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Filed June 16, 1941

2 Sheets-Sheet 1

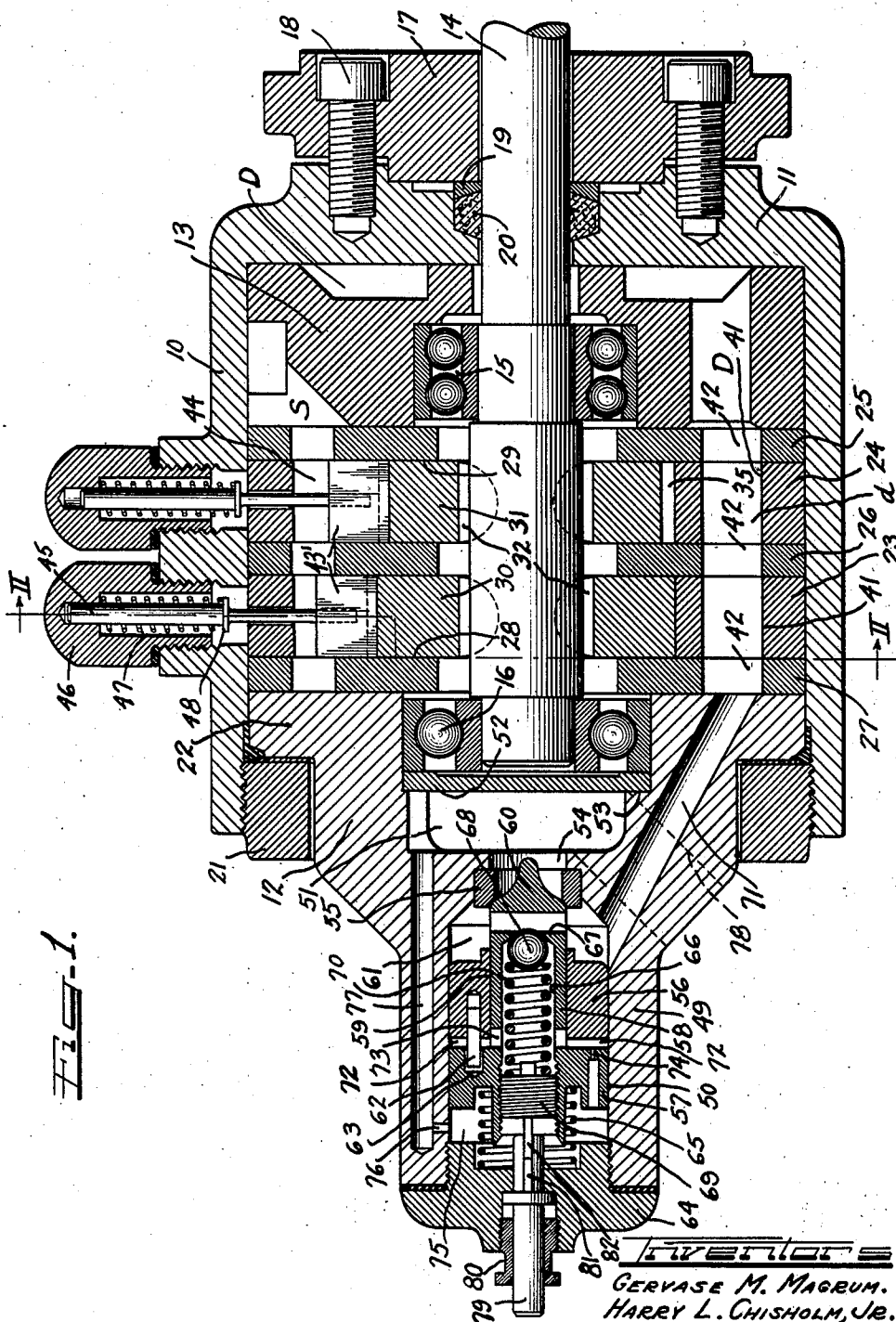


FIG. 1.

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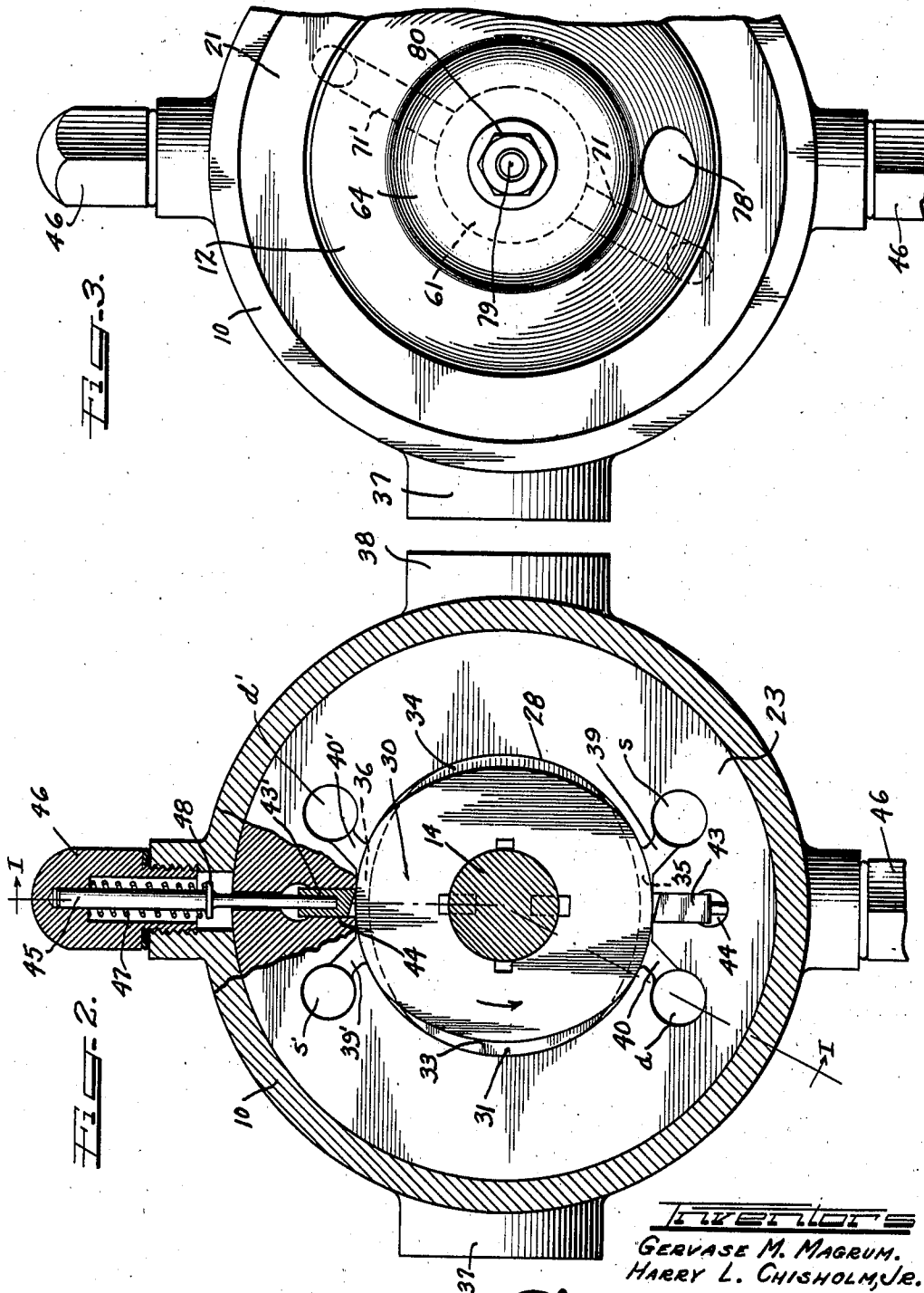
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ROTARY HYDRAULIC PUMP AND PRESSURE
CONTROL VALVING THEREFOR

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13 Claims. (Cl. 103—42)

This invention relates to rotary hydraulic pumps and particularly to valving assembly forming part of the pump structure for controlling the pump pressure.

The important object of the invention is to provide compact valving assembly subjected to the pressure of the fluid pumped by the pump and functioning for relieving the pressure should the pump pressure gradually rise above normal predetermined pressure, and to provide blow-off for quick return to normal of the pressure should the pressure suddenly rise abnormally, the pump being thus protected against overloading automatically and holding the pump pressure within its predetermined limits.

Another important feature of the invention is the compact assembly and housing of the valving elements in an extension on one of the heads of the pump where the valve assembly will be subjected to the pressure at the discharge end of the pump.

The invention also embodies other features of arrangement and operation, and all these features are embodied in the structures shown on the drawings, in which drawings

Figure 1 is a longitudinal section on plane I—I of Figure 2;

Figure 2 is a section on plane II—II of Figure 1;

Figure 3 is an elevation of the left end of the pump structure.

The pump structure shown is of the well-known type as, for example, that shown in the pending application of Sherwood C. Bliss, Serial No. 282,447, filed July 1, 1939, issued into Patent No. 2,271,730, dated February 3, 1942.

Briefly describing the pump, its housing comprises the cylindrical wall 10 having the inner end wall or head 11 integral therewith, the outer end of the housing receiving the outer end wall or head 12. Fitting into the wall 10 and seating against the head 11 is the cylindrical block 13 between which and the outer head 12 are clamped the various elements which form the pump cylinders. A drive shaft 14 extends into the housing and is journaled in ball bearings 15 and 16 supported respectively by the block 13 and the head 12, the shaft extending outwardly from the head 11 for mounting, or connection with, a driving source (not shown) such as an electric motor. A fitting 17 receives the shaft and is secured, as by bolts 18, to the head 11, and may serve as a bracket for supporting the pump structure. The fitting 17 engages a washer 19 for

compressing packing 20 around the shaft to prevent leakage.

The pump cylinder forming elements are rings and plates clamped together between the head 12 and the block 13 by a clamping ring 21 having threaded engagement in the open end of the housing wall 10 and abutting the flange 22 on the head 12. As shown there are two rings 23 and 24 respectively, an inner plate 25, an intermediate plate 26, and an outer plate 27, the outer diameters of the rings and plates being such that they will fit snugly in the cylindrical bore of the wall 10. The rings and plates define annular cylinder spaces 28 and 29 into which the rotor members 30 and 31 respectively extend to be rotated by the shaft 14 to which they are secured as by keys 32.

Referring to Figure 2, the rotor elements 30 and 31 are of generally elliptical shape so as to define with the cylinder space walls crescent shaped working chambers. The two rotors are displaced ninety degrees from the shaft 14 so that the opposite working chambers 33 and 34 between the rotor 30 and the ring 23 will be displaced respectively ninety degrees from the working chambers 35 and 36 between the rotor 31 and the ring 24.

The block 13 is cored out to provide a suction or intake space S and a discharge space D, the suction space S communicating with the inlet 37 on the wall 10 connected by suitable piping with a source of fluid such as oil, and the discharge space or chamber D communicating with the outlet 38 on the wall 10 connectable by suitable piping with hydraulic devices for receiving the fluid under pressure from the pump.

For the cylinder spaces 28 and 29 in which the rotors operate, fluid inlet and fluid outlet ports are provided. As shown on Figure 2, each cylinder space has diametrically opposite inlet ports 39 and 39' and diametrically opposite discharge ports 40 and 40'. As shown on Figure 1, the rings 23 and 24 have transverse bores 41 there-through which align with the transverse bores 42 in the plates 25, 26 and 27 to form an outlet passageway which at its inner end communicates with the discharge space D connected with the outlet 38. The ports 40 extend through the rings 23 and 24 to connect the pump chambers with the discharge passageway through the rings and plates. At a diametrically opposite point, the rings and plates are bored to form another passageway therethrough connecting with the discharge space D and connected by the ports 40' with the pump chambers. On Figure 2 the two

discharge passageways through the ring and plate assemblies are indicated by d and d' .

The rings and plates are also bored to provide diametrically opposite inlet passageways s and s' communicating with the suction or inlet space S and connected by the ports 39 and $39'$ with the pump chambers.

The rings 23 and 24 are each provided with diametrically opposite blades 43 and $43'$ for co-operating with the rotors surrounded by the respective rings, the blades operating in radially extending slots 44 , the blades 43 being located between the inlet and discharge passageways s and d and the blades $43'$ being between the inlet and discharge passageways s' and d' (Figure 2) the rotor engaging edges of the blades being directed toward the respective discharge passageways, the rotors rotating in the direction of the arrow on Figure 2.

Each blade has a stem 45 extending upwardly through the ring and the wall 10 of the housing and into a plug 46 threaded into the wall 10 , a spring 47 surrounding the stem to engage between a collar 48 on the stem and the top of the plug 46 , the springs tending to hold the blades with its edge in engagement with the respective rotors.

When the pump is being driven the fluid will be drawn into the space S from a source of supply such as a reservoir, the fluid being drawn by the rotors through the inlet passageways s and s' and through the ports 39 and $39'$ into the working chambers 33 , 34 and 35 , 36 and the blades will intercept the fluid and direct it from the working chambers into the outlet passageways d and d' and into the discharge space D for outflow from the outlet 38 of the pump.

Describing now the valving structure for controlling the pump pressure, the valving assembly is located within the extension 49 from the pump head 12 . The extension has the outer bore 50 , and the inner bore 51 of larger diameter forming a chamber whose inner end is closed by a plate 52 engaging between the ball bearing 16 and the shoulder 53 on the extension 49 . The chamber 51 is connected with the bore 50 by a passageway 54 which is surrounded by an annular valve seat 55 . A distance outwardly from the valve seat 55 a guide member or plug 56 is seated in the bore 50 and is rigidly held in the bore as by press fit therein, or other means. Outwardly of the plug 56 , a plunger member 57 is axially shiftable in the bore 50 and has a stem 58 extending through the bore 59 of the plug 56 , the stem terminating in a conical valve end 60 for engagement with the valve seat 55 to shut off communication between the chamber 51 and the space 61 between the valve seat and the plug.

The plunger 57 is held against rotary movement in the bore 50 as by means of a stop pin 62 extending from the plug 56 into a recess 63 in the plunger. The outer end of the bore 50 is closed by a detachable cap 64 having threaded engagement with the extension 49 , and between this cap and the plunger is a spring 65 which tends to hold the plunger in position for seating engagement of the valve end 60 with the valve seat 55 .

The plunger and its stem has the bore 66 therethrough and the stem, a distance outwardly from the valve end 60 , has the annular internal flange 67 forming a seat for a relief valve which may be in the form of a ball 68 within the bore 66 . The bore 66 at its outer end is threaded for reception of the abutment plug or nut 69 between which and the valve 68 is interposed a spring 70 which tends to hold the valve to its seat 67 to disconnect the plunger bore 66 from the space 61 .

Passageways 71 and $71'$ through the head 12 connect this space 61 with the outlet ends of the discharge passageways d and d' of the pump so that the space 61 always contains fluid under pump pressure.

When the plunger 57 is in its normal position with the valve end 60 engaging against the seat 55 , the plunger body is separated from the guide plug 56 by an annular space 72 which is in communication through ports 73 with the bore in the stem 58 inwardly of the abutment nut 69 . The plunger body has the restricted orifice 74 connecting the space 72 with the space 75 between the plunger and the cap 64 , this space being connected by a passageway 76 with the passageway 77 extending through the extension 49 to communicate with the chamber 51 . The space 51 has an outlet passageway 78 therefrom through the head 12 to the exterior of the pump, and this passageway may be connected with the supply source or reservoir for the pump.

In order to adjust the tension of the spring 70 against the check valve 68 , provision is made for rotation of the abutment nut 69 from the exterior of the pump. As shown, an adjusting pin 79 extends through a gland 80 on the cap 64 and has at its inner end a slot 81 receiving a tongue 82 on the nut 69 . Upon turning of the stem 79 , the nut is turned, and by virtue of its threaded engagement in the plunger bore, it will be shifted axially for adjusting the tension of the spring 70 against the valve 68 .

Describing now the operation and functioning of the valving assembly, the pressure of springs 65 and 70 is such that the valves 60 and 68 will remain closed so long as the pump operates at or below a predetermined maximum delivery pressure. Should the delivery demand on the pump become less than the capacity of the pump, the delivery pressure will rise, and when the pressure becomes higher than the predetermined magnitude, the pressure against the valve 68 will overcome the resistance of the spring 70 and fluid will flow from the passages 71 and $71'$, past the valve 68 into the bore of the plunger stem, and from there through ports 73 and into the space 72 . From here it must flow through the relatively small orifice 74 , and into the space 75 , thence through the orifice 76 and the passageway 77 into the chamber 51 , from which it flows through the relief outlet 78 , back to the reservoir. The rate of flow through these passages is relatively very small.

As the pump pressure rises above maximum, the valve 68 will be lifted off its seat, allowing fluid to flow into space 72 . Since the size of the orifice 74 is relatively smaller than the opening afforded by the valve 68 , pressure will build up in the space 72 , causing the plunger structure with its valve end 60 to be lifted off its seat 55 , allowing the fluid in excess of the demand to pass back to the reservoir.

When the valve 68 has opened sufficiently to handle the excess fluid, the pressure will stabilize at the maximum, or set pressure, and the valve 68 will partly close until the flow past the valve 68 is the same as the flow through the orifice 74 , thus maintaining a constant amount of fluid in the space 72 , and holding the valve 60 to the proper opening. By the same process, any further change in delivery demand will cause the valve to readjust itself. If there is no delivery demand, the entire pump delivery will flow back to the reservoir.

When the pressure has dropped below maximum, i. e., when the demand is the same or less

than the pump capacity, the valve 68 will close, and the spring 65 will force the valve 60 to close. In closing, the fluid in space 72 has to pass through orifice 74, thus cushioning the re-seating of the plunger structure on its seat 55.

The orifice 76 is of such size as to cause sufficient restriction that it makes a dashpot of space 75, thus preventing the plunger structure from chattering.

By our improved valving arrangement the pump is efficiently protected against overloading entirely automatically. By assembling the valving elements in the pump head the valving assembly becomes a unitary part of the pump structure.

We have shown a practical and efficient embodiment of our invention but we do not desire to be limited to the exact construction, arrangement and operation shown and described as changes and modifications may be made without departing from the scope of the invention.

We claim as our invention:

1. A valving assembly for controlling the pressure in a rotary hydraulic pump to prevent overloading, comprising a pressure chamber connected to receive fluid from the pump under discharge pressure, a blow-off passageway from said valve chamber to the exterior thereof, a blow-off valve extending through said pressure chamber and means normally holding it for closure of said blow-off passageway, means defining a relief passageway from said pressure chamber to the exterior thereof, said blow-off valve having a pressure surface thereon exposed only to flow through said relief passageway when said passageway is opened, a valve for said relief passageway and means normally holding it closed against normal pressure in said pressure chamber, excess pressure against said relief valve causing opening thereof for flow of fluid through said relief passageway and against said pressure surface on the blow-off valve whereby said blow-off valve will be moved for opening of said blow-off passageway.

2. Valving assembly for controlling the pressure in a rotary hydraulic pump to prevent overloading, comprising a pressure chamber connected to receive fluid from the pump under discharge pressure, a blow-off passageway from said pressure chamber to the exterior thereof, a blow-off valve for closing said passageway, a relief passageway from said pressure chamber to the exterior thereof, said blow-off valve having a pressure surface normally unexposed to the pump discharge pressure but exposed to the flow through said relief passageway when said passageway is open, a valve for said relief passageway and means yieldingly holding said valve closed against normal pump pressure, abnormal pump pressure opening said valve for flow through said relief passageway and against said pressure surface on the blow-off valve, yielding means tending to hold said blow-off valve closed and permitting opening thereof under excess pressure flow through said relief passageway for opening of said blow-off passageway.

3. A valving assembly for controlling the pressure in a rotary hydraulic pump to prevent overloading, comprising a pressure chamber connected to receive fluid from the pump under discharge pressure, a blow-off passageway from said pressure chamber to the exterior thereof, a blow-off valve for closing said passageway, a relief passageway from said pressure chamber to the exterior thereof, said blow-off valve having a pres-

sure surface thereon normally unexposed to the pump discharge pressure but exposed to the flow through said relief passageway when said passageway is opened, a valve for said relief passageway, means for holding said valve closed against normal pump pressure but permitting opening of said valve by abnormal pressure for relief flow through said relief passageway and exposure of said blow-off valve pressure surface to the flow through said relief passageway, means restricting the flow through said relief passageway, means tending to hold said blow-off valve closed but yielding to the relief flow pressure against said blow-off valve pressure surface for opening of said blow-off passage by said blow-off valve when the pump pressure becomes excessive.

4. Valving assembly for controlling the pressure in a rotary hydraulic pump to prevent overloading, comprising a valve chamber connected to receive fluid from the pump at discharge pressure, a blow-off passageway from said valve chamber to the exterior thereof, a blow-off valve for closing said passageway, a relief passageway from said valve chamber to the exterior thereof, said blow-off valve having a pressure surface normally unexposed to the pump discharge pressure and exposed to the flow through said relief passageway only when said passageway is open, a valve for said relief passageway and yielding means normally holding it closed against normal pump pressure, said valve opening under abnormal pump pressure for relief flow through said relief passageway and exposure of said blow-off valve pressure surface to said relief flow pressure, yielding means tending to hold said blow-off valve closed against said relief flow pressure, a restricting orifice included in said relief flow passageway for relieving said pressure against said blow-off valve pressure surface sufficiently to prevent opening of said blow-off valve by said pressure against said yielding means but being insufficient to sufficiently relieve the pressure under excess pump pressure whereby said blow-off valve will then be opened for pump pressure relief through said blow-off passageway.

5. Valving assembly for controlling the pressure in a rotary hydraulic pump to prevent overloading, comprising a valve chamber connected to receive fluid from the pump at discharge pressure, a blow-off passageway from said valve chamber to the exterior thereof, a blow-off valve for closing said passageway, a relief passageway from said valve chamber to the exterior thereof, said blow-off valve having a pressure surface normally unexposed to the pump discharge pressure and exposed to the flow through said relief passageway only when said passageway is open, a valve for said relief passageway and yielding means normally holding it closed against normal pump pressure, said valve opening under abnormal pump pressure for relief flow through said relief passageway and exposure of said blow-off valve pressure surface to said relief flow pressure, yielding means tending to hold said blow-off valve closed against said relief flow pressure, a restricted passageway through said blow-off valve included in the relief flow for relieving the pressure against said blow-off valve to prevent opening thereof under ordinary abnormal pump pressure but being insufficient to relieve the pressure sufficiently under excess pump pressure whereby said blow-off valve will then be opened by the pressure against said yielding means for opening of the blow-off passageway and relief of the excess pressure.

6. A valving assembly for controlling the pressure in a rotary hydraulic pump to prevent overloading, comprising a valve chamber connected with the pump to receive fluid under discharge pressure, a blow-off passageway from said valve chamber to the exterior thereof for relief of excessive abnormal pump pressure, a relief passageway from said valve chamber to the exterior thereof for relief of ordinary abnormal pump pressure, a blow-off valve in said valve chamber for closing said blow-off passageway, a relief valve for controlling the flow through said relief passageway, yielding means holding said relief valve closed against normal pump pressure but permitting opening thereof for flow through said relief passageway under ordinary abnormal pump pressure, means restricting the flow through said relief passageway whereby relief through said passageway will be gradual, yielding means tending to hold said blow-off valve closed, said blow-off valve having a pressure surface normally unexposed to the pump discharge pressure and exposed to the flow through said relief passageway only when said passageway is opened by said relief valve, excess abnormal pump pressure first causing opening of said relief valve and then acting against said pressure surface to effect opening of said blow-off valve for quick relief of the excess pressure through said blow-off passageway.

7. A valving assembly for controlling the pressure in a rotary hydraulic pump to prevent overloading, comprising a valve chamber in the pump frame, a valve guiding member secured in said valve chamber intermediate its ends, the inner end of said valve chamber being connected with the pump to receive fluid therefrom under discharge pressure, a blow-off passageway from the inner end of said valve chamber to the exterior thereof, a blow-off valve movable in said guide member and yielding means normally holding said valve to close said blow-off passageway, a plunger head on said blow-off valve movable in the outer end of said valve chamber and normally unexposed to the pump discharge pressure, a valve chamber in said blow-off valve, a relief passageway from the inner end of said valve chamber to the exterior thereof and including the valve chamber in said blow-off valve, a relief valve in the valve chamber of said blow-off valve for said relief passageway, yielding means normally holding said relief valve closed against normal pump pressure but permitting opening thereby of said relief passageway under abnormal pump pressure, the inner side of said plunger head being exposed to the flow through said relief passageway only when said passageway is opened, whereby under excess abnormal pump pressure said relief valve will first be opened for flow through said relief passageway and said blow-off valve will then be opened by the excess pressure for opening of the blow-off passageway.

8. A valving assembly for controlling the pressure in a rotary hydraulic pump to prevent overloading, comprising a valve chamber in the pump frame, a valve guiding member secured in said valve chamber intermediate its ends, the inner end of said valve chamber being connected with the pump to receive fluid therefrom under discharge pressure, a blow-off passageway from the inner end of said valve chamber to the exterior thereof, a blow-off valve movable in said guide member and yielding means normally holding said valve to close said blow-off passageway, a plunger head for said blow-off valve movable in the outer end of said valve chamber and normally unexposed

to the pump discharge pressure, a valve chamber in said blow-off valve, a relief passageway from the inner end of said valve chamber to the exterior thereof and including the valve chamber in said blow-off valve, a relief valve in the valve chamber of said blow-off valve for said relief passageway, yielding means holding said relief valve closed against normal pump pressure but permitting opening thereby of said relief passageway under abnormal pump pressure, the inner side of said plunger head being exposed to the flow through said relief passageway only when said passageway is open, whereby under excess abnormal pump pressure said relief valve will first be opened for flow through said relief passageway and said blow-off valve will then be opened by the excess pressure for opening of said blow-off passageway, said plunger head having a restricted passageway therethrough included in the flow through said relief passageway for retarding the closure movement of said blow-off valve by its yielding means after relief of the excess pump pressure through said blow-off passageway.

9. A valving assembly for controlling the pressure in a rotary hydraulic pump to prevent overloading thereof, comprising a pressure chamber connected to receive fluid from the pump under discharge pressure, a blow-off passageway from said pressure chamber to the exterior thereof, a blow-off valve in said valve chamber and means normally releasably holding it for closure of said blow-off passageway, said blow-off valve having a pressure surface normally unexposed to the discharge pressure in said valve chamber, a second passageway for conducting fluid flow under discharge pressure from said pressure chamber against said blow-off valve surface, a valve for said second passageway and means normally yieldably holding it to close said second passageway against discharge flow under normal pressure, excess discharge pressure against said valve causing the opening thereof for flow of discharge fluid through said second passageway and against said blow-off valve surface whereby said blow-off valve will be moved for opening of said blow-off passageway.

10. A valving assembly for controlling the pressure in a rotary hydraulic pump to prevent overloading, comprising a pressure chamber connected to receive fluid from the pump under discharge pressure, a blow-off passageway from said pressure chamber to the exterior thereof, a blow-off valve in said valve chamber and means normally yieldably holding it for closure of said passageway, said blow-off valve having a pressure surface thereon normally unexposed to the discharge pressure in said pressure chamber, a passageway through said blow-off valve for the flow of fluid under discharge pressure to said pressure surface, a valve for said passageway in the blow-off valve and means normally yieldably holding said valve closed against normal pressure in said pressure chamber, excess pressure against said valve in said passageway in the blow-off valve structure causing the opening thereof for flow of fluid under discharge pressure against said pressure surface of the blow-off valve whereby said blow-off valve will then be moved for opening of said blow-off passageway.

11. A valving assembly for a rotary hydraulic pump for holding delivery pressure below a predetermined maximum, comprising a pressure chamber connected with the pump to receive fluid therefrom under discharge pressure, a blow-off

passageway from said valve chamber to the exterior of the pump, a blow-off valve movable in said pressure chamber and yielding means normally holding it for closure of said blow-off passageway, a second passageway from said pressure chamber to the exterior of the pump, said blow-off valve having a pressure surface thereon adapted to be exposed only to flow through said secondary passageway, and a check valve normally closing said second passageway against flow to said pressure surface but subjected to the pressure in said pressure chamber to open said second passageway for flow therethrough against said surface when the pump discharge pressure rises above the predetermined maximum thereby causing opening movement of said blow-off valve for opening of said blow-off passageway.

12. A valving assembly for a rotary hydraulic pump for holding the delivery pressure below a predetermined maximum, comprising a pressure chamber connected with the pump to receive fluid therefrom under discharge pressure, a blow-off passageway from said pressure chamber to the exterior of the pump, a blow-off valve movable in said pressure chamber and yielding means normally holding it for closure of said blow-off passageway, a valve chamber within said blow-off valve, a second passageway from said pressure chamber to the exterior of the pump and including said valve chamber, said blow-off valve having a pressure surface thereon exposed only to flow through said second passageway, a spring pressed check valve in said valve chamber normally closing said second passageway against flow to said pressure surface but subjected to the pressure in said pressure chamber to open said second passageway for flow therethrough against said

surface when the pump discharge pressure rises above a predetermined maximum thereby causing movement of said blow-off valve to open said blow-off passageway for reduction of the pump discharge pressure below the predetermined maximum.

13. A valving assembly for a rotary hydraulic pump for holding the delivery pressure below a predetermined maximum, comprising a pressure chamber connected with the pump to receive fluid therefrom under discharge pressure, a blow-off passageway from said pressure chamber to the exterior of the pump, a blow-off valve movable in said pressure chamber and yielding means normally holding it for closure of said blow-off passageway, a valve chamber within said blow-off valve, a second passageway from said pressure chamber to the exterior of the pump and including said valve chamber, said blow-off valve having a pressure surface thereon exposed only to flow through said second passageway, a spring pressed check valve in said valve chamber normally closing said second passageway against flow to said pressure surface but subjected to the pressure in said pressure chamber to open said second passageway for flow therethrough against said surface when the pump discharge pressure rises above a predetermined maximum thereby causing movement of said blow-off valve to open said blow-off passageway for reduction of the pump discharge pressure below the predetermined maximum, and means in said second passageway for resisting the flow therethrough when said check valve is open whereby to retard the opening movement of said blow-off valve.

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