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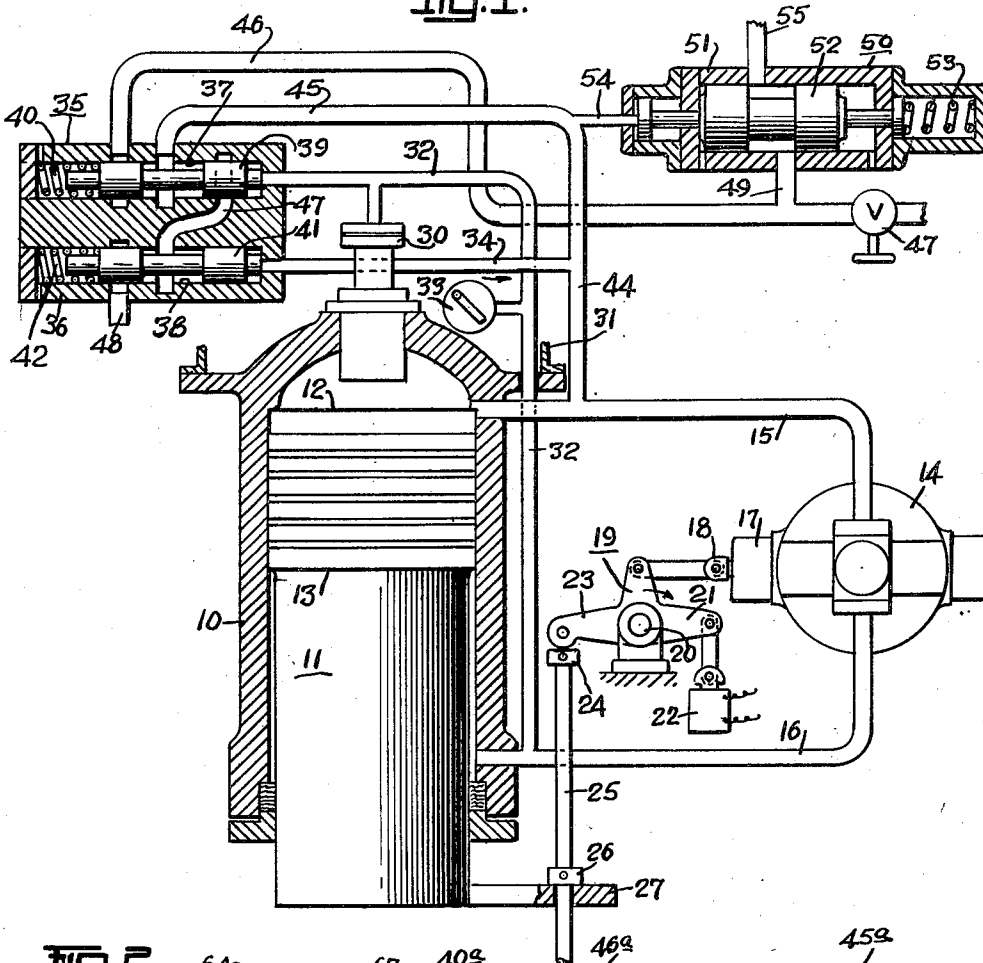
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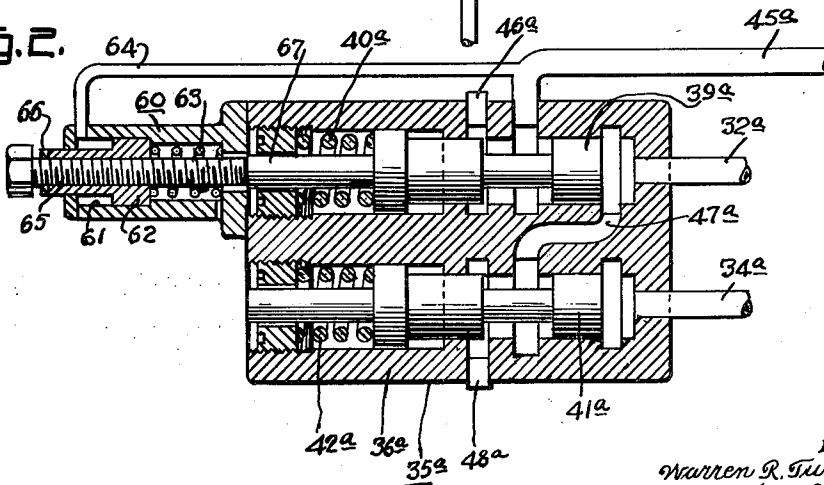
MAIN CYLINDER RELEASE AND PUMP BYPASS VALVE

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Fig. 1.



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MAIN CYLINDER RELEASE AND PUMP
BYPASS VALVE

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9 Claims. (Cl. 137-153)

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This invention relates by hydraulic systems and, in particular, to control systems for hydraulic presses.

Many classes of work such as sheet metal drawing, metal forging and other allied pressing operations are best performed by a reciprocating hydraulic ram. In this type of press a ram is advanced into the work under hydraulic pressure sufficiently great adequately to perform the work to be accomplished. Since much of this work requires high forces, the working pressures encountered are likewise relatively high. The operation of such a press involves reciprocating the ram under both high and low pressures and it is with the problem of changing from high to low pressures that the present invention is concerned.

It is a primary object of the present invention to provide a valve structure for an operating system for a hydraulic press wherein the changeover from high pressure operation to low pressure operation is accomplished smoothly, and without shock, and in a minimum of time.

It is another object to accomplish the aforementioned changeover of pressures in a minimum of time by means of controls on the valve.

This application is a division of our co-pending application Serial No. 525,140, filed March 6, 1944, now abandoned.

These and other objects will become more apparent from the following description taken in connection with the attached drawings in which:

Figure 1 is a diagrammatic view of a hydraulic press having an operating circuit according to this invention, and

Figure 2 is a portion of the circuit of Figure 1 showing a modified structure capable of accomplishing the objects of this invention.

General arrangement

According to this invention, a fluid operable motor which may be a downward acting plunger type of motor, has actuating fluid supplied thereto from any suitable source of pressure fluid.

The ram is caused to move into engagement with the work and thereafter to perform the work by introducing pressure fluid into the advancing area of the said ram. Upon the accomplishment of the work the ram is reversed by exhausting the advancing area and supplying pressure fluid to the retraction area.

If, during the working stroke of the ram, a high pressure has been established on the advancing area, then, an appreciable amount of energy is stored within the compressed fluid and the stressed mechanical parts of the press struc-

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ture. A sudden release of the pressure on the advancing area would result in a severe shock to the hydraulic circuit and the press. Therefore, it is desirable that the fluid on the advancing area be drawn off at a controlled rate in order to eliminate the aforementioned shock.

According to this invention a valve means is provided which initially permits the release of pressure fluid from the advancing area at a controlled rate and, subsequently, when the pressure has reached a predetermined lower value permits the complete and free evacuation of the remainder of the fluid from the advancing area.

According to the principal form of this invention pressure fluid is supplied to the ram by a reversible variable delivery pump. During the aforementioned period, that is, during the time that the pressure is being released from the advancing area, the discharge of the pump is bypassed by a valve structure operatively associated with the valve structure which is accomplishing the relief of pressure from the advancing area. When the aforementioned shift-over from controlled relief of the pressure on the advancing area to the free evacuation thereof takes place the valve which is by-passing the pump shifts automatically to direct the delivery from the pump to the retraction area of the ram so as to initiate the retraction stroke of the said ram.

Structural arrangement

Referring to the drawings, and in particular to Figure 1, there is shown a pressure cylinder 10 having reciprocably mounted therein a double acting plunger 11 having an advancing area 12 and a retraction area 13. Actuating fluid is supplied to the advancing and retracting areas by a pump 14, which may be of any type such as a reversible variable delivery pump. The pump 14 is connected to the advancing area by means of the conduit 15 and, to the retraction area by means of a conduit 16.

The pump 14 has associated therewith any suitable flow controlling means such as the servomotor structure 17 which is operable to control the direction and rate of delivery of the pump in accordance with the operation of the linkage 18 interconnecting the servomotor with the three-armed lever 19. The three-armed lever 19 is pivoted at 20 and includes, in addition to the arm which engages the linkage 18, an arm 21 which is operatively connected with the solenoid 22. The third arm 23 is adapted to be engaged by the collar 24 of the rod 25. The rod 25 further comprises the adjustable collar 26 which is

adapted to be engaged by the arm 27 of the plunger 11 when the latter is in its fully retracted position.

A surge valve 30 is mounted in the top of the cylinder 10 and is operable to permit fluid from the surge tank 31 to fill the advancing chamber of the cylinder 10 during the initial advancing stroke of the plunger and, freely to evacuate the said advancing chamber during the retraction stroke of the said plunger. A conduit 32 interconnects the operating cylinder of the surge valve 30 with the conduit 16 so that the said surge valve is responsive to a predetermined pressure created within the conduit 16 or the retraction chamber of the cylinder 10. Normally, the weight of the plunger 11 maintains a pressure within the retraction chamber of the cylinder 10 sufficient to hold the surge valve 30 in an open position so as to cause the same to permit fluid communication between the tank 31 and the advancing chamber of the cylinder 10. A check valve 33 is arranged within the tank 31 and is connected with the conduit 32 and permits free flow from the tank 31 into the conduit 32 but not vice-versa. This valve is for the purpose of supplying fluid to the pump 14 during the working stroke of the plunger 11 in a manner which will become more apparent hereinafter.

Connected to the retraction area by the conduit 32 and, to the advancing area by the conduit 34 is a valve generally indicated at 35. The valve 35 comprises a casing 36 having a pair of bores 37 and 38 therein. Reciprocally mounted within the bore 37 is a valve member 39 which is continuously urged to the right by a spring 40 and reciprocally mounted within the bore 38 is a valve member 41 which is continuously urged to the right by a spring member 42. Each of the reciprocable members 39 and 41 comprises a spool shaped element adapted to effect fluid communication between various conduits and ports in the valve. The member 39 is adapted to be moved to the left against the thrust of the spring 40 by pressure fluid delivered to the right hand end of the member 39 by the conduit 32. When the valve member 39 moves to the left under the influence of pressure delivered thereto from the retraction area by the conduit 32, fluid communication is established between the conduits 45 and 46, the former of these conduits being connected with the advancing area. Movement to the left of the member 39 is also effective to establish fluid communication between the conduit 32 and the passage 47 within the casing 36. The passage 47 terminates within the bore 38 at a point midway between the enlarged end portions of the member 41. Pressure fluid from the advancing area is conducted through the conduit 44 to the right hand end of the member 41 and, when sufficiently great, urges the said member leftwardly against the thrust of the spring 42 so as to establish fluid communication between the passage 47 and the outlet passage 48, which latter opens into the reservoir or tank 31.

The conduit 46 communicates with the reservoir 31 through an adjustable throttling valve 47 and is also connected with a two-way valve generally indicated at 50 by means of the conduit 49.

The valve 50 comprises a casing 51 within which is reciprocable a valve member 52 which has attached thereto, or in abutting relationship therewith, a pair of operating plungers. The plunger at the right end serves continuously to urge the member 52 to the left by means of the spring 53 and, the plunger at the left of the valve

is effective to urge the member 52 to the right against the thrust of the spring 53 in response to pressure conveyed to the said plunger from the advancing area by the conduits 44, 45 and 54.

The arrangement of the valve 50 is such that the spring 53 normally moves the member 52 into position to establish fluid communication between the conduits 49 and 55, the latter of which communicates with the reservoir 31. In response to a predetermined pressure within the advancing chamber of the cylinder 10, higher than that required to shift the valve member 41, the valve member 52 is urged to the right against the thrust of the spring 53 thereby to interrupt the communication between the conduits 49 and 55.

Referring now to Figure 2, there is shown an alternative structure for obtaining the result accomplished by the structure of Figure 1. In Figure 2 the valve generally indicated 35a is substantially identical with the valve generally indicated at 35 in Figure 1 and similar parts are similarly numbered with the addition of an *a*. The valve 35a is connected into a press circuit in a manner identical with the manner in which valve 35 is connected in Figure 1, with the exception that the valve 50 is eliminated. Instead, the conduit 46a communicates directly with the reservoir.

In Figure 2 the valve includes, in addition to the structure described in connection with valve 35 in Figure 1, an additional piston-cylinder construction generally indicated at 60. The piston-cylinder 60 is attached to the casing 36a of the valve in alignment with the reciprocable member 39a. The cylinder of the unit 60 comprises a shouldered bore 61 within which is reciprocable a piston 62. The piston 62 is urged leftwardly by a spring 63 and is adapted to be urged to the right by pressure fluid conducted thereto by a conduit 64 which is in continuous hydraulic communication with the conduit 45a and, hence, with the advancing chamber of the associated hydraulic motor. The piston 62 is centrally bored and threaded to receive a screw 65 which is locked in any desired position of adjustment by a lock nut 66. The screw 65 extends completely through the piston 62 and extends rightwardly therefrom through an aperture in the bottom of the unit 60 so as to be in position to abut the tail rod 67 of the member 39a when the latter is in a predetermined position.

The arrangement is such that, when pressure fluid from the retraction chamber of the hydraulic motor is conducted by conduit 32a to the right hand end of the member 39a and moves the latter to the left, the screw 65 abuts the rod 67 before the said movement is completed. Specifically, the member 39a is stopped at a point which will provide a predetermined restriction between the conduits 45a and 46a while permitting free fluid communication between the conduit 32a and the passage 47a. It will be apparent that the amount of restriction created by the member 39a may be varied by adjusting the screw 65 so as to vary the position at which the member 39a is stopped.

With the valve in the position indicated in Figure 2, the delivery from the pump is by-passed through conduit 32a, the passage 47a and the conduit 48a to the reservoir. At the same time the pressure within the advancing area of the associated motor is decreased at a controlled rate through the conduit 45a and the conduit 46a to the reservoir. So long as the pressure within the advancing chamber and the conduit 45a is above

the predetermined level, the piston 62 is maintained in its rightward position by the pressure conducted thereto through the conduit 64 from the conduit 45a. When the pressure within the advancing chamber is decreased to a predetermined level, the thrust of the spring 63 and the thrust of the right hand end of the member 39a becomes effective to move the member 39a and the piston 62 to the left. The further movement to the left of the member 39a is effective to eliminate the restriction between the conduits 45a and 46a and the flow of pressure fluid from the advancing chamber of the hydraulic motor is, therefore, unrestricted and, the pressure therein is reduced to substantially that of the atmospheric pressure of the reservoir.

Simultaneously with the final movement to the left of the member 39a, and complete release of pressure within the advancing chamber, the pressure standing on the right hand end of the member 41a is released and the spring 42a becomes effective to move the said member to the right thereby interrupting fluid communication between the passage 47a and the conduit 48a. The delivery of the pump which has been bypassed through the aforementioned fluid passage is now directed to the retraction area of the reciprocable plunger and the latter commences its retraction stroke.

The operation of the circuit of Figure 1 is identical with that of Figure 2 except that the final release of pressure from the advancing chamber is accomplished by the actuation of the valve member 52 of the valve 50 by the spring 53 when the pressure within the advancing chamber has been reduced to a predetermined level.

Also, simultaneously with the actuation of the valve member 52 by the spring 53 or, of the piston 62 by the spring 63, the surge valve 30 is actuated by the increased pressure established in the retraction chamber and, therefore, in the conduit 32 thereby to permit the free evacuation of the fluid within the advancing chamber during the retraction stroke of the plunger 11.

Operation

In operation, an advancing stroke of the plunger may be instituted by energizing the solenoid 22 whereby the lever 19 is rotated in a clock-wise direction and, through the linkage 18 and the servomotor 17 places the pump in position to deliver fluid to the advancing chamber through the conduit 15. During the advancing movement of the plunger the pump withdraws fluid from the retraction chamber through the conduit 16 so as to permit the plunger 11 to move rapidly downwardly by its own weight to work engaging position. During this initial portion of the advancing stroke, the surge valve 30 is held open by the pressure in the retraction chamber or by the suction within the advancing chamber thereby permitting fluid to flow into the advancing chamber from the reservoir 31.

When the plunger engages the work the surge valve closes and pressure is built up within the advancing chamber. During the working portion of the advancing stroke the pump draws fluid from the reservoir through the check valve 33 in order to compensate for the difference in displacement between the advancing and retraction chambers.

Following the accomplishment of the work to be done, the retraction stroke of the plunger is instituted by de-energizing the solenoid 22 in

any convenient manner such as by a switch operated manually, by the pressure within the advancing chamber or by the position of the plunger.

The de-energization of the solenoid permits a spring (not shown) within the servomotor 17 to shift the pump into position to deliver fluid into conduit 16 and, also shifts the linkage 18 to the left and therethrough the lever 19 into a position counter-clockwise from its Figure 1 position.

It will be noted that the working pressure established within the advancing chamber during the working stroke of the plunger was effective to shift the valve member 41 to the left and the valve member 52 to the right but that this had no effect on the operation of the circuit since the fluid connections established by the valve members are effective only in cooperation with fluid connections established by the valve member 39.

However, when the pump is shifted to deliver into conduit 16, the pressure developed within the retraction chamber and also in conduits 16 and 32 will shift the valve member 39 to the left. At the same time the pressure within the advancing chamber remains relatively high because the fluid therein is highly pressurized and the mechanical parts of the press are stressed and, hence, the valve members 41 and 52 are maintained in their left and right hand positions respectively.

With the valve members 39 and 41 in their left hand position and the valve member 52 in its right hand position, the pump is bypassed through conduits 16 and 32, passage 47 and conduit 48 to the reservoir. Optionally, the conduit 48 may comprise a choke valve for the purpose of maintaining a predetermined pressure within the aforementioned channel. Simultaneous with the bypassing of the pump the pressure within the advancing chamber is released through conduits 15, 44, 45, 46 and valve 47 to the tank or reservoir. The valve 47 is preferably adjusted to permit fluid to flow therethrough as rapidly as is possible without releasing the pressure from the advancing chamber so suddenly as to create a shock within the hydraulic circuit.

When the pressure within the advancing chamber has been reduced to a predetermined value, the spring 53 becomes effective to move the valve member 52 to the left thereby to permit the sudden release of the remaining pressure within the advancing chamber. However, the pressure in the advancing chamber being relatively low at this time, no shock is created within the hydraulic system.

In a manner described hereinbefore, the complete release of pressure from the advancing chamber is effective to permit the valve member 41 to move to the right thereby directing the delivery of the pump to the retraction chamber and creating a pressure therein which is conducted through the conduit 32 to the surge valve to open the latter.

The retraction stroke of the plunger now commences with the pump delivering into the retraction chamber of the cylinder 10 while the advancing chamber is exhausted through the surge valve 30 to the reservoir. The retraction stroke of the plunger continues until the arm 27 attached therewith engages the collar 26 and lifts the latter together with the rod 25 and the collar 24 so as to rotate the three-armed lever 19 in a clock-wise direction. The clockwise rotation of the lever 19 is effective, by means of the linkage 18, to actuate the servomotor 17 of

the pump to move the latter into substantially no delivery position thereby to halt the retraction stroke of the plunger.

It will be apparent that the time required for the relief of pressure within the advancing chamber and the institution of the retraction stroke is materially reduced through the use of this invention and, accordingly, the hydraulic press associated with the circuit is capable of performing work at an increased rate.

It will be understood that the particular structure shown and described in connection with our invention is merely exemplary and does not represent the only use to which this invention may be put.

Accordingly, we do not wish to be limited by the specific structure shown in the drawings and described in the specification but desire to comprehend such modifications in structure and arrangement as may be considered to come within the spirit of the appended claims.

We claim:

1. In a valve for releasing the pressure from a first body of fluid while simultaneously by-passing a second body of fluid the combination of; a first valve member movable in response to a predetermined pressure of said second body for establishing fluid communication between said first body and exhaust; a second valve member movable in response to a predetermined pressure on said first body to establish fluid communication between said second body and exhaust; and fluid-pressure-responsive means communicating with said first body and responsive to a predetermined pressure thereon for restricting the flow of fluid from said first body to exhaust.

2. A valve comprising a casing having a first bore and a second bore therein; a fluid inlet and a fluid outlet in each of said bores; a control member reciprocable in each of said bores for controlling communication between the inlet and outlet of each of said bores; fluid pressure responsive means associated with each of said control members and operable in response to a predetermined pressure to move the associated control member into position to establish fluid connection between the associated inlet and outlet; means hydraulically connecting the fluid inlet of each bore with the fluid pressure responsive means associated with the other of said bores; and other fluid-pressure-responsive means hydraulically connected with one of said inlets and operable in response to a predetermined pressure therein to control the rate of discharge from one of said outlets.

3. In a valve for releasing the pressure from a first body of fluid while simultaneously by-passing a second body of fluid the combination of; a first valve member movable in response to a predetermined pressure of said second body for establishing fluid communication between said first body and exhaust; a second valve member movable in response to a predetermined pressure on said first body to establish fluid communication between said second body and exhaust; stop means engageable with said first valve member to limit movement thereof to a position providing for restricted flow of fluid from said first body to exhaust; and fluid pressure responsive means associated with said stop means for maintaining said stop means in engagement with said first valve member in response to a predetermined pressure within said first body.

4. A valve comprising a casing having a bore with an inlet port and outlet port therein; a con-

trol member reciprocable in said bore between a first end position for disconnecting said ports and a second end position for connecting said ports; yielding means for continuously urging said member toward said first position; fluid operable means for urging said member toward said second position; stop means adapted to engage and stop said member between said first and second end positions; yielding means for urging said stop means into ineffective position; fluid operable means for rendering said stop means effective and hydraulically connected with said inlet port; and means for by-passing at least a portion of the fluid supplied to said first mentioned fluid operable means.

5. In a valve comprising a casing having a bore with an inlet and an outlet port therein; a control member reciprocable within said bore between a first end position for disconnecting said ports and a second end position for connecting said ports; fluid pressure responsive means operable in response to a predetermined pressure for moving said member from said first end position into said second end position; stop means associated with said member for halting the same intermediate said first and second positions; fluid pressure responsive means hydraulically connected with said inlet port and associated with said stop means and operable to render the latter effective in response to a predetermined pressure; and means for by-passing at least a portion of the fluid supply to said first mentioned fluid pressure responsive means.

6. A valve comprising a casing having a bore with an inlet and an outlet port therein; a control member reciprocable within said bore between a first position for interrupting fluid communication between said ports into a second position for establishing fluid communication between said ports; fluid pressure responsive means for moving said member from said first position into said second position; stop means for halting said member intermediate said first and second positions; means responsive to a predetermined pressure at said inlet port for rendering effective said stop means; and means automatically operable for by-passing at least a portion of the fluid supplied to said fluid pressure responsive means.

7. A valve comprising a casing having a bore with an inlet and an outlet port therein; a control member movable in said bore between a first position for interrupting fluid communication between said ports and a second position for establishing fluid communication between said ports; means for moving said control member from said first position into said second position; stop means for halting said member intermediate said first and second positions; and means responsive to a predetermined pressure at said inlet port for rendering effective said stop means.

8. A valve comprising a casing having a bore with an inlet and an outlet port therein; a control member reciprocable within said bore between a first position for interrupting fluid communication between said ports and a second position for establishing substantially free fluid communication between said ports; fluid pressure responsive means for moving said member from said first position into said second position; stop means for halting said member intermediate said first and second positions for establishing a restricted fluid communication between said ports; and means responsive to a predetermined pressure at said inlet port for rendering effective said stop means.

9. A valve comprising a casing having a bore with an inlet port and outlet port therein; a control member reciprocable in said bore between a first end position for disconnecting said ports and a second end position for connecting said ports; yielding means for continuously urging said member toward said first position; fluid operable means for urging said member toward said second position; adjustable stop means movable into a first position for halting said control member between said first and second end positions and into a second position for permitting said control member to move into said second end position; fluid operable means associated with said stop means and hydraulically connected with said inlet port for moving said stop means into said first position; yielding means associated with said stop means for urging the same into said second position; and fluid pressure responsive means hydraulically connected with said inlet

port and operable to by-pass at least a portion of the fluid supplied to said fluid operable means associated with said control member.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
853,693	Healy -----	May 14, 1907
894,102	Banjock -----	July 21, 1908
1,956,758	Ernst -----	May 1, 1934
2,268,205	Ernst -----	Dec. 30, 1941
2,316,944	Ernst -----	Apr. 20, 1943
2,335,809	Stacy -----	Nov. 30, 1943
2,362,864	Fowler -----	Nov. 14, 1944
2,366,382	Burton -----	Jan. 2, 1945