Sept. 21, 1948. E. CANNON 2,449,639

HYDRAULIC PRESS SYSTEM WITH CONTROL MEANS YIELDING HIGH-SPEED OPERATION THEREOF

Filed Jan. 13, 1943 3 Sheets-Sheet 1

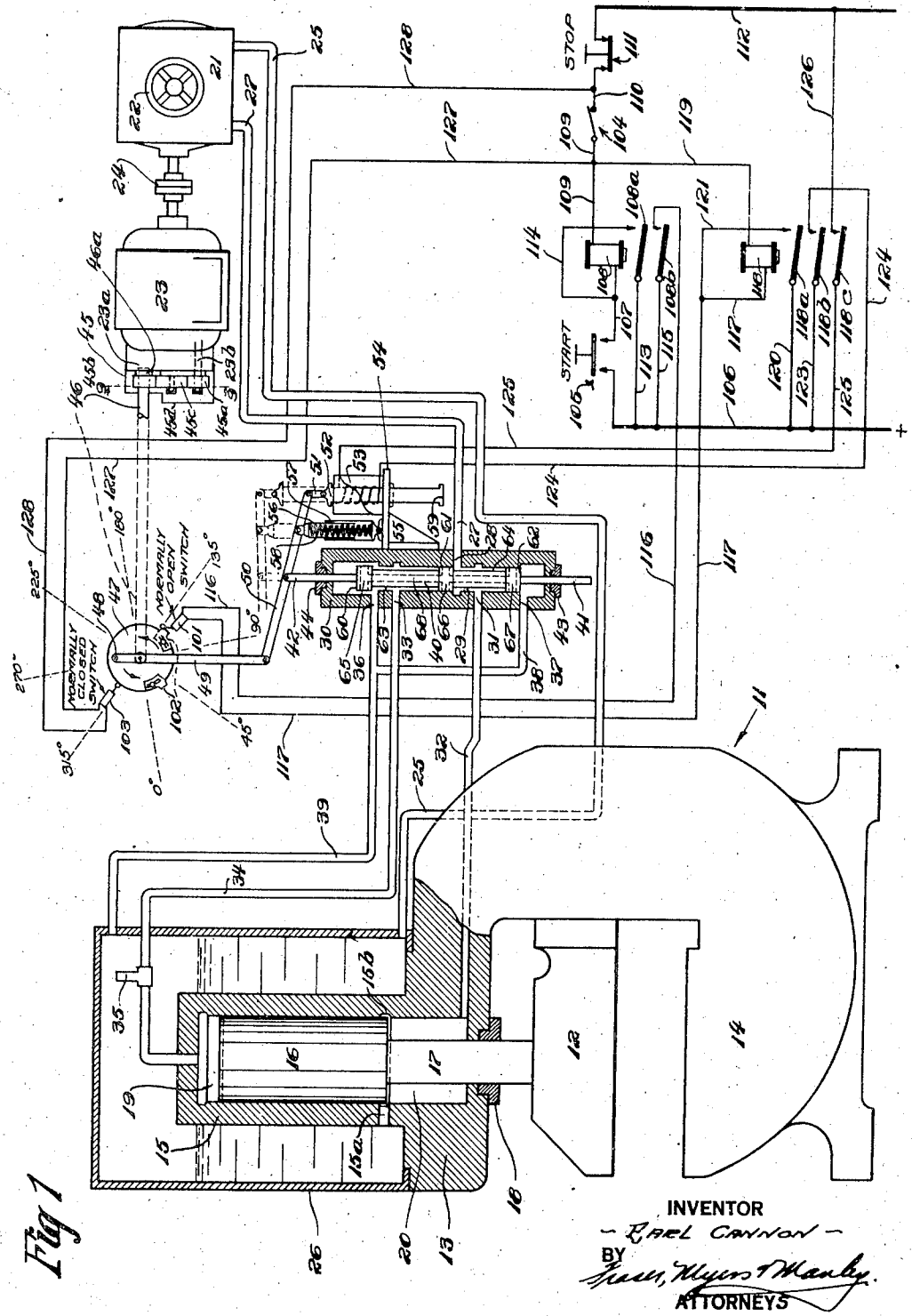


Fig 1

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HYDRAULIC PRESS SYSTEM WITH CONTROL MEANS YIELDING HIGH-SPEED OPERATION THEREOF

Filed Jan. 13, 1943 3 Sheets-Sheet 2

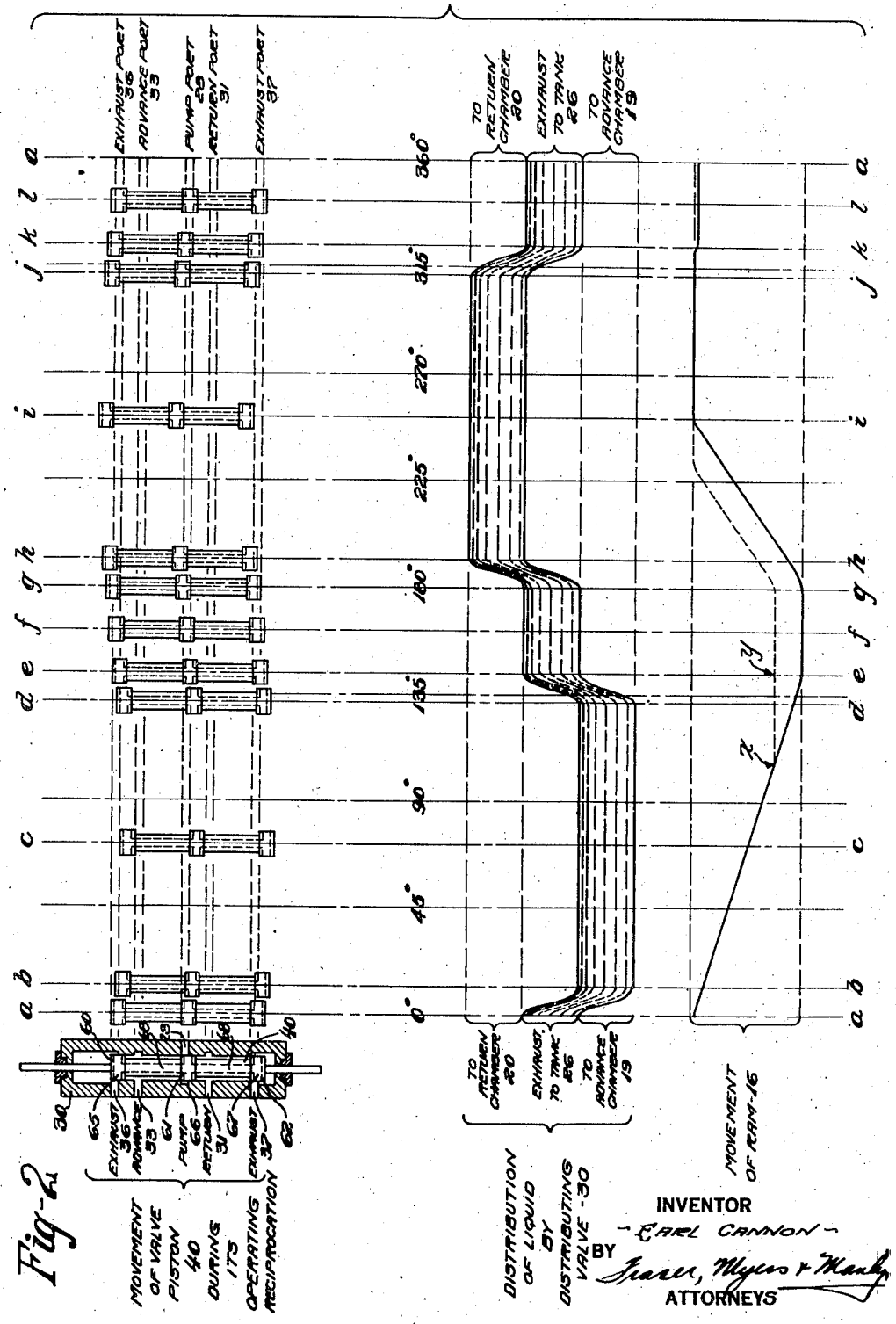


Fig. 2

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HYDRAULIC PRESS SYSTEM WITH CONTROL MEANS YIELDING HIGH-SPEED OPERATION THEREOF

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Fig-3

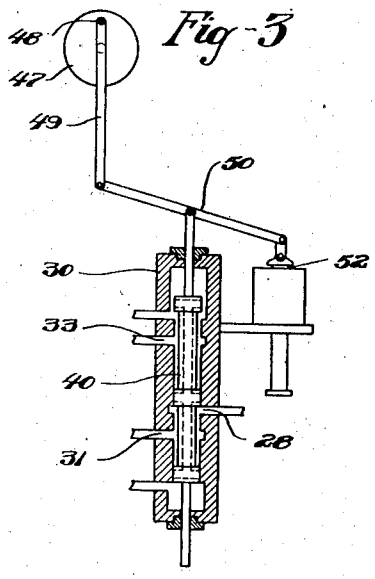


Fig-4

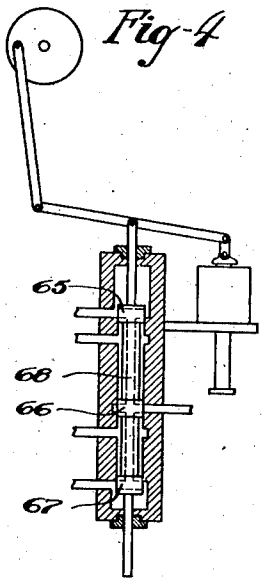


Fig-5

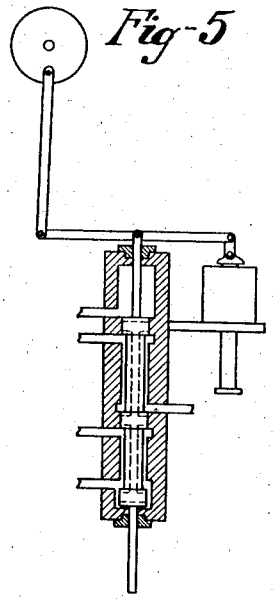


Fig-6

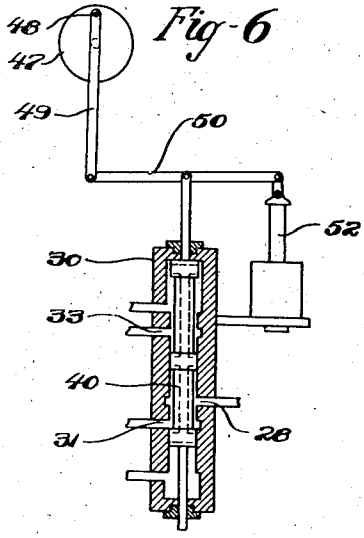


Fig-7

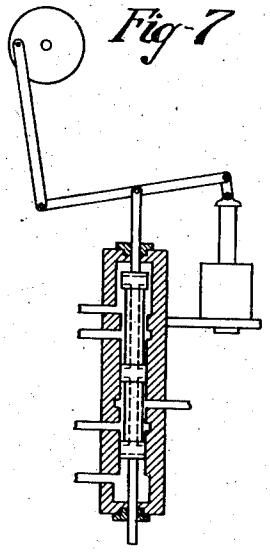


Fig 8

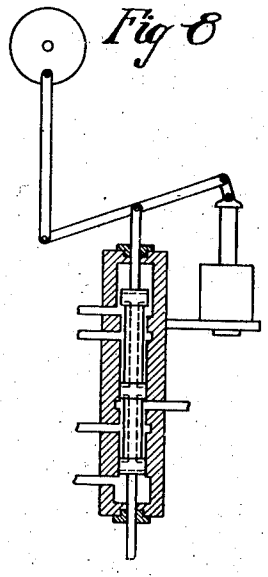


Fig-9

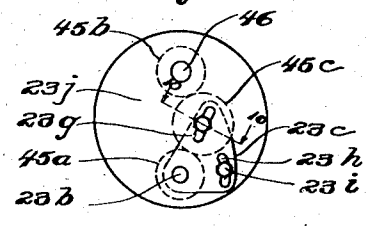
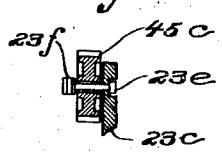


Fig 10



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HYDRAULIC PRESS SYSTEM WITH CONTROL MEANS YIELDING HIGH-SPEED OPERATION THEREOF

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Application January 13, 1943, Serial No. 472,184

6 Claims. (Cl. 60—52)

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This invention relates to improvements in hydraulic press systems and more particularly relates to systems including hydraulic presses which, if desired, may be operated satisfactorily at speeds favorably comparable to the attainable speeds of mechanical presses of corresponding sizes. Such hydraulic presses are referred to herein as high speed presses.

One of the difficulties heretofore encountered in providing high speed hydraulic presses has arisen from the fact that the reversal of the stroke of the press in both directions has ordinarily been accomplished by the use of a distributing valve operating mechanism actuated either by a cam, cooperating with a lever or switch arrangement, or by a pressure reversing arrangement, either of which functioned only upon the press ram substantially reaching the end of each stroke. This dependency of the reversing means upon the press ram reaching the end of its stroke, together with the unavoidable time factor involved in the operation of the said reversing means and in the resulting operation of the said distributing valve, caused a material lag in the reversal of the press stroke and a consequent limitation upon the operating speed of prior press systems. Even in well-designed electrically controlled installations, the mentioned lag entailed a time loss which so reduced the attainable speed of prior hydraulic presses as to render the latter unacceptable for many high speed jobs for which mechanical presses could be employed.

The principal objects and broader aspects of the invention

An important object of the present invention is the provision of an improved high-speed hydraulic press system, whereby to make the well-known unique advantages of hydraulic presses available on work requiring high-speed press operation.

Another important object of this invention is the provision of means assuring that, when the press is started, its first stroke will be a complete rather than a partial stroke.

Another important object is the provision of means whereby, when the press is stopped, the ram thereof is always brought to rest at its uppermost or open position.

Still another object is the provision of means for conveniently adapting the system either to operation wherein the reciprocation of the press ram continues uninterruptedly until stopped by the operator (hereinafter referred to as "continuous" operation), or to operation wherein the ram pursues only a single advance stroke followed by a single return stroke (hereinafter referred to as "cyclic" operation).

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The foregoing and other objects, which will be apparent from a consideration of the following specification and the accompanying drawings, are accomplished, according to the present invention, by providing a liquid distributing valve which is continuously operated by a motor which functions independently of the ram of the press, and by providing other features hereinafter described.

According to a preferred form of the invention, the said distributing valve is in the form of a reciprocating slide valve in which a piston is reciprocated continuously through a lever having a fulcrum variable between one point which is so located that reciprocation of the said piston functions to distribute liquid to various hydraulic chambers in the press in the proper sequence to cause the press to operate (hereinafter referred to as "operating reciprocation"), and another fulcrum point which is so located that, although the said lever may continue to move, and in consequence the said piston may continue to reciprocate, the liquid distributing valve, instead of directing liquid to several chambers in sequence to cause the press to operate, functions to direct liquid only into one press chamber, causing the press to be opened and held open (hereinafter referred to as "idling reciprocation").

The invention also includes means whereby the distributing valve is so operated that the first, as well as succeeding press strokes, are complete strokes, and also means whereby either continuous or cyclic operation may be derived in the operation of the press.

The illustrated embodiment of the invention

For the purpose of illustrating the present invention and its manner of operation and without any consequent limitation of the scope of the invention, a preferred embodiment thereof is illustrated in the accompanying drawings, in which:

Figure 1 is a diagram of a preferred embodiment of the invention;

Fig. 2 is a graph illustrating the movement of a distributing valve piston throughout a cycle of operation; also the effect of such movement in controlling the distribution of liquid to the several hydraulic chambers of the press and a

liquid supply tank, and the consequent effect upon the operation of the ram of the press;

Figs. 3, 4 and 5 are diagrams of a distributing valve, shown in Fig. 1, and certain parts of its operating gear, illustrating the range of operating reciprocation of a valve element in said valve;

Figs. 6, 7 and 8 are diagrams of the same general character as Figs. 3, 4 and 5, illustrating, however, the range of idling reciprocation of the mentioned valve element;

Fig. 9 is a cross-sectional view of changeable reduction gearing, the section being on the line 9—9 of Fig. 1; and

Fig. 10 is a cross-sectional view of an idler gear and its mounting, the section being on the line 10—10 of Fig. 9.

Referring to Fig. 1 and observing that in said figure no attempt has been made to indicate the proportions of the various component parts of the system relatively to one another, a hydraulic press 11 of a type ordinarily used for relatively light work, comprises a slide 12 suitably guided for reciprocation within jaws constituting a crown 13 and a bed 14. Upon or within the crown 13 is a cylinder 15, and within a vertical bore therein a ram 16 is accurately fitted for reciprocation. The ram 16, preferably is formed integrally with an extension 17, of reduced diameter, which extends downwardly through a portion of the crown 13 and through a suitable packing assembly 18 to the exterior of said crown. The slide 12 is fixed upon the lower end of the extension 17, and, hence, the said slide reciprocates with the ram 16.

The area above the ram 16 within the bore of the cylinder 15 constitutes a hydraulic chamber 19, the pressure in which coacts with the ram to force the latter downwardly on what may be termed its advance stroke and said chamber 19 is hereinafter referred to as the "advance chamber." The area below the ram 16 and extending around the extension 17 within the mentioned bore of the cylinder 15 constitutes a hydraulic chamber 20, the pressure in which coacts with the ram to force the latter upwardly on what may be termed its return stroke, and said chamber 20 is hereinafter referred to as the "return chamber."

A port 15*a* is provided in the cylinder 15 at a point substantially coincident with the lower end of the ram 16 when the latter is at the top of its stroke. An annular groove 15*b* may be provided within the cylinder 15 coinciding with the mentioned port. It should be observed that the length of the ram in relation to its stroke is such that the port 15*a* is uncovered only when the ram is substantially in its uppermost position.

The liquid circulating system comprises a pump 21, preferably having means which may include an adjusting wheel 22 for varying the rate of delivery of liquid by the pump to the press. The pump may be driven by a motor 23 to the shaft of which the pumping mechanism of the pump is suitably connected by a coupling 24. In operation the pump 21 continuously draws liquid through a pipe 25 from a tank 26 which conveniently may be located upon the crown 13 of the press and may extend completely about the cylinder 15.

The pump 21 discharges liquid through a pipe 27 and a port 28 into a longitudinal bore 29, at an intermediate point thereof, within a distributing valve 30. The said bore is connected at other intermediate points through a port 31 and a pipe 32 to the return chamber 20 and through a port 33 and a pipe 34 to the advance chamber 19, the last-mentioned pipe being provided with a relief valve 35 which is preferably located within the tank 26. At points near the end of the bore 29 the latter is connected through ports 36 and 37 and pipes 38 and 39 to the tank 26, the latter pipe preferably being connected to said tank at an upper part thereof. For convenience in understanding the operation of the valve 30, the several mentioned ports thereof will be referred to hereinafter as follows: the port 28 as the "pump port," the port 31 as the "return port," the port 33 as the "advance port," and the ports 36 and 37 as the "exhaust ports."

The course of movement of liquid through the valve 30 is controlled by a piston 40 which is accurately fitted to slide within the bore 29 and is preferably provided with a lower extension 41 and an upper extension 42 which extend through suitable packing assemblies 43, 44 to the exterior of the valve.

The piston 40 may be moved continuously in a reciprocating movement by a suitable motor provided solely for that purpose, or, as shown in Fig. 1, by the motor 23, which drives the pump 21. The shaft of said motor, through easily changeable reduction gearing 45, drives a shaft 46 to which is keyed, or otherwise constrained to turn therewith, a crank wheel 47, and the crank pin 48 of said wheel is pivotally linked by a pitman 49 to one end of a rocking lever 50 which is pivotally connected at an intermediate point thereof to one of the piston extensions, the said connection being to the upper extension 42 in the illustrated embodiment. The other end of the rocking lever 50 serves as a fulcrum whicl is rendered variable by pivotally connecting the latter end of the said lever through a link 51 to an end of the core 52 of a solenoid 53 mounted upon a platform 54 of a bracket 55 which may be fixed upon the casing of the valve 30.

A form of the mentioned changeable reduction gearing is illustrated in Figs. 1, 9 and 10. In this structure the rotation of the rotor of the motor 23 is transmitted, through suitable transmission gears (not shown) in the transmission gear box 23*a* to a shaft 23*b*, which for present purposes may be considered as a drive shaft. The changeable reduction gearing 45, by means of which the rotation of the drive shaft 23*b* is transmitted to shaft 46, comprises a changeable gear 45*a* keyed to the drive shaft 23*b*, a gear 45*b* keyed to the shaft 46, the end of which is carried in a suitable bearing 46*a*, and a changeable idler gear 45*c* the position of which is variable with respect to both gears 45*a* and 45*b*.

The gear 45*a* may be retained upon the shaft 23*b* by a suitable nut and lock-nut arrangement so that a larger or smaller gear 45*a* may easily be substituted as desired. The idler gear 45*c*, or a substituted idler gear, may easily be re-positioned to properly coact with the gear 45*b* and a substituted gear 45*a*, because of the idler gear being mounted upon a substantially triangular plate 23*c* which is adapted to pivot about the drive shaft 23*b*. The said idler gear 45*c*, as best seen in Fig. 10, may turn freely upon a bushing 23*d*, somewhat longer than the width of the hub of said gear, the bushing being secured upon the said plate by a headed bolt 23*e* and locking nuts 23*f*. The said bolt is disposed within a slot 23*g* in said plate and the said bushing and bolt assembly may easily be loosened and moved along the slot 23*g* to permit adjustment of the position of the idler gear relatively to the gear 45*a*. The described mount-

ing of the idler gear also permits easy substitution of a larger or smaller idler gear, as desired.

The plate 23c is provided, also, with a slot 23h through which a machine bolt 23i extends and threads into wall 23j of the transmission gear box 23a. This arrangement permits adjustment of the position of the idler gear 45c relatively to the gear 45b and also permits the plate 23c to be locked firmly in place. The mentioned reduction gearing is provided with a suitable easily removable cover 45d.

In the drawing, the parts of the solenoid 53 are shown in solid lines in the relative positions they assume when the latter is energized. When the solenoid is deenergized, the fulcrum end of the lever 50 and the core 52 are pushed upwardly, as indicated in broken lines, by a compression spring 56 which may be enclosed within telescoping tubular members 57, 58. These tubular members may be pivotally connected to the platform 54 and to a point on the lever 50 between the latter's fulcrum end and the point on said lever where the piston extension 42 is connected. The upward movement of said core and of the fulcrum end of the lever is limited by any suitable means, which, in the drawing, are indicated as comprising an enlarged lower end 59 of the core 52 which may be engaged and be arrested in its upward movement by the under side of the platform 54.

The piston 40 is provided with piston heads 60, 61 and 62 and between said heads with neck portions 63 and 64. The said piston heads have lateral passages 65, 66 and 67, extending completely through said heads and a longitudinal passage 68 extends interiorly of the piston 40 and affords communication between the several mentioned lateral passages. The mentioned passages are adapted, at parts of the stroke of the piston, to pass pumped liquid from the pump port 28 to either or both of exhaust ports 36, 37. The said piston heads and neck portions are preferably of the size and disposition relatively to the several ports and other parts of the valve 30, substantially as indicated in the drawing, the said proportions being such as to yield the operation hereinafter described. It will be understood, of course, that, as a matter of design, changes may be made in the disposition of the mentioned ports, and corresponding changes may be made in the disposition of the piston heads, but the design indicated in the drawing is well suited to the purposes of the present invention.

Continuous operation of the press system

In order to understand the operation of the press system, it will be helpful at first to assume that, when the solenoid 53 is in a de-energized state and the fulcrum end of the lever 50 is in raised position, as indicated in broken lines in the drawing, the operation of the motor 23, although causing the piston 40 to reciprocate, nevertheless will not operate the press except to hold the ram 16 and the slide 12 in their uppermost positions, in which it may be said that the press is "open." Therefore, in considering the operation of the press system, we may first assume that the solenoid 53 is in its mentioned deenergized condition. The motor 23 is then set in operation by the closing of a suitable switch (not shown in the drawing), whereupon idling reciprocation of the piston 40 will commence. Thereupon, in order to operate the press, an electric circuit through the solenoid 53 may be closed

by any suitable means, thereby energizing said solenoid and moving the core 52 of the latter and the fulcrum end of the lever 50 to the positions thereof indicated in full lines in Fig. 1 (hereinafter referred to as their "operating positions").

It may be assumed for present purposes that the energizing of said solenoid takes place at the moment when the crank pin 48 of the crank wheel 47, in its counterclockwise movement indicated by arrows in the drawing, reaches the point in its travel indicated as 0°. By referring to the graph, Fig. 2, it is convenient to observe the movement of the valve piston 40, the distribution of liquid by the distributing valve 30, and also the movement of the ram 16 throughout a complete cycle corresponding to the turning of the crank wheel 47 through 360°.

In the graph, Fig. 2, certain successive positions of the piston 40 of the valve 30, during its operating reciprocation, are indicated at vertical coordinates *a*—*l* in substantial relation to various points in the movement of the crank wheel 47 throughout its cycle indicated by vertical coordinates with suitable degree markings. Broken horizontal lines in said graph indicate the positions of the several ports of the valve 30, the range of movement of the ram 16, and also the parts of the press to which liquid is pumped. In said graph the liquid being pumped is represented by a relatively broad band.

At the beginning of the cycle, as shown by the graph, the piston 40 is moving downwardly and is at position *a*; the entire volume of pumped liquid is passing from the pump port 28 of the valve, through the passages 66, 68, 65 and 67 to the exhaust ports of said valve, and thence to the tank 26; and the ram 16 is slightly below the top of its stroke.

As the piston passes position *a*, head 61 uncovers pump port 28, thus permitting pumped liquid to pass therefrom to advance port 33 and thence to the advance chamber 19 and head 62 uncovers exhaust port 37 permitting liquid from return chamber 20 to pass from return port 31 to the said exhaust port 37 and thence to the tank, thus causing the ram 16 to start moving downwardly.

Upon piston 40 reaching *b* position, passage 66 is closed off from pump port 28, whereupon the entire volume of pumped liquid passes into the advance chamber, and the ram then pursues a regular or uniform descent which may continue until the piston 40 reaches position *d* in its upward stroke when the passage 66 commences to reopen into communication with the pump port 28 to carry a portion of the pumped liquid to the tank 26 while a portion of the liquid still passes to the advance chamber 19. Thus, during the movement of the piston from position *d* to position *e*, the ram is decelerating somewhat until at position *e* the pump port 28 is completely closed off from the advance and return ports.

This completes isolation of the pump port from the advance and return ports continues while the piston 40 passes from position *e* to position *g* during which period the ram 16 remains stationary or dwells at the bottom of its stroke. When the piston reaches position *g*, the head 61 commences to uncover the pump port 28 to open up communication between said port and the return port 31 while head 60 commences to open up communication between exhaust port 36 and

advance port 33, thus starting an accelerating upward movement of the ram 16 which continues until the passage 66 is closed off at position *h* of the piston whereafter the entire volume of pumped liquid passes into the return chamber 20, causing the ram 16 to rise at a substantially uniform speed.

Assuming that the ratio of the effective pressure receiving areas at the top and bottom of the ram 16 is as two is to one, the mentioned upward movement of the ram is twice as rapid as the downward movement thereof. Hence, the ram reaches its uppermost position approximately at the time the crank wheel 47 completes 250° of its cycle. From this point in said cycle until about the time the wheel 47 reaches 315° in its cycle, liquid continues to be pumped into the return chamber 20 and the excess liquid passes therefrom through port 15*a* in the cylinder 15, into the tank 26. The pressure incident to the pumping of such excess liquid into said chamber serves to hold up the ram and thus open said port 15*a* sufficiently to enable the latter to pass such excess liquid into the tank.

At about the time the crank wheel 47 completes 315° of its cycle, the piston head 61, during the movement of the piston 40 from position *j* to position *k*, covers pump port 28 and closes off the latter from communication with the return port 31, thus ending the pumping of liquid to return chamber 20. Upon termination of the pumping of liquid to the return chamber, at position *k* of the piston 40, the ram 16 descends slightly until it completely closes port 15*a* after which the liquid trapped in return chamber 20 holds the ram slightly below its uppermost position until the cycle is completed and the various moving parts of the press system are in position to commence the next cycle.

The broken line indication of ram movement in the graph, shows a possible limitation of the downward movement of the ram, caused, for example, by a substantially thick blank or mass being pressed. If the output of the pump 21 and the speed of the crank wheel 47 and other factors governing the stroke of the ram were such as to yield the full stroke indicated in solid lines in the graph, and such a thick blank or mass were being pressed, the relief valve 35 would blow off during the period from *x* to *y* indicated on the ram travel line in the graph.

In practice the said blow off preferably is kept at a minimum by so correlating the factors controlling the limits of the press stroke that when the piston 40 reaches its position *e* the volume of liquid pumped into advance chamber 19 is only slightly more than enough to yield the desired length of the advance stroke of the ram 16. The adjustment in this respect may be accomplished by adjusting the pump 21 whereby to reduce the output thereof, or by changing the gears in the reduction gearing 45 to increase the speed of the crank wheel 47 relatively to the motor 23. It will be understood also that the speed of the press may be varied simply by varying the speed of the motor 23.

Stopping the press in open position

The operation of the press, as thus far described, deals with the manner of movement of the parts of the press and of the liquid-distributing valve and the associated valve operating mechanism when the solenoid 53 is in an energized state. Such operation is continuous and automatic. When the operation of the press is to be stopped, it is, of course, desirable for the press slide 12 to come to rest in its uppermost or open position. To accomplish this, the electric circuit theretofore maintained in the solenoid 53 is opened, thereby de-energizing the said solenoid and permitting the solenoid core 52 and the fulcrum end of the lever 50 to be moved to their uppermost or "idling" positions, as indicated in broken lines in Fig. 1, in response to the compression of the spring 56. By thus raising the fulcrum point of the lever 50, the range of reciprocation of the valve piston 40 is raised so that although the motor 23 continues to operate without interruption, and the piston 40 continues to reciprocate, the reciprocation of the piston head 61 of the latter is confined to the portion of the bore 29 between the pump port 28 and the advance port 33 so that the entire volume of liquid pumped into the valve 30 is directed uninterruptedly to the return port 31 whence it is carried by pipe 32 into return chamber 20 whereby to raise and hold up the ram 16.

The differences derived in operation of the valve 30 by changing the fulcrum point of the lever 50 may easily be understood by comparing Figs. 3, 4 and 5, which, respectively, show the positions of the piston 40 relatively to the several ports of the said valve when the crank pin 48 is at the top, middle and bottom of its stroke while the fulcrum end of the lever is in its operating position, with Figs. 6, 7 and 8, which, respectively, show the positions of the said piston when the crank pin is at the same points in its stroke while the fulcrum end of the lever is in its idling position.

The operating range of reciprocation of the piston 40, illustrated in Figs. 3–5, is such that liquid from the pump 21 is directed from the pump port 28 alternately to the advance port 33 (thence to advance chamber 19) and to the return port 31 (thence to return chamber 20), while an inverse alternation takes place in the exhaustion of liquid from the return port 31 (from return chamber 20) and the advance port 33 (from advance chamber 19), whereby to reciprocate the ram 16. In the mid-position of the operating range of reciprocation (Fig. 4), the entire output of the pump 21 is by-passed from pump port 28, through the interior passages 66, 68, 65 and 67 of the valve element, to exhaust ports 36 and 37, and thence to the tank 26. This by-passing of liquid, occurring in both the downstroke and the upstroke of the crank pin 48 yields the dwell of the ram 16 at the top and bottom of the latter's stroke, as shown in the graph, Fig. 2.

The idling range of reciprocation of the piston 40, illustrated in Figs. 6–8, is such that, in both extreme positions of the piston and in all intermediate positions thereof, the pump port 28 is in uninterrupted liquid communication with return port 31, and advance port 33 is in uninterrupted liquid communication with exhaust port 36, so that in said idling range of reciprocation, liquid is constantly pumped into return chamber 20 and exhausted from advance chamber 19 whereby to hold the ram and press slide in their uppermost or open positions.

The liquid continuously being pumped into the return chamber during idling reciprocation of the piston 40 holds up the ram sufficiently to at least partly open the port 15*a* through which the pumped liquid continues to pass to the tank 26 until the press is again operated or until the motor 23 is stopped. If the motor 23 is stopped when the press is open, the ram 16 moves down-

wardly until the lower end thereof closes the port 15a after which the ram is held in position, indicated by the broken line in Fig. 1, by the liquid confined within the return chamber 20.

Desirable objectives in the control of the press

The foregoing description explains the manner in which continuous operation of the press is established, maintained and terminated, and, insofar as control means were concerned in said description, it has been necessary only to indicate that by suitable means the motor 23 would be started and stopped and the solenoid 53 would be energized and de-energized, and, of course, simple switch arrangements are well known in the art for accomplishing such operation of the said motor and solenoid. In actual practice, however, it is often desired that instead of operating the press continuously, it should be operated only through a single cycle at a time, which operation is herein referred to as "cyclic" operation. Such operation involves merely the closing and opening of the press, bringing it to rest at the top of the stroke of the press slide, so that the time during which the press is open for reloading of a blank or blanks is entirely within the control of the operator.

Within the present invention an electric control system may be provided to permit either continuous or cyclic operation of the press as desired. Fig. 1 includes a diagram of such a control system.

Before describing the electric control system, it is well to note the importance of having the energizing of the solenoid 53 occur during the latter part of a cycle of the crank wheel 47 so that, in either continuous or cyclic operation of the press, the first advance stroke or the only advance stroke will be a full-length stroke derived from the pumping of a full charge of liquid into the advance chamber rather than a partial stroke which would be derived if the solenoid were to be energized at any time during the movement of the crank wheel between 0° and about 135° in its cycle.

The control system disclosed and described herein is adapted to assure that even though a starting switch is operated during the mentioned early part of said cycle, the solenoid, nevertheless, is not energized until at, or slightly before, the end of said cycle so that the resulting advance stroke of the ram 16 will be a full-length stroke.

The means for controlling the operation of the press

The electric control system includes a normally open limit switch 101 which is so positioned adjacent the crank wheel 47 that, when the crank pin 48 reaches the position indicated as zero degrees, the said switch is engaged and closed by a cam 102 which is slotted and adjustably mounted upon the crank wheel 47 by a set screw or other suitable means which will permit the said cam to be adjusted circumferentially of the crank wheel within certain limits. The electric system also includes a normally closed limit switch 103 which is disposed in such position adjacent the crank wheel 47 that it is engaged and opened by the cam 102 as the crank pin 48 passes the position indicated as 180°. With this preliminary description of the relationship of certain portions of the electric control system to certain mechanical portions of the press system, the said control system and its operation may be conveniently understood from a description of the operation thereof.

Control of continuous operation

Assuming that the operator desires to establish continuous operation of the press, and that the solenoid 53 is in de-energized condition, so that the piston 40 is undergoing idling reciprocation, he first closes selection switch 104. Then he momentarily presses starting switch 105, thus establishing a circuit from positive (+) lead 106 through said starting switch, thence by wire 107 through relay coil 108, wire 109, selection switch 104, wire 110, and press-button stop switch 111 to negative (—) lead 112. The closing of said circuit causes relay contactor 108a to close a holding circuit through wires 113 and 114 bridging the starting switch 105 so that, when the latter switch is released and opened, the said holding circuit, nevertheless, maintains the relay coil 108 in its energized condition.

As a result of the circuit established and maintained through relay coil 108, relay contactor 108b is moved to and held in its closed position in a circuit which may be open or closed, depending upon the position of the crank wheel 47, the said circuit extending between leads 106 and 112, and including wire 115, relay contactor 108b, wire 116, normally open limit switch 101, wire 117, relay coil 118, wire 119, wire 109, selection switch 104, wire 110, and stop switch 111.

If, at the moment the starting switch 105 is closed and, in consequence, the relay contactor 108b is closed, the crank wheel 47 is in a position in which the cam 102 is not in operating engagement with the limit switch 101, there is no immediate closing of the last-mentioned circuit, but such closing occurs at the instant the cam 102 engages and closes the said limit switch. Upon the closing of said circuit and the consequent energizing of relay coil 118, relay contactor 118a closes a holding circuit through wires 120, 121 and 117 bridging both the limit switch 101 and relay contactor 108b in this way maintaining the circuit through relay coil 118 even after the cam 102 disengages and opens the limit switch 101 with the continued movement of the crank wheel 47.

As a result of the establishment and maintenance of the mentioned circuit through relay coil 118, relay contactors 118b and 118c close a circuit through the coil of the solenoid 53, extending between leads 106 and 112 and including, in addition to said contactors and solenoid, wires 123, 124, 125 and 126. The establishment and maintenance of the mentioned circuit through the coil of solenoid 53 energizes the latter and causes the solenoid core 52 and the fulcrum end of the lever 50 to move downwardly from their idling positions, as indicated in broken lines in Fig. 1, to their operating positions, indicated in full lines, thus causing the valve 30 to distribute pumped liquid and operate the press in the manner indicated in the graph, Fig. 2.

The press operates continuously during the maintenance of the said circuits through the coils of the several mentioned relays and the solenoid. To stop such operation, the stop switch 111 is opened to bring the press to rest. The opening of said stop switch breaks the circuits through both relay coils 108 and 118, thus moving all mentioned relay contactors to their open positions and de-energizing solenoid 53 to permit the fulcrum end of the lever 50 to be moved to its idling position by the compression spring 56. As

already explained, the shifting of the mentioned fulcrum point to its idling position causes the press to stop and the ram 16 to come to rest at its uppermost position.

Control of cyclic operation

Assuming that the operator desires to employ cyclic operation of the press and that the solenoid 53 is in de-energized condition, so that the piston 40 is undergoing idling reciprocation, he first makes certain that selection switch 104 is open. Then he momentarily presses starting switch 105, thus establishing a circuit from lead 106 through said starting switch, thence by wire 107 through relay coil 108, wire 109, wire 127, normally closed limit switch 103, wire 128, wire 110 and press-button stop switch 111 to lead 112. This circuit constitutes the only difference in the effective circuits employed in cyclic operation as compared to continuous operation.

The closing of said circuit through relay coil 108 functions in the manner already described (with reference to continuous operation) to cause circuits to be closed and maintained through relays 118 and solenoid 53 to start operation of the press. However, although limit switch 103 is entirely ineffective in continuous operation of the press because of being connected in parallel with selection switch 104, which is closed during such continuous operation, said limit switch 103, when the switch 104 is open for cyclic press operation, is effectively in series with stop switch 111. Thus, limit switch 103 is adapted to function as a stop switch. In the same manner as the opening of stop switch 111 functions to bring the press ram to rest at the top of its stroke under continuous operation, the limit switch 103, upon being engaged and opened by the cam 102 upon the completion of approximately 180° of the crank wheel cycle, functions to break the circuits through the several relays, including their respective holding circuits, and as a result breaks the solenoid circuit whereby to bring the ram 16 to rest in its uppermost position in the manner already described.

The closing of the mentioned circuit through limit switch 103 will take place at the instant the starting button is pressed only if at that instant the cam 102 is not in operative or opening engagement with the normally closed switch 103. However, if at the instant the starting button is pressed, the cam 102 is in engagement with the limit switch 103 and is holding the latter open, that condition would obtain only momentarily inasmuch as the normal duration of the manual holding of the starting switch 105 in its closed position would be greater than the time during which the cam 102 holds the switch 103 open.

It should be observed that, although an attempt has been made, in the foregoing description, to show quite accurately the relationship of the movement of the ram to the reciprocation of the piston of the distributing valve, a difference, not reflected in this description, may occur, in practice, in the relative movements of said ram and piston as a result of the inertia of the ram and of the liquid in the system and possibly as a result of other factors. This description, however, should suffice as an explanation of the principles upon which the present invention is founded.

This description also shows clearly that the movement of the ram is substantially dependent upon the operation of the distributing valve and that the said valve is positively operated or driven independently of the movement of the ram or of the pressure present in any ram actuating chamber, in contrast to prior systems wherein the operation of a distributing valve was substantially controlled by the movement of the ram or by the pressure in one or the other of hydraulic chambers causing such ram movements or by other means directly associated with the ram or its movement. In the accompanying claims, this independence of the operation of said valve from control by the ram or factors directly associated therewith is indicated by referring to the said valve as "operated independently of control by the movement (or reciprocation) of said reciprocating member (or ram)" or by other words of similar import.

If it is desired, in practice, to change the characteristics of the graph line indicating the movement of the ram, as, for example, to shorten either or both periods of dwell at the extremities of the ram stroke, a suitable cam arrangement or other suitable means could be used, within the present invention, instead of the crank wheel, to reciprocate the valve piston. Also, it should be obvious that, if desired, the control apparatus could be so arranged that the solenoid would be de-energized to start the operation of the press and energized to stop the press operation.

It is apparent that the press system described herein affords substantial flexibility of adjustment of the length and speed of stroke of the press ram and that various changes may be effected in adjustment, design, structure or operation without, however, departing from the spirit of the invention.

What I claim is:

1. In a hydraulic, material-forming press system, the combination of a distributing valve having a movable valve element shiftable from either to the other of an operating range of movement adapted to control delivery of liquid to a hydraulic press so as to continuously operate the latter, and an idling range of movement adapted to control delivery of liquid to such a press so as to cause the press to open and remain open, means for continuously actuating said valve element, and means for shifting the latter from either to the other of the two said ranges of movement thereof, the said actuating means comprising a valve gear, and a motor connected through said valve gear to said valve for operating the latter, the said shifting means comprising an oscillating lever, connected to said valve element and constituting a part of said valve gear, and means for varying the fulcrum-point of said lever, the latter means comprising a solenoid having a core to which the lever is pivotally connected at its fulcrum-point.

2. A hydraulic press system comprising a press having a reciprocable ram adapted to impose force upon material to form the latter, a continuous-delivery pressure-liquid supply, liquid distribution means including a distributing valve having a reciprocable valve element for controlling the distribution of liquid, from said supply, with respect to said ram to reciprocate the latter, a continuously-operable fixed-stroke eccentric device and motion-transmitting means including a lever coacting with said device and said valve element for reciprocating the latter independently of said ram, and control means, independent of said ram, for changing the motion-transmitting means from either to the other of an operating condition in which the said ram reciprocates, and an idling condition in which

the said ram is at rest, the said control means comprising a shiftable fulcrum-point support for said lever, shifting means, including electromagnetic means, for shifting said support from either to the other of a first position characteristic of such operating condition of said motion-transmitting means, and a second position characteristic of such idling condition of said motion-transmitting means, an electric circuit for controlling the operation of said electromagnetic means, starting-switch means, associated with said circuit, which are manually controllable to cause the said shifting means to shift and hold the said lever in its mentioned first position, and stopping-switch means, associated with said circuit, which are automatically operable in timed relation to said eccentric device to cause the said shifting means to shift and hold the said lever in its mentioned second position.

3. A hydraulic press and controls therefor, comprising a reciprocable ram, a reciprocable valve for controlling the distribution of liquid with respect to said ram to reciprocate the latter, driving means, including a lever coacting with said valve element, for reciprocating the latter independently of said ram, and control means, independent of said ram, for changing the said lever from either to the other of an operating condition, in which the said ram is caused to reciprocate, and an idling condition in which the said ram is at rest, the said control means comprising a shiftable fulcrum-point support for said lever, shifting means, including electrically-actuated means, for shifting said support between a first position characteristic of such operating condition of the said lever and a second position characteristic of such idling condition of the said lever, an electric system for controlling the operation of said electrically-actuated means, starting-switch means, in said system, which are at least partially manually controllable to cause the said shifting means to shift the said lever to and hold it in its mentioned first position to establish reciprocation of the said ram, and stopping-switch means, in said system, which are automatically operable in timed relation to said driving means to cause the said shifting means to shift the said lever to and hold it in its mentioned second position to discontinue reciprocation of the ram.

4. A hydraulic press and controls therefor, according to claim 3, the said starting-switch means including a starting switch, manually operable to effect incomplete conditioning of the electric system for causing reciprocation of the ram, and a switch, automatically operable in timed relation to said driving means, to complete the conditioning of the electric system for causing reciprocation of the ram.

5. A hydraulic press and controls therefor, comprising a reciprocable ram, a reciprocable valve for controlling the distribution of liquid with respect to said ram to reciprocate the latter, driving means, including a lever coacting with said valve element, for reciprocating the latter independently of said ram, and control means, independent of said ram, for changing the said lever from either to the other of an operating condition, in which the said ram is caused to reciprocate continuously, and an idling condition in which the said ram is at rest, the said control means comprising a shiftable fulcrum-point support for said lever, and shifting means, including electrically-actuated means, for shifting said support between a first position characteristic of such operating condition of the said lever and a second position characteristic of such idling condition of the said lever, further characterized in including an electric system for controlling the operation of said electrically actuated means, starting switch means, in said system, which are at least partially manually controllable to cause the said shifting means to shift the said lever to and hold it in its mentioned first position to establish reciprocation of the said ram and manually operable stopping-switch means, in said system, adapted to cause the said shifting means to shift the said lever to and hold it in its mentioned second position to discontinue reciprocation of the ram.

6. A hydraulic press and controls therefor, comprising a reciprocable ram, a reciprocable valve for controlling the distribution of liquid with respect to said ram to reciprocate the latter, driving means, including a lever coacting with said valve element, for reciprocating the latter independently of said ram, and control means, independent of said ram, for changing the said lever from either to the other of an operating condition, in which the said ram is caused to reciprocate, and an idling condition in which the said ram is at rest, the said control means comprising a shiftable fulcrum-point support for said lever, shifting means, including electrically-actuated means, for shifting said support between a first position characteristic of such operating condition of the said lever and a second position characteristic of such idling condition of the said lever, an electric system for controlling the operation of said electrically-actuated means, manually controllable starting-switch means, in said system, adapted to operate in timed relation to said driving means to cause the said shifting means to shift and hold the said support in its mentioned first position, and manually controllable stopping-switch means, in said system, adapted to operate in timed relation to said driving means to cause the said shifting means to shift and hold the said lever in its mentioned second position.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
400,519	Trethewey	Apr. 2, 1889
776,159	Whiteside	Nov. 29, 1904
929,433	Holmes	July 27, 1909
1,064,390	Spillman	June 10, 1913
1,071,701	Christopher	Sept. 2, 1913
1,123,273	Gregersen	Jan. 5, 1915
1,927,583	Ernst	Sept. 19, 1933
1,989,891	Sprado	Feb. 5, 1935
1,995,815	Purdum	Mar. 26, 1935
2,001,336	Vágó	May 14, 1935
2,014,162	Benedek	Sept. 10, 1935
2,019,766	Peterson	Nov. 5, 1935
2,055,530	Hallenbeck	Sept. 29, 1936
2,127,168	Grant	Aug. 16, 1938
2,214,817	Harrington	Sept. 17, 1940
2,227,279	Smith	Dec. 31, 1940
2,273,721	Muller	Feb. 17, 1942