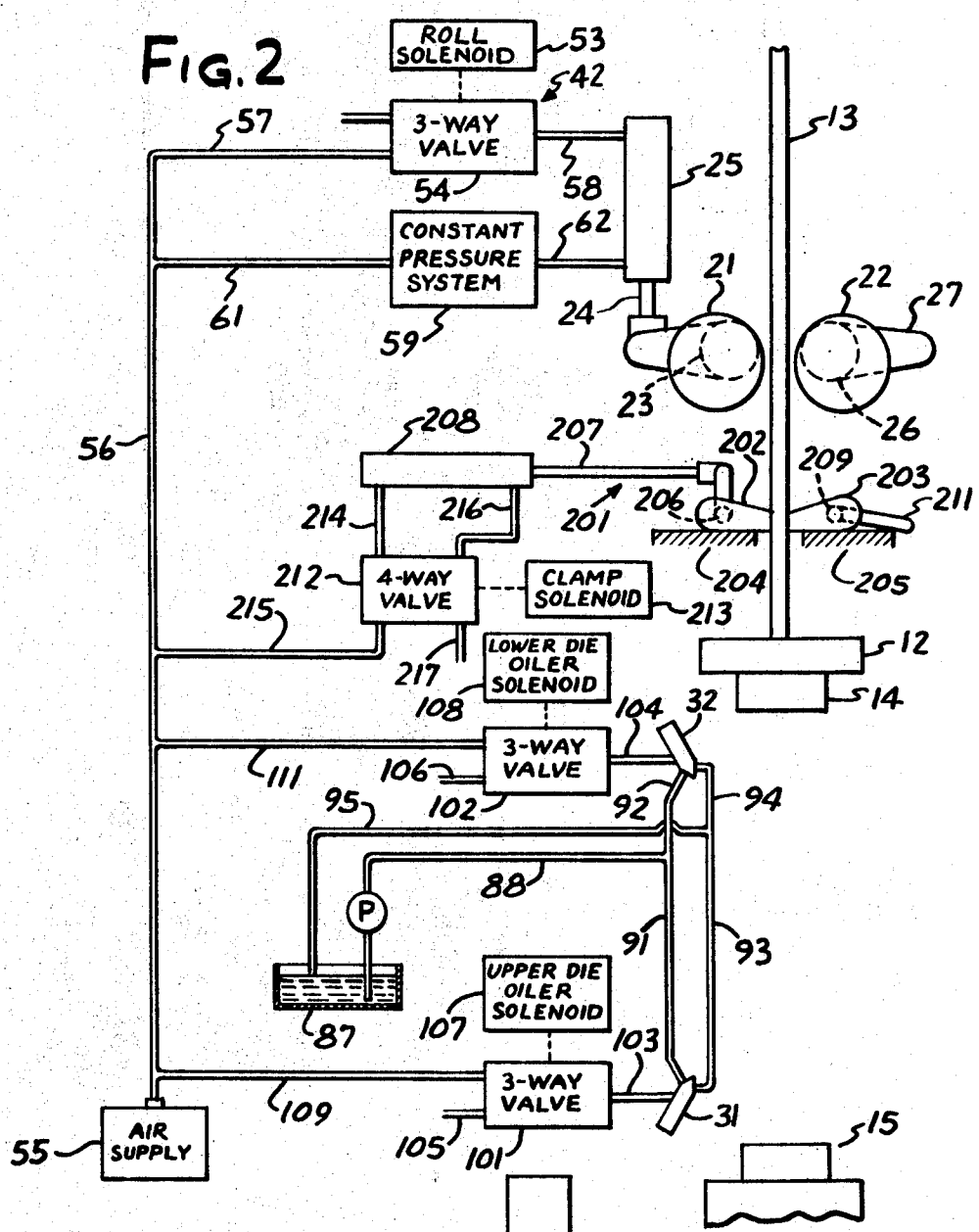
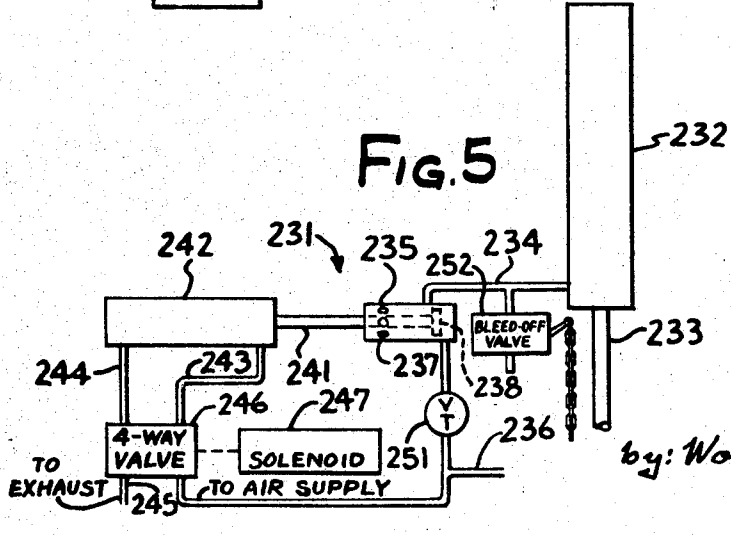


FIG. 5



INVENTORS
LAWRENCE R. TETZLOFF
LOWELL L. CROM

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

Feb. 9, 1971 L. R. TETZLOFF ET AL 3,561,238

AUTOMATIC DIE LUBRICATOR FOR DROP HAMMERS

Filed May 22, 1968 4 Sheets-Sheet 3

FIG. 4

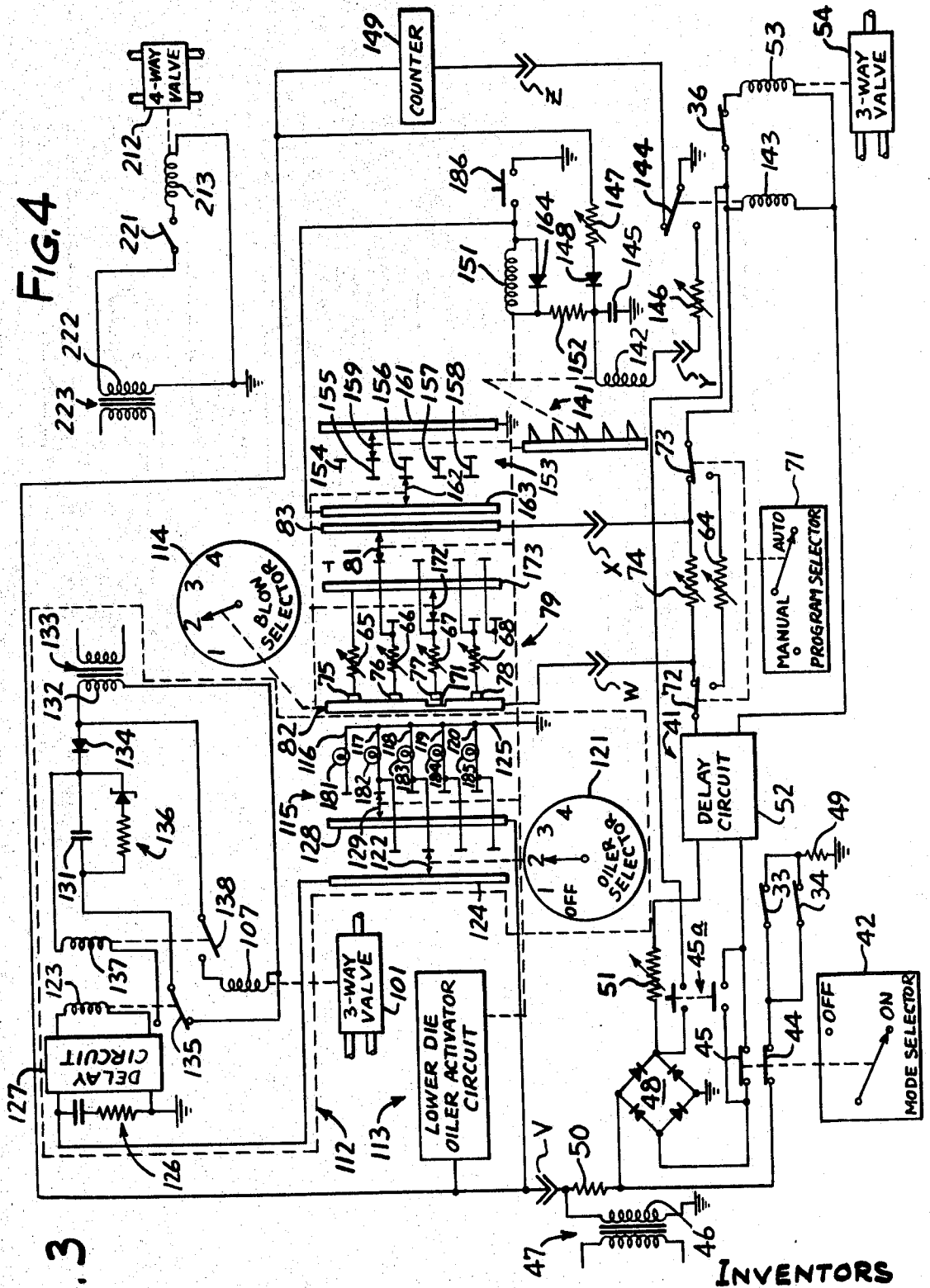


FIG. 3

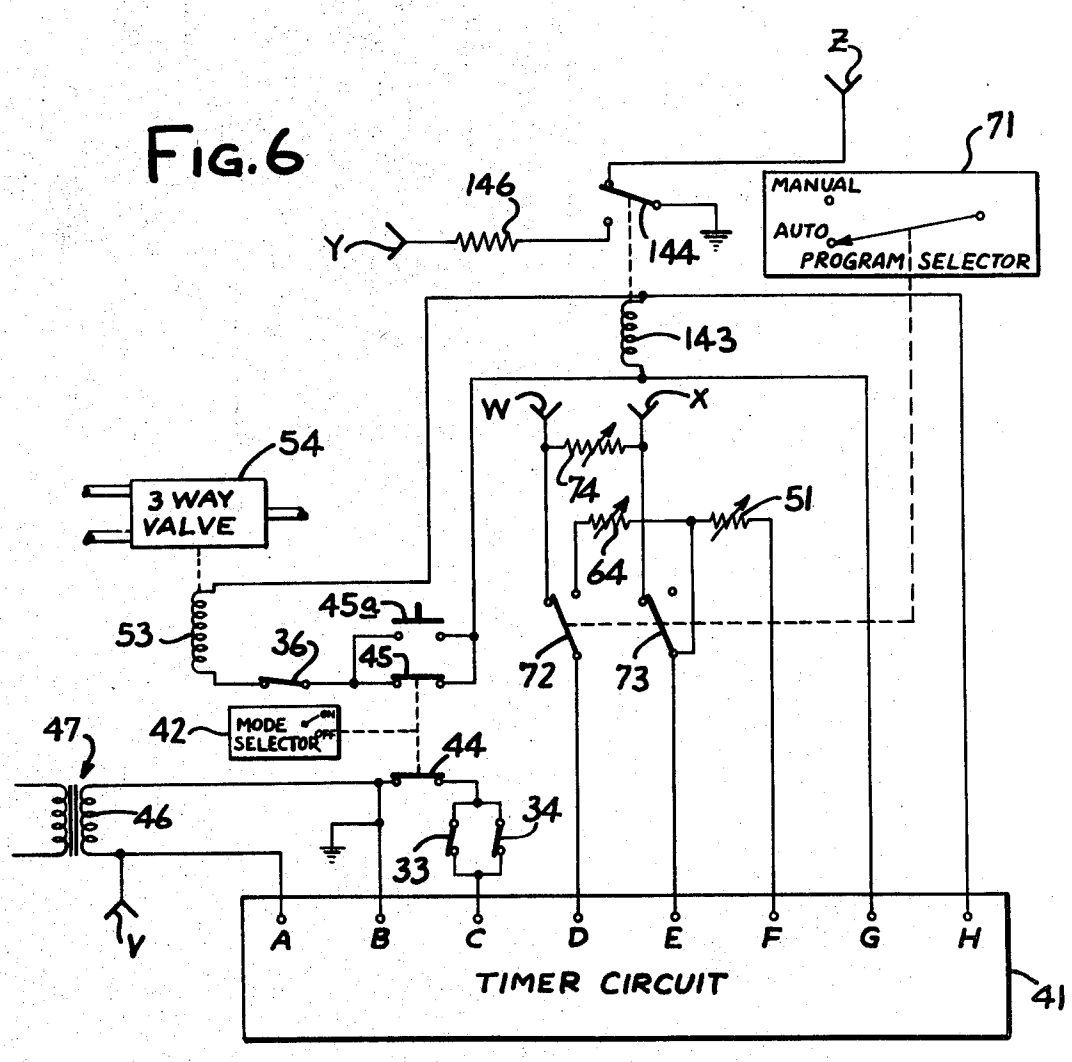
INVENTORS
LAWRENCE R. TETZLOFF
LOWELL L. CROM

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

AUTOMATIC DIE LUBRICATOR FOR DROP HAMMERS

Filed May 22, 1968 4 Sheets-Sheet 4

FIG. 6



INVENTORS
LAWRENCE R. TETZLOFF
LOWELL L. CROM

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

United States Patent Office 3,561,238 Patented Feb. 9, 1971

3,561,238

AUTOMATIC DIE LUBRICATOR FOR DROP HAMMERS

Lawrence R. Tetzloff, Calumet City, Ill., and Lowell L. Crom, Hammond, Ind., assignors to Indiana Forge and Machine Company, East Chicago, Ind., a corporation of Indiana

Filed May 22, 1968, Ser. No. 731,112
Int. Cl. B21j 3/00, 7/06
U.S. Cl. 72—23 18 Claims

ABSTRACT OF THE DISCLOSURE

An automatic die lubricator for drop-type hammers wherein nozzles are positioned to spray lubrication over the die faces and a control system is provided to actuate these nozzles after the delivery of each series of a predetermined number of working blows. The control system includes proximity switches which are responsive to the movement of the reciprocating upper die for providing a control signal upon the delivery of each blow, and a stepping switch which is advanced one station by each control signal until a final station is reached whereupon a circuit for actuating the lubricating nozzles is closed. The stepping switch is then reset and the cycle repeats without interruption.

To control the intensity of the working blows, the control system includes a timer which has an off-time circuit to govern the moment of initiation of each control signal and an on-time circuit to govern the duration of each. The timed control signals are then employed to actuate the upper die lifting mechanism. The timer may have a single on-time circuit so that each control signal is of the same duration whereby each blow is delivered from the same height, or a different on-time circuit for each blow of a predetermined blow pattern whereby such blows may be delivered from varying heights. In this latter case, the different on-time circuits are each connected to a respective station of a stepping switch which is advanced one station in response to the initiation of each control signal and which is recycled to the first station by the reset means in response to the initiation of the control signal following the delivery of the complete pattern.

BACKGROUND OF THE INVENTION

This invention relates to the drop hammer art, and more particularly to an automatic die lubricator for drop hammers.

One of the prerequisites for properly forging most workpieces is that the dies of the hammer be maintained properly lubricated to prevent the workpiece from sticking thereto. In the past, this has generally required the operator to periodically pass an oil soaked swab over the die faces, with resultant distraction of the operator from his main task of properly forging the workpiece, as well as all too frequent workpiece damage due to improper lubrication. Additionally, oil frequently drips from the swab in the work area thereby creating a safety hazard.

SUMMARY OF THE INVENTION.

Accordingly, it is an object of this invention to provide an automatic die lubricator for drop-type hammers. A more specific object is to provide a die lubricator which may be preset according to the requirements of the workpiece to automatically provide timely die lubrication with little waste of lubricating oil.

Another object of this invention is the provision of an automatic die lubricator suitable for use throughout the full range of drop hammer operating speeds. A related object is to provide an automatic die lubricator which is

suitable for use with drop hammers operating under either programmed or nonprogrammed control.

Still another object is to provide an automatic die lubricator which can be adapted to use with presently existing drop hammers.

DESCRIPTION OF THE DRAWINGS

Other objects and advantages will become apparent upon reading the attached detailed description and upon reference to the drawings, in which:

FIG. 1 is a simplified front elevation of a board-type drop hammer equipped for either programmed or nonprogrammed control, and shows the mounting of the lubricating nozzles provided according to the present invention;

FIG. 2 is a block diagram of the pneumatic and hydraulic circuits provided for the drop hammer and automatic die lubricator;

FIG. 3 is a simplified electrical schematic illustrating the control circuit for providing selectable programmed or nonprogrammed control of a drop-type hammer, and shows the cooperation between that circuit and the automatic die lubricator control circuit.

FIG. 4 is another simplified electrical schematic illustrating a typical clamp control circuit for a drop hammer;

FIG. 5 is a block diagram showing the modifications of the pneumatic circuit illustrated in FIG. 2 for use with an air-type drop hammer; and

FIG. 6 is a diagram, partly in block form and partly in schematic form, illustrating a modification of the control circuit shown in FIG. 3.

DETAILED DESCRIPTION

While the invention is described in connection with a particular embodiment, it should be understood that the intent is not to limit it to that embodiment. To the contrary, the intention is to cover all the various alternatives, equivalents and modifications as are included within the spirit and scope of the present invention as defined by the appended claims.

(1) Drop hammer construction

Turning now to the drawings and particularly to FIGS. 1 and 2, the drop hammer shown comprises a massive double column frame, indicated generally by **11**, which slidably guides a vertically movable ram **12** which is generally constructed of a ferrous material. The construction and operation of such a hammer is well known, so it suffices for present purposes merely to note that a plurality of heavy hardwood boards **13** carry the ram **12** which, in turn, carries an upper die **14**. To complete a forging, a heated workpiece blank is placed on a lower die **15**, and the massive ram **12** and upper die **14** are then permitted to repeatedly drop from a height to deliver a series of working blows sufficient to forge the blank to the desired configuration.

Power means are provided to reciprocate the ram **12** and associated upper die **14**. For this purpose, a pair of motors **16** and **17** are connected, typically through belt and pulley arrangements **18** and **19**, respectively, to each rotate one of the rolls **21** and **22** in a direction to cause lifting of the upper die **14**. To permit the lifting rolls **21** and **22** to raise the upper die **14** to the top of its stroke and then release it to drop under the force of gravity, the roll **21** is mounted on an eccentric **23** which is connected to the piston **24** of an air cylinder **25**. Extension of the piston **24** rotates the eccentric **23** to bring the rolls **21** and **22** into frictional lifting engagement with the boards **13**, and subsequent retraction of the piston **24** rotates the eccentric **23** to cause the lifting rolls to release the boards **13** thereby enabling the upper die **14** to fall. To provide an adjustment for variations in board thickness due to

wear or the like, the lifting roll **22** is also mounted on an eccentric **26** which may be rotated by operation of a lever arm **27**.

In accordance with the present invention oiler means are provided. To this end, a pair of nozzles **31** and **32** are mounted on the frame **12** in a manner such that the upper die lubricating nozzle **31** is aimed toward a selected point in the upward movement of the upper die **14**, while the lower die lubricating nozzle **32** is directed toward the stationary lower die **15**. While a pair of nozzles have been shown, those skilled in the art will realize that it is frequently necessary to lubricate only the reciprocating upper die **14**.

(2) Control system

(a) Detector switches.—As part of the control circuit for actuation of the power means and oiler means, switch means are employed to detect the position of the upper die **14** relative to a predetermined lower level. To this end, in the illustrated embodiment, a pair of normally open magnetic proximity switches **33** and **34** are fixed to the frame **11** by a shock absorbing mounting belt **35** and are disposed for operation responsive to the movement of the ram **12**. While, for purposes of clarity, only upper and lower switches, **33** and **34**, respectively, have been shown, it will be understood that a sufficient number of intermediate switches should be provided so that the ram **12** is always in the field of at least one until the upper die **14** falls below the lower level predetermined by the level at which the switch **34** is mounted.

To protect the hammer, a normally closed magnetic proximity switch **36** is fixed to the mounting belt **35** at a level defining the upper limit to which the ram **12** may be safely raised.

(b) Timer.—Turning to FIG. 3, in order to supply a precisely timed control signal in response to the conditions of the switches **33** and **34**, the control circuit further includes a timer circuit **41**. Under normal operating conditions, where the mode selector **42** is in the "on" position to close the ganged contacts **44** and **45**, the parallel proximity switches **33** and **34** are connected across the secondary winding **46** of a supply transformer **47** in parallel with the bridge rectifier **48** of the timer circuit **41**.

As shown, to protect the transformer **47**, there is a pair of resistors **49** and **50**. When either of the switches **33** or **34** is closed, the resistors **49** and **50** act as a voltage divider, and the voltage applied across the input of the bridge rectifier **48** is reduced below the level necessary for effective energization of the timer circuit **41**, i.e., the level necessary to initiate the timing action thereof as hereinafter described. On the other hand, when both of the proximity switches are open, the voltage divider effect is eliminated, and the signal applied to the rectifier **48** increases to the level required to initiate the timing action.

To govern the moment at which the power means is actuated to begin raising the upper die **14**, the timer circuit **41** includes an off-time circuit **51** which is connected to the input of a delay circuit **52**. The off-time circuit **51** is formed by a variable resistance which is adjusted to set the delay between the time the lower level switch **34** opens and the time the output of the delay circuit **52** rises to the level necessary to energize the solenoid coil **53**, i.e., the time a "control signal" is initiated.

Referring to FIG. 2, energization of the coil **53** shifts a solenoid controlled three way valve **54** to couple the head end of the cylinder **25** to a high pressure supply **55** through a main supply line **56**, a branch line **57**, and head end supply line **58**. At the same time, a lower, constant pressure is maintained on the rod end of the cylinder **25** by a constant pressure system **59** which is coupled to the main supply line **56** through a branch line **61** and to the cylinder **25** through a rod end supply line **62**. Energization of the coil **53** thus actuates the cylinder **25** to extend the piston **24** to bring the lifting rolls **21** and **22** into engagement with the board **13**. In practice, resistance **51** should be adjusted so that lifting rolls **21** and **22** are engaged immediately after the delivery of each working blow. The constant pressure system **59** insures that there is sufficient pressure on the rod end of the cylinder **25** so that the piston **24** is promptly retracted as soon as the roll solenoid **53** is deenergized causing the valve **54** to shift to exhaust the pressure from the head end of the cylinder **25**.

Turning back to FIG. 3, the height to which the upper die **14** is raised is governed by the duration of the control signal, subject to the operation of the upper safety limit switch **36** should the control signal be so long that the upper die is raised to the level set by the switch **36**. To establish this duration, one of the on-time circuits **64–68** is coupled to the output of the delay circuit **52**. Each of these circuits is formed by a rheostat adjusted to govern the delay between the time the lower switch **34** (FIG. 1) is re-closed in response to the upward movement of the upper die **14** and the time the control signal is terminated to deenergize the roll solenoid **53**, i.e., the time that the output of the delay circuit **52** falls below the level necessary to maintain the solenoid **53** energized.

To enable the operator to select either programmed or non-programmed operation, a program selector **71** and a pair of ganged switches **72** and **73** are employed. To provide nonprogrammed operation such that the height of each working blow is constant, the program selector **71** is placed in the "manual" position thereby connecting the auxiliary on-time circuit **64** to the output of the delay circuit **52**. In this condition, the blow height is determined by the adjustment of the rheostat **64**. To provide programmed operation, the program selector **71** is placed in the "automatic" position to thereby couple the parallel combination of a rheostat **74** and a selected one of the on-time circuits **65–68** to the output of the delay circuit **52**. By establishing a maximum resistance presented to the output of the delay circuit **52**, the rheostat **74** governs the maximum height to which the upper die **14** may be raised during programmed operation, and by reducing the actual resistance presented to the output of the delay circuit, the on-time circuits **65–68** govern the actual height to which the upper die is raised within the limit set by the rheostat **74**. In order that the on-time circuits **65–68** are sequentially coupled across the master rheostat **74**, the on-time circuits **65–68** are connected to the stations **75–78**, respectively, of a stepping switch **79**, and these stations are successively coupled across the rheostat **74** by a stepped contactor and a pair of conducting plates **82** and **83**. Thus, by individually adjusting the rheostats **65–68**, a pattern of working blows, each having an independently selected height, may be provided. Of course, it will be understood that while only four on-time circuits for programmed operation have been shown, any number may be provided, each connected to a station of the stepping switch **79** as before described.

(c) Timer bypass.—Under normal operating conditions the motors **16** and **17** are in an energized state so that the rolls **21** and **22** continuously rotate as they move into and out of engagement with the boards **13**. However, it will be appreciated, that if the motors **16** and **17** are deenergized and the rolls **21** and **22** are brought into engagement with the boards **13**, there is considerable resistance to downward movement of the upper die. Accordingly, and in keeping with one feature of the present invention, to permit the upper die **14** to be inched upwardly when the roll motors **16** and **17** are energized and to be inched downwardly when the motors are deenergized so that the upper die may be precisely positioned for die setting and maintenance purposes, provision is made to selectively energize the coil **53** to bring the rolls **21** and **22** into engagement with the boards **13** independently of the operation of the switches **33** and **34** and of the timer circuit **41**. For this purpose, the mode selector switch **42** has an "off" position in which the contacts **44** and **45** are

opened and there is a normally open, manually operable bypass switch **45***a* for permitting the operator to selectively energize the coil **53** regardless of the position of the upper die and without incurring the delay normally provided by the timing elements of the timer circuit **41**. As can be seen, through operation of the bypass switch **45***a*, the rolls **21** and **22** can be brought into engagement with the boards **13** for any desired period and regardless of whether the roll motors are energized or deenergized.

(d) Alternative timer.—An alternative to the timing circuit **41** of FIG. 3 is the timing circuit **41***a* shown in block form in FIG. 6. The particular construction of the timing circuit **41***a*, which is available from Syracuse Electronics Corp. is timer model TR352A, is not known to applicants, but it has been successfully employed in practice and found to provide an adjustable on-time and off-time for the control signals in generally the same manner as previously discussed with reference to the timer circuit **41**. It should be noted that the terminals of the Syracuse timer **41***a* are lettered A–H as they appear from left to right looking face-on at the timer with the terminals at the top. Also, the circuit components shown in FIG. 6 correspond to the identically referenced components of FIG. 3, and the leads marked V–Z in FIG. 6 connected to the correspondingly identified leads shown in FIG. 3.

(e) Oiler control.—Referring again to FIG. 2, in carrying out the present invention, each of the oilers **31** and **32** are normally closed nozzles, preferably of the spray-type. To provide a fast response to actuation and to minimize sludge accumulation, each of the nozzles **31** and **32** is preferably provided with a continuously circulating oil supply. To this end, lubricating oil is supplied to the nozzles from a reservoir tank **87** through a pressure line **88** and respective branch lines **91** and **92**, and returned to the tank **87** through respective branch lines **93** and **94** and a drain line **95**. The nozzles **31** and **32** may each typically be held in a normally closed condition by a pneumatically operated needle valve. Such valves are well known and need not be shown in detail. Suffice to note that the needle valve may be carried by a piston which is biased to urge the needle forwardly to seal the nozzle exit orifice, and actuation of the nozzle is provided by the application of pneumatic pressure to the piston to retract the needle.

To provide controlled actuation of the nozzles **31** and **32** in the illustrated embodiment, solenoid controlled, three-way valves **101** and **102**, respectively, are employed. Valves **101** and **102** operate to maintain nozzle supply lines **103** and **104** normally connected to exhaust lines **105** and **106**, respectively. To actuate the nozzles **31** and **32**, solenoid coils **107** and **108**, respectively, are energized. Energization of the coil **107** causes the valve **101** to shift to connect the supply line **103** to the main pressure supply line **56** through a branch line **109**, while energization of the coil **108** causes the valve **102** to shift to connect the supply line **104** to the main pressure supply line **56** through a branch line **111**.

Referring back to FIG. 3, to automatically energize the solenoid coils **107** and **108** for timely lubrication of the dies **14** and **15** as required by the nature of the workpiece, control means are employed. To this end, the solenoid coils **107** and **108** are coupled in activator circuits **112** and **113**, respectively. Only activator circuit **112** is shown in detail since activator circuit **113** may be generally the same in construction and operation.

As will be more fully described hereinafter, a blow selector **114** is supplied to enable the hammer operator to preset the number of blows constituting a blow pattern. To permit the operator to preselect a particular blow within the pattern for actuation of the oiler **31**, the activator circuit **112** includes a second stepping switch **115** with a plurality of stations **116–120** and an oiler selector **121** with a mechanically linked contactor **122**. While only one oiler selector **121** and a single associated contactor **122** have been shown, it should be clear that additional contactors may be employed and that such additional contactors may be set either by the selector **121** or, preferably, an independent selector. By setting the selector **121** to a particular blow number, the stepping switch station corresponding to that number is connected across a solenoid coil **123** through the contactor **122**, a conductive plate **124**, a stub lead **125**, a RC arc quenching network **126**, and a delay circuit **127**. To energize the selected station as the upper die is raised for the preselected blow number, the stations **116–120** are successively connected across the secondary winding **46** of the supply transformer **47** through a conductive plate **128** by a stepped contactor **129**. The delay circuit **127** is employed to prevent actuation of the solenoid coil **107** until the upper die **14** has been raised to the point at which the nozzle **31** is aimed.

The solenoid coil **107** is energized in response to the energization of the coil **123**. To this end, while the coil **123** is deenergized, a capacitor **131** is connected across the secondary winding **132** of an auxiliary supply transformer **133** to charge through a diode **134** and a solenoid controlled switch **135** to the level set by a parallel regulating circuit **136**. When the contactor **129** is stepped to energize the station preselected by the placement of the contactor **122**, and after the delay provided by the delay circuit **127**, the coil **123** is energized to provide a discharge path for the capacitor **131** through a solenoid coil **137** and the switch **135**. Discharge of the capacitor **131** energizes the coil **137** to close a switch **138** which in turn energizes the upper die oiler solenoid **107**.

(f) Stepping mechanism.—To advance the contactors **81** and **129** one station for each working blow delivered, a control signal responsive stepping means is provided. To this end, the contactors **81** and **129** are mechanically linked to a solenoid controlled stepping mechanism **141** which is activated to advance one step each time a control solenoid **142** is energized. Inasmuch as stepping switches and their associated solenoid controlled stepping mechanisms are well known, a diagrammatic illustration suffices. However, it is noted that rotary stepping switches have been successfully employed in practicing the invention.

To energize the coil **142** in response to each control signal, a solenoid coil **143** is connected across the output of the timer circuit **41** in parallel with the series combination of the upper safety limit switch **36** and the roll solenoid coil **53**. Energization of the coil **143** in response to a control signal from the timer circuit pulls a switch **144** down to provide a discharge path for the capacitor **145** through the coil **142** and a rheostat **146**. A charge path for the capacitor **145** is provided from the secondary winding **46** of the main supply transformer **47** through a charge time constant setting rheostat **147** and a rectifying diode **148**.

For maintenance purposes or the like, means may be employed to provide an indication of the total number of blows delivered by the hammer over an extended period of time. For this reason, a counter **149** is connected across the secondary winding **46** through the switch **144** so that the counter is pulsed during the interval between each control signal.

(g) Reset mechanism.—To recycle the oiler activator circuits **112** and **113** and, if programmed operation has been selected, the timer circuit **41**, after the delivery of a predetermined number of blows, reset means are provided. To this end, a reset coil **151** is coupled to the stepping mechanism **141** in such a manner that energization of the coil **151** causes the stepping mechanism **141** to return to the first step (the lower tooth as diagrammatically illustrated). To energize the reset coil **151** after the delivery of the predetermined number of blows, the coil **151** is connected across the storage capacitor **145** through a resistor **152** and a stepping switch **153**. The stepping switch **153** has a plurality of stations **154–158**, a stepped contactor **159** to sequentially connect these stations to a conductive plate **161**, and a preset contactor **162** to connect one of these stations to a conductive plate **163**. Consequently, capacitor **145** discharges through the coil

151 to reset the stepping mechanism 141 when the contactor 159 is stepped to the station preselected by the setting of the contactor 162. To act as an arc quencher and to provide a short period of continued energization for the coil 151 sufficient to permit the stepping mechanism 141 to reset, a diode 164 is coupled in parallel with the coil 151.

To enable the operator to preset the number of working blows constituting a complete blow pattern, the blow selector 114 is ganged to the contactor 162. Adjustment of the blow selector 114 for a particular number of blows causes the contactor 162 to move to the reset stepping switch station to which the stepped contactor 159 is advanced in response to the energization of the stepping coil 142 upon the initiation of the control signal after the delivery of the last of the blows in the pattern. For programmed operation, to permit the selection of a number of the on-time circuits 65–68 corresponding to the number of blows in the pattern, the blow selector 114 is mechanically linked to the plate 82 so that a decoupling notch 171 formed in the plate is moved to the station to which the stepped contactor 81 is advanced upon the initiation of the control signal following the delivery of the last blow in the pattern. To provide an on-time circuit to control the duration of this control signal, which is the control signal for the first blow in the succeeding pattern, the blow selector 114 is also mechanically linked to connect a contactor 172 to the station to which the contactor 81 is advanced upon the initiation of this control signal. In this manner, the first on-time circuit 65 is coupled across the master rheostat 74 through the conductive plate 82, a conductive plate 173, the contactor 172, the contactor 81, and the conductive plate 83 and is thereby effective to govern the duration of this control signal.

Forging requires that the operator manipulate the workpiece in preparation for different blows in the pattern. Consequently, it is desirable that an indication of the blow number being performed at any given instant be provided. As a convenient way of doing this, in the illustrated embodiment, lamps 181–185 are connected to the stations 116–120, respectively, of the stepping switch 115. Due to the stepping of the contactor 129, the lamp 181 is lit upon reset of the stepping mechanism 141 while the lamps 182–185 are sequentially lit upon the completion of the successive blows in the pattern. Should the operator fail to manipulate the workpiece properly for the different blows, means are provided to enable him to manually reset the hammer to begin a new pattern. To this end, a push button 186, which may be depressed to complete a discharge circuit for the capacitor 145 through the reset coil 151, is supplied.

(*h*) Clamp mechanism.—For various reasons, the operator may wish to temporarily terminate the operation of the hammer. For this purpose and referring to FIG. 2, a clamping mechanism 201 is employed. The clamping mechanism 201 includes a pair of clamps 202 and 203 which may be actuated to halt hammer operation. Preferably, the clamps 202 and 203 act only to prevent downward movement of the upper die 14. For this reason, the clamps 202 and 203 are mounted (by means not shown) for rotation away from the boards 13 while the upper die 14 is being lifted and are provided with supporting stops 204 and 205, respectively, to prevent rotation free from the boards 13 as the upper die 14 is falling.

To actuate the clamping mechanism 201, the clamp 202 is mounted on an eccentric 206 which is connected to the piston 207 of a cylinder 208. Thus, as the piston 207 is extended, the eccentric 206 is rotated to force the clamp 202 forward until the boards 13 are firmly held between the clamps 202 and 203. To provide for adjustment of the clamping mechanism 201 in order to accommodate boards of different thickness, the clamp 203 is also mounted on an eccentric 209 and may be advanced or retracted as required by the rotation of the eccentric 209 through operation of a lever arm 211.

In the interest of safety, the clamping mechanism 201 is constructed so that circuit integrity and positive action on behalf of the operator is required to release the clamps 202 and 203. To this end, a four way valve 212, which is controlled by a solenoid 213, is connected so that, when the solenoid 213 is deenergized, the head end supply line 214 for the cylinder 208 is coupled to the main pressure supply line 56 through a branch line 215 while the rod end supply line 216 for the cylinder 208 is coupled to an exhaust line 217. Under these conditions, the piston 207 is extended to engage the clamps 202 and 203. Turning to FIG. 4, to release the clamps, the operator closes a switch 221 to connect the clamp solenoid coil 213 across the secondary circuit 222 of an auxiliary supply transformer 223. As a matter of convenience, switch 221 may be a treadle switch located at the base of the hammer in the operator's station (FIG. 1). Referring back to FIG. 2, energization of the solenoid coil 213 shifts the valve 212 so that the rod end supply line 216 is connected to the main pressure line 56 through the branch line 215 while the head end supply line 214 is connected to the exhaust line 217. Under these conditions, the piston 207 is retracted to disengage the clamps 202 and 203.

(i) Modifications for use with air hammer.—The previously described automatic die oiler and hammer control circuit can also be used with a pneumatically operated drop hammer, commonly referred to as an air hammer. The major differences between a board drop hammer and an air hammer are in the power means for raising the upper die. Referring to FIG. 5, the power means 231 for an air hammer include a cylinder 232 and associated piston 233 which carries the ram 12 and upper die 14 in the same manner as the boards 13 (FIG. 1). The upper die 14 is raised and dropped in response to the increase and decrease, respectively, of pressure at the rod end of the cylinder 232. To this end, in the illustrated embodiment, the rod end supply line 234 is coupled to a plunger-type valve 235. The valve 235 is connected to a pressure line 236 at one end and has a plurality of exhaust ports 237 at the other end. Selective coupling of the pressure line 236 and exhaust ports 237 to the rod end supply line 234 for the cylinder 232 is afforded by a plunger 238.

The position of the plunger 238 is controlled so that the pressure at the rod end of the cylinder 232 is increased until the upper die 14 reaches the predetermined height for the working blow and is then rapidly decreased whereupon the die 14 falls to deliver the working blow. For this reason, the plunger 238 is carried by the piston 241 of a cylinder 242. The rod end and head end supply lines, 243, 244, respectively, for the cylinder 242 are selectively coupled ot the pressure line 236 and the exhaust line 245 by a four way valve 246 which is controlled by a solenoid 247. Specifically, when the solenoid 247 is energized, the valve 246 operates to connect the rod end supply line 243 to the exhaust line 245 and the head end supply line 244 to the pressure line 236. Under these conditions, the plunger 238 is positioned to cause the piston 233 to lift the upper die. On the other hand, when the solenoid 247 is deenergized, the valve 246 connects the rod end supply line 243 and the head end supply line 244 to the pressure line 236 and the exhaust line 245, respectively, and the plunger 238 is positioned to permit the upper die 14 to fall. For energization in response to the control signal, the solenoid 247 may be coupled across the output of the timer circuit 41 in the same manner as shown for the solenoid 53 in FIG. 3.

To control the rate at which the upper die 14 is raised under normal operating conditions and to permit the upupper die to be selectively positioned independently of the operation of the switches 33 and 34 and of the timer 41, connected between the valve 235 and the main supply line 236 there may advantageously be a throttle valve

251. Under normal operating conditions, the throttle valve 251 is adjusted to provide a predetermined flow rate so that the upper die raises a certain distance for each increment of time that a control signal exists.

However, during die setting and maintenance-type operation, when the mode selector 42 (FIG. 3) is in the "off" position, the throttle valve 251 is used essentially as a gate valve. That is, to enable the operator to inch the die 14 upwardly, the valve 251 remains open so that when the operator closes the bypass switch 45*a*, the die raises. Then, as the die approaches the desired height, the throttle valve 251 is gradually closed. Finally, when the die reaches the desired height, the valve 251 is fully closed and the clamps 202 and 203 are engaged. On the other hand, to permit the die to be inched downwardly, the throttle valve 251 is closed. Then, while maintaining the bypass switch 45*a* closed, the operator can bring the die down gradually by slowly exhausting the head end of the cylinder 232 by opening a manually operable, normally closed bleed-off valve 252. Of course, in practice the inching process is usually not a smooth operation, but one requiring vertical jogging of the upper die until it is positioned as desired.

SUMMARY

It should now be clear that the present invention provides a novel automatic die lubricator suitable for use under a variety of conditions. For example, the die lubricator may be used either without the timing circuit 41, with the timing circuit 41 set for nonprogrammed operation, or with the timing circuit 41 set for programmed operation. Moreover, the control system of the present invention can be very advantageously employed, with or without automatic die lubrication, to provide either upward or downward movement of the upper die so that it can be precisely positioned for die setting or maintenance purposes.

It should be understood that various modifications can readily be made. For example, the solenoid coil 107 could be connected directly across the selected station of the stepping switch 115 if sufficient power was applied to the switch to energize the coil. In many instances, where solenoid switches have been shown, other devices, such as electronic switches, could be employed. The mentioning of these various modifications are not intended to be limiting, but merely illustrative of the true scope of the present invention. Other possible modifications will be readily apparent to one skilled in the art.

As a matter of definition, as used herein, reference to the initiation or termination of a signal upon the occurrence of an event, such as initiation of the control signal after delivery of a working blow or termination of the control signal upon the upper die reaching a particular height, means that the effect of the control signal is initiated or terminated, as the case may be, upon the occurrence of the event.

We claim as our invention:

1. An automatic die lubricator for a drop-type hammer having a stationary lower die, a vertically movable upper die adapted to be dropped for delivery of a working blow, and power means for raising said upper die, said die lubricator comprising the combination of a control circuit responsive to the movement of said upper die to provide an electrical control signal after the delivery of each working blow, oiler means disposed for lubricating at least one of said dies, and control means coupled to said control circuit and responsive to at least one of said control signals to actuate said oiler means.

2. The automatic die lubricator of claim 1 wherein said control means responds to said control signal after each delivery of a predetermined number of blows to thereby provide timely lubrication for said die.

3. The automatic die lubricator of claim 2 wherein said oiler means includes a nozzle, and an oil supply coupled to and continuously circulating through said nozzle whereby said oiler means rapidly responds to actuation and sludge accumulation is minimized.

4. The automatic die lubricator of claim 1 wherein said control means includes a stepping switch having a plurality of stations, and an oiler selector connected to energize at least a selected one of said stations, and further including stepping means coupled to said control circuit and connected to advance said stepping switch one station responsive to each of said control signals whereby said oiler means is actuated upon advancement of said switch to said selected station.

5. The automatic die lubricator of claim 4 further including reset means coupled to said stepping switch and responsive to said control signal after the delivery of a preselected number of blows to reset said stepping switch to the first of said stations, and a blow selector coupled to said reset means to preselect said number of blows.

6. The automatic die oiler of claim 1 wherein said oiler means includes a first nozzle disposed for lubricating said upper die and a second nozzle disposed for lubricating said lower die, and wherein said control means includes an activator circuit for actuating each of said nozzles, and each of said activator circuits includes an oiler selector to preselect the control signals to which said activator circuit responds.

7. The automatic die oiler of claim 6 wherein said first nozzle is disposed for lubricating said upper die as it passes a particular point in its upward movement, and said activator circuit for said first nozzle includes delay means to prevent actuation of said first nozzle until said upper die reaches said point.

8. A control system for a drop-type hammer having a stationary lower die, a vertically movable upper die adapted to be dropped for delivery of a working blow, and power means for raising said upper die, said control system comprising the combination of switch means disposed for operation by the movement of said upper die such that said switch means is in a first condition when said upper die is below a preselected level and a second condition when said upper die is above said level, timer means coupled to said switch means and responsive to the conditions thereof to provide an electrical control signal after the delivery of each working blow, actuator means coupled to said timer means and responsive to each of said control signals to actuate said power means, oiler means disposed to lubricate at least one of said dies, and control means responsive to at least one of said control signals to actuate said oiler means.

9. A control system according to claim 8 wherein said timer means includes an off-time circuit responsive to the first condition of said switch means to control the instant of initiation of said control signal thereby governing the moment said power means is actuated, an on-time circuit responsive to the second condition of said switch means to control the moment at which said control signal is terminated thereby governing the height to which said upper die is raised, and wherein said conrol means includes delay means whereby said oiler means is actuated at the instant said upper die is at a predetermined height.

10. A control system according to claim 9 wherein said control means is responsive to said control signal only after each delivery of a predetermined number of working blows to thereby provide timely lubrication for said die, and further including means for continuously circulating oil through said oiler means to thereby provide a fast response and minimize sludge accumulation.

11. A control system according to claim 8 wherein said control means includes a stepping switch having a plurality of stations, and an oiler selector connected to said switch to energize at least one of said stations, and further including stepping means connected to said switch and responsive to each of said control signals for advancing said switch one station whereby said oiler means

is actuated upon advancement of said switch to said energized station, and reset means responsive to said control signal upon the advancement of said switch to the last of said stations for resetting said switch to the first of said stations whereby the actuation of said oiler means recycles.

12. A control system for programming a drop-type hammer to deliver a preselected pattern of working blows, said hammer having a stationary lower die, a vertically movable upper die adapted to be dropped for delivery of a working blow, and power means for raising said upper die, said control system comprising the combination of switch means disposed for operation by the movement of said upper die such that said switch means is in a first condition when said upper die is below a preselected level and a second condition when said upper die is above said level, circuit means energizable to actuate said power means, timer means coupled between said switch means and said circuit means and responsive to the conditions of said switch means to provide said circuit means with a respective energizing signal having an independently preselected duration for each blow in said pattern to thereby govern the height to which said upper die is raised for each of said blows, oiler means disposed for lubricating at least one of said dies, and control means responsive to at least one of said energizing signals to actuate said oiler means.

13. The control system of claim **12** wherein said control means includes an oiler selector to preset said control means to actuate said oiler means in response to the energizing signal for a particular blow in said pattern.

14. The control system of claim **13** wherein said timer means includes an off-time circuit responsive to the first condition of said switch means to initiate an energizing signal at a predetermined moment after delivery of each working blow thereby governing the instant that said power means is actuated to raise said die for a succeeding blow, a plurality of on-time circuits each selectable to respond to the second condition of said switch means to terminate said energizing signal after a preselected time to thereby control the height to which said upper die is raised for said succeeding blow, and a first stepping switch having a plurality of stations each connected to one of said on-time circuits, and further including stepping means connected to said first switch and responsive to each of said energizing signals to advance said first switch one station to thereby sequentially select said on-time circuits whereby said preselected blow pattern is obtained.

15. The control system of claim **14** wherein said control means further includes a second stepping switch having a plurality of stations at least a selected one of which is energized by said oiler selector, and said stepping means is connected to advance said second switch one station in response to each of said energizing signals whereby said oiler means is actuated upon advancement of said second switch to said selected station, said control system further including reset means coupled to said switches and responsive to the energizing signal for the blow succeeding the last blow in said pattern to reset said switches, and a blow selector coupled to said reset means to preset the number of blows in said pattern.

16. The control system of claim **15** wherein said oiler means includes a nozzle disposed for lubricating said upper die as it passes a particular point in its upward movement, and said activator means further includes delay means connected to said second switch to prevent actuation of said nozzle until said upper die reaches said point.

17. A control system for a drop-type hammer having a stationary lower die, a vertically movable upper die adapted to be dropped for delivery of a working blow, and power means actuatable in a first state for raising said upper die and in a second state for resisting the downward movement thereof, said control system comprising the combination of switch means disposed for operation by the movement of said upper die such that said switch means is in a first condition when the upper die is below a preselected level and a second condition when said upper die is above said level, timer means coupled to said switch means and responsive to the conditions thereof to provide an electrical control signal after the delivery of each working blow, actuator means coupled to said timer means and responsive to each of said control signals to actuate said power means, and bypass means coupled to said actuator means for selectively actuating said power means independently of said switch means and said timer means whereby said upper die may be inched upwardly when said power means is in said first state and inched downwardly when said power means is in said second state.

18. The control system of claim **17** further including oiler means disposed for lubricating at least one of said dies and control means coupled to said timer means and responsive to at least one of said control signals for actuating said oiler means.

References Cited

UNITED STATES PATENTS

1,990,478	2/1935	Fitzgerald	72—23
2,861,486	11/1958	Brauer	72—435
3,187,548	6/1965	Murek	72—435

FOREIGN PATENTS

339	1/1907	Great Britain	72—43
749,010	5/1956	Great Britain	72—45

RICHARD T. HERBST, Primary Examiner

E. M. COMBS, Assistant Examiner

U.S. Cl. X.R.

72—43, 45