

H. SPILLMANN.
HYDRAULIC POWER PLANT.
APPLICATION FILED FEB. 19, 1912.

1,064,390.

Patented June 10, 1913.

7 SHEETS—SHEET 1.

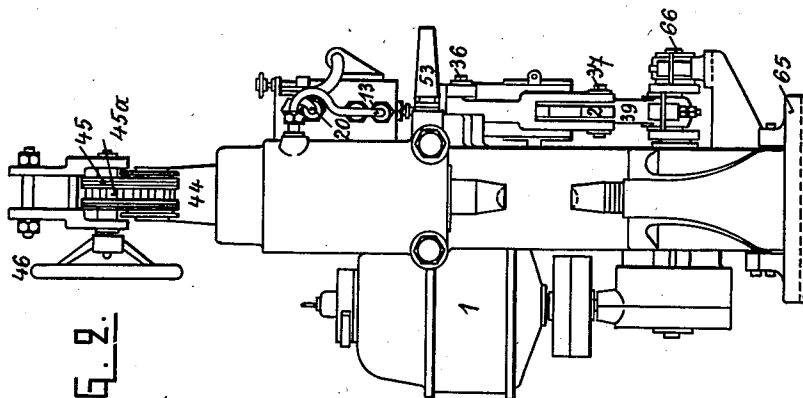


FIG. 2.

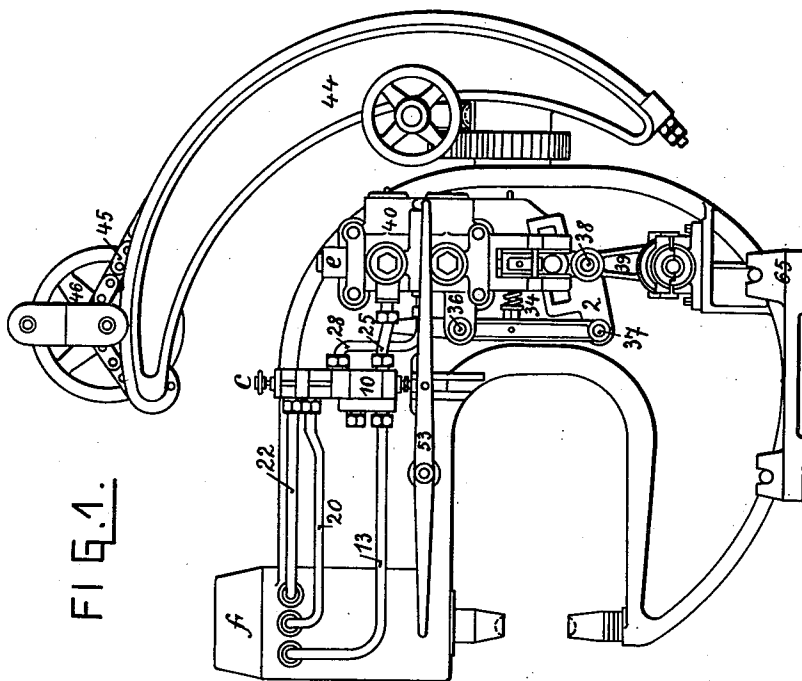


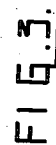
FIG. 1.

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7 SHEETS—SHEET 2.



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7 SHEETS—SHEET 3.

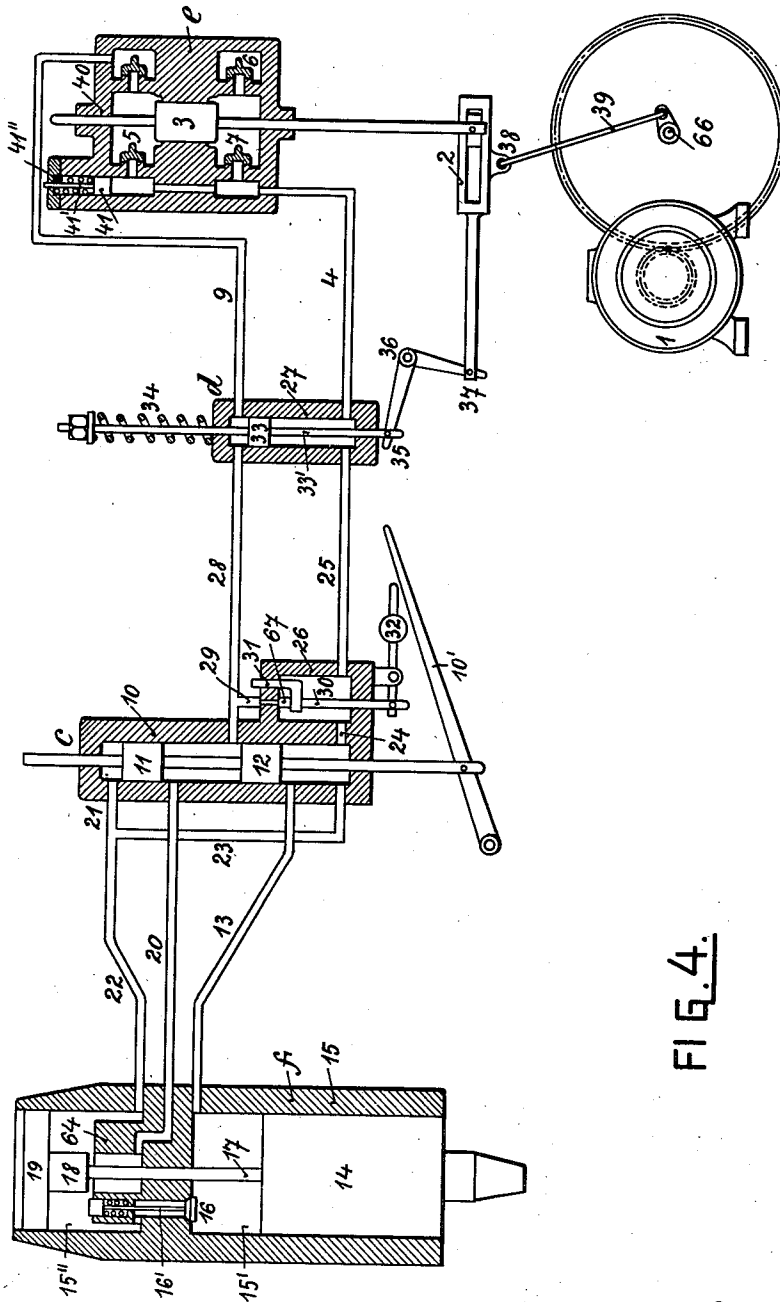


FIG. 4.

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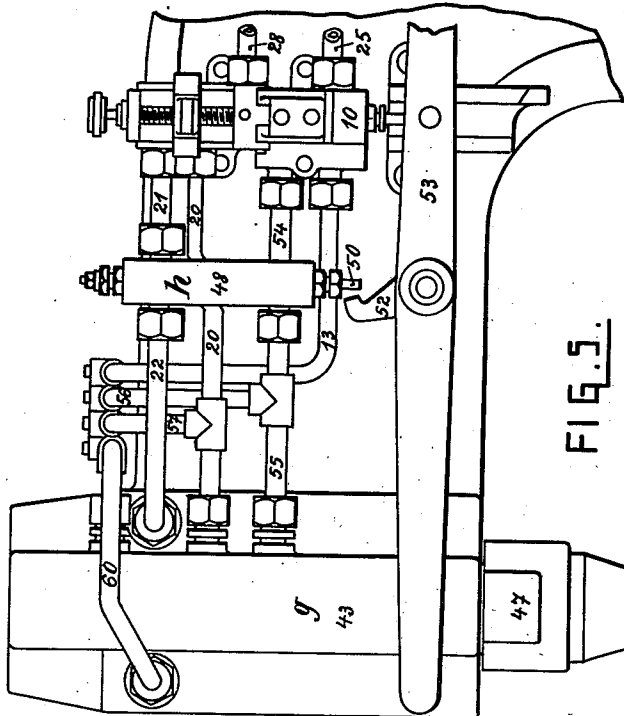
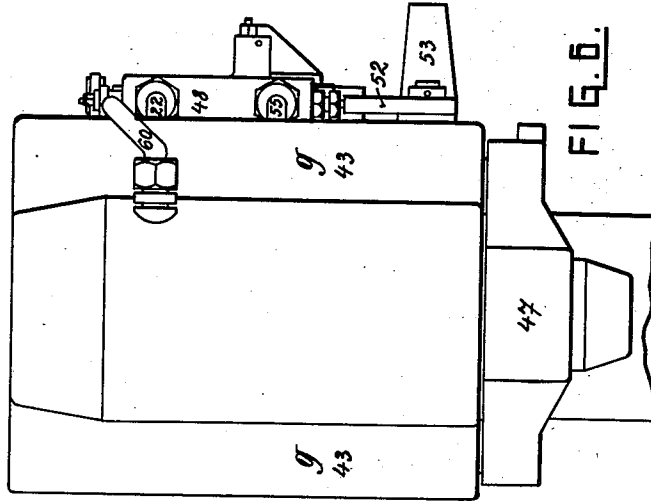
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7 SHEETS—SHEET 4.



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7 SHEETS—SHEET 5.

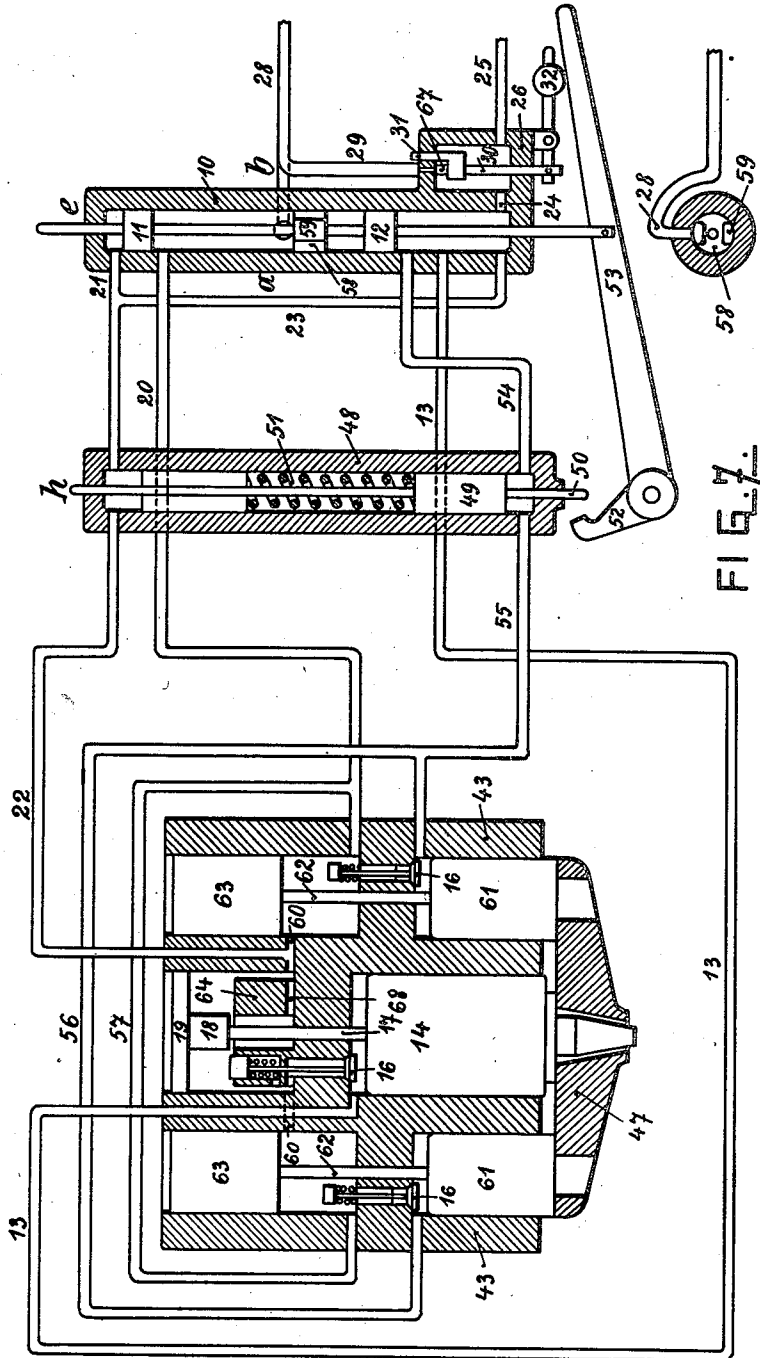


FIG. 7a.

FIG. 7.

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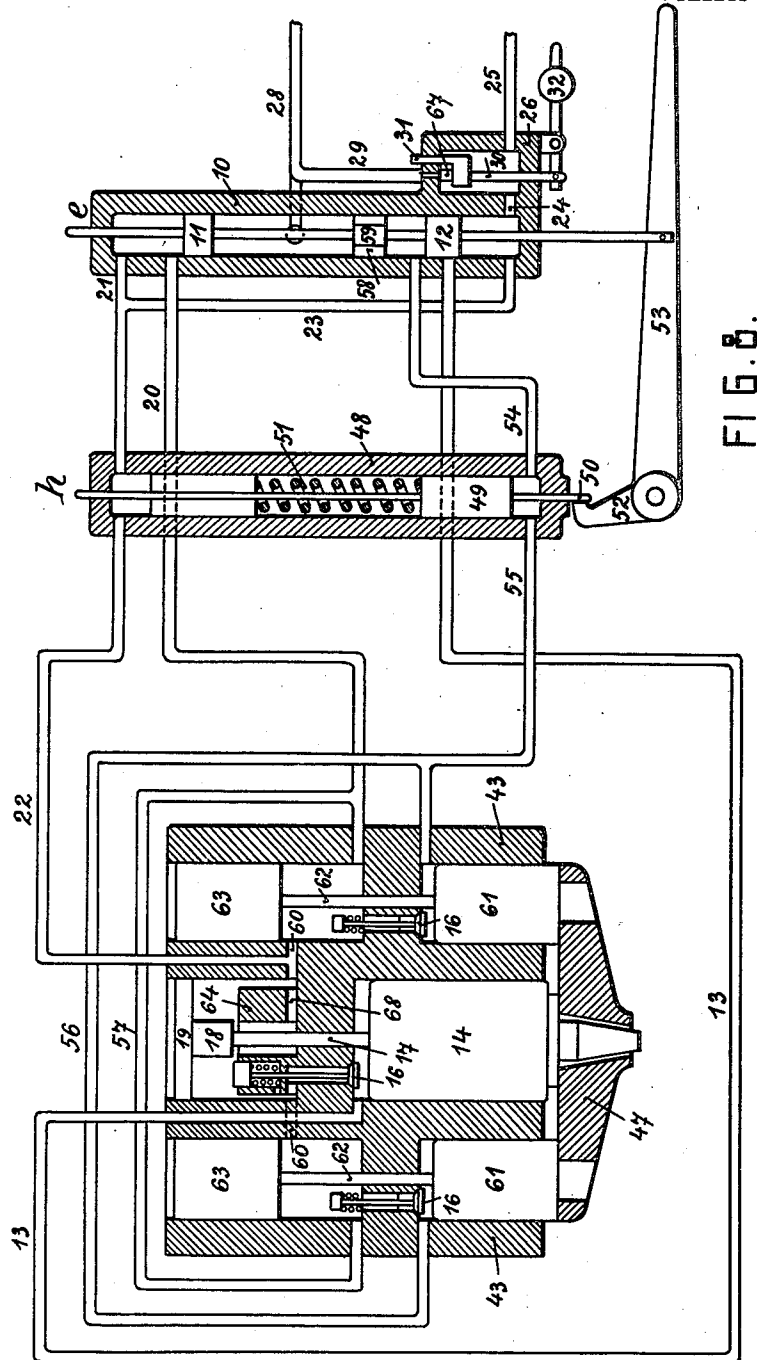
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7 SHEETS—SHEET 6.



Witnesses:
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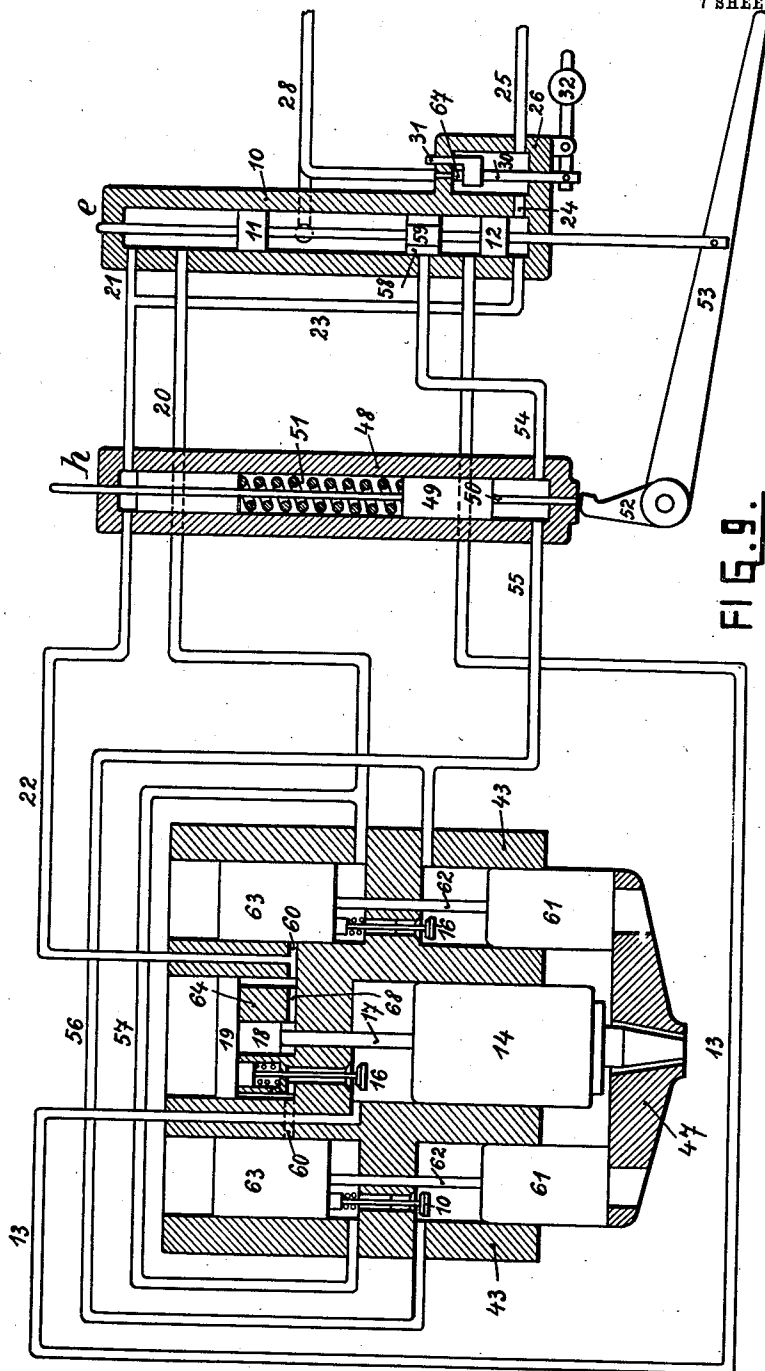
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7 SHEETS—SHEET 7.



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UNITED STATES PATENT OFFICE.

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HYDRAULIC-POWER PLANT.

1,064,390.

Specification of Letters Patent.

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Application filed February 19, 1912. Serial No. 678,695.

To all whom it may concern:

Be it known that I, HEINRICH SPILLMANN, a citizen of the Swiss Republic, and residing at Zurich, Switzerland, have invented certain new and useful Improvements in Hydraulic-Power Plants, of which the following is a specification.

The subject-matter of my invention is a hydraulic power plant whose essential feature is that the double-acting pump-plunger and press-plunger of the hydraulic power plant operate in such manner in a system completely shut off from the action of the outer atmosphere and completely filled with liquid that, without any change in the magnitude of the total volumetric capacity of the system filled with liquid, to each increase in volume of the chambers connected to the delivery chamber of the double-acting pump there nevertheless corresponds an equally large diminution in volume of the chambers connected to the suction chamber of the double-acting pump and, reversely, to each diminution in volume of the former chambers there corresponds an equally large increase in volume of the latter chambers.

Hydraulic machines of all kinds can be provided with a hydraulic power plant according to my invention. Hydraulic machines for pressing; embossing, riveting, stamping, perforating or hydraulic shears, as well as hydraulic lifting gear can be operated in the described manner, and it is immaterial whether these machines are portable or stationary. More particularly, a hydraulic power plant according to the invention can be used for tilting Bessemer converters and for turning the rudders of ships, because particularly in the latter case, which is specially suitable for the employment of the invention, motive power due to high speed and small force must be converted into work of great force at low speed.

In the above-described hydraulic plant many advantages are obtained as compared with well-known hydraulic machines; for example, owing to the atmosphere exercising no action on the working liquid of the hydraulic machine the entire liquid of the machine constitutes, as it were, one uniform rigid body, and a perfectly positive circulation of liquid occurs both in the delivery, and in the suction chamber of the system and in the chambers connected thereto. Thus, when the pump-plungers move, al-

though no suction or delivery air-vessel is employed, the column of liquid in the machine can never rupture, so that no hydraulic hammering and blows with their injurious consequences for the pump and gearing can ever occur. Further, a hydraulic machine according to my invention is able to work in any desired position without the system filled with liquid emptying, and without the machine being subjected to any injurious strain. Furthermore, the herein described hydraulic plant may comprise a high-speed, high-pressure pump which possesses no kind of suction and delivery air-vessel, as well as valves without any auxiliary load, because the acceleration and retardation of the column of liquid take place positively both in the suction chamber and also in the delivery chamber and in the chambers connected thereto whenever the plunger of the pump moves.

In a hydraulic machine constructed according to my invention it is necessary that the press-plunger of the machine be rigidly connected with a second plunger or piston of equal volumetric displacement which works in a chamber connected to the suction chamber of the pump while the press-plunger moves in a chamber connected to the delivery chamber. This balancing plunger or piston is preferably formed with a large and a small piston, whereby I attain that the return movement of the press-plunger takes place at a velocity considerably greater than that of the forward movement thereof.

Another important feature of my invention is that owing to suitably arranged valves, or to the arrangement of the driven pistons of the press-cylinder and of the ports in the manner of a slide-valve, provision is made that when the press-plunger is in its end position the suction and delivery chambers of the system are automatically connected, because otherwise the parts of the gearing in the machine could be subjected to undesirable strain.

A hydraulic power plant according to my invention also comprises a device which prevents an evacuated space being formed when a diminution of liquid occurs, say in consequence of leaks, within the system shut off from the atmosphere. This device substantially consists of a loaded, displaceable piston or the like which bounds the system

filled with liquid, and moves forward when a diminution of liquid occurs and thereby diminishes the volumetric capacity of the system.

5 When the hydraulic power plant constructed according to my invention constitutes a hydraulic machine of the type of a hydraulic press, *e. g.* a riveting-machine, this machine can be very conveniently combined with a plate-closer which, before a
10 rivet is pressed, compresses the plates to be riveted. The plate-closer is constructed like the main press, it being carried by press-plungers which are likewise connected with balancing pistons; by means of a separate
15 pipe from the distributing device these pistons are operated in such manner through the medium of the operating lever that the plate-closer die is first pressed down, then the press-plunger provided with
20 the snap head die is driven forward while the plate-closer die remains under pressure, and lastly the closing die is subsequently lifted. The closing die drives with it the
25 press-plunger until, when reaching its end position, the balancing pistons of the plate-closer automatically connect the delivery chamber of the machine with the suction chamber.

30 For the purpose of making it impossible for a machine provided with a plate-closer to be operated improperly, such a machine is provided with a hydraulic locking device for the operating lever whose locking
35 member, located in its rest position in the path of the operating lever, is connected with a spring-pressed piston; this piston is in the system filled with liquid and, under the action of the liquid pressure, removes
40 the locking member out of the way of the operating lever only when the plate-closer die is pressed down, so that the operating lever can be moved still farther for the purpose of starting the motion of the press-plunger only after the closing die has been
45 pressed down.

One illustrative embodiment of my invention is represented by way of example in the accompanying drawing, wherein:—

50 Figures 1 and 2 are side elevation and front elevation, respectively, showing a complete hydraulic riveting-machine according to the invention, but without the plate-closer; Figs. 3 and 4 are diagrams showing
55 the internal connection of this machine, Fig. 3 showing the parts of the machine at the moment after the termination of the depression of the press-plunger, the controlling members being still adjusted to pressure, while Fig. 4 shows the parts of the machine
60 at the moment after the press-plunger has been lifted, that is while the machine runs idle. Figs. 5 and 6 are side and front elevation, respectively, showing part of a
65 machine comprising a plate-closer, and Figs.

7, 7^a, 8 and 9 are diagrams showing the internal connections of the latter machine and its plate-closer; Fig. 7 shows the machine in its rest position with the press-plunger raised, Fig. 8 in the position in
70 which the plate-closer commences to operate and Fig. 9 in the compressing position, while Fig. 7^a is a detail view.

Referring to the drawings, the hydraulic riveting machine represented in Figs. 1 to 4
75 substantially consists of the high-pressure double-acting piston-pump *e* driven by an electric motor 1, the part *f* of the press, the distributing device *c*, and the speed governor *d* not shown in Figs. 1 and 2. The
80 machine is arranged in such manner that it can be readily conveyed from place to place and comprises a suspension bow 44 to whose two ends is attached in a novel and improved manner a flexible suspension member
85 45, *e. g.* a chain, rope, belt or the like. The machine is suspended by means of this member 45 from a sprocket-wheel 45^a which can be rotated by means of a hand-wheel 46 so that the entire machine can be readily rotated
90 in a plane passing through the bow 44. Owing to employing the flexible suspension member the bow 44 may remain unworked, *i. e.* can be employed in its untrimmed cast condition. When the machine
95 is to be employed vertically I use a special base-plate 65 which is a member independent of the machine proper, and consequently the weight of the machine is less during transport and when used suspended than
100 if the base-plate were rigidly attached to it.

The machine represented in Figs. 5 to 9 comprises the plate-closer *g* and the hydraulic locking device *h* in addition to the other parts of the machine.

I will now describe the construction of the machine shown in Figs. 1-4 with reference to its mode of operation. The motor 1 imparts its rotatory motion in known manner to a crank-shaft 66 by which it is imparted by a connecting-rod 39 to an adjustable lever 2. The piston 3 of a double-acting, high-speed, high-pressure force pump possessing neither suction nor delivery air-vessel is connected with this lever. When
110 the plunger 3 moves liquid is sucked out of the suction pipe 4 and liquid is forced into the pipe 9, both the suction valve 5 and the pressure valve 6, and the suction valve 7 and the pressure valve 8 opening alternately. Each movement of the plunger 3 results in a diminution in volume of equal size in both the suction chamber and also in the delivery chamber which is of importance for the running of the machine. After
115 flowing through the pressure valves 6 and 8 the liquid passes into the pipes 9 and 28 and arrives between the two distributing pistons 11 and 12 of the distributing device *c*. In the position of these pistons connected
120 125 130

with the operating lever 10' shown in Fig. 3, *i. e.* in the pressure position, the liquid under pressure is conducted through the pipe 13 to over the press-plunger 14 movable in the pressure chamber 15' in the press-cylinder 15. The press-plunger consequently moves downward, because the valve 16 in the press-cylinder is normally closed, as shown in Fig. 4, and finally arrives into its lowest position shown in Fig. 3. When the plunger 14 moves downward it drives the balancing piston 18, 19 comprising the two pistons 18 and 19, which is movable in the balancing chamber 15'' and is connected by the rod 17 with the plunger 14. The liquid under the piston 18 escapes through the pipe 20 into the distributing box or cylinder 10 and hence into the pipe 23. The liquid under the piston 19 escapes through the pipe 22 also into the pipe 23. As the total area of the pistons 18 and 19 is equal to the operative area of the plunger 14, the volume of liquid displaced by the piston 18, 19 is equal to the volume of liquid which enters over the plunger. The pipe 23 conducts the liquid through the cylinder 10, the duct 24, the box 26 of the pressure adjusting valve 67, and from here through the pipe 25 and the casing 27 of the hydraulic speed governor *d* into the above-mentioned suction pipe 4. As soon as the piston 19 has reached its lowest position it abuts against the top end of the rod 16' of the valve 16 and opens this valve so that a connection of the plunger chamber 15' is established with the pipe 22 and a circulation of liquid not under pressure occurs. The maximum height of the hydraulic pressure produced in the pipe 28 and consequently above the plunger 14 is limited by the valve 67 which is pressed by means of an adjustable weight 32 or a spring on its seat. The load on this valve is so adjusted that it corresponds to the desired working pressure of the machine tool. If this pressure is exceeded the valve 67 controlling the branch pipe 29 to the pipe 28 opens until the hydraulic pressure has diminished to the maximum admissible value. The valve 67 has a guide-rod 31 having a section equal to that of the valve-rod 30, so that when the position of the valve changes no change of volume of the chamber in the box 26 takes place. The liquid pressure existing in the pipes 9 and 28 when the distributing valve-gear is in the position shown in Fig. 3 is used for regulating the velocity of the press-plunger by operating in the governor *d*. This governor comprises a casing 27 in which is slidable a piston 33 which is under the influence of both a spring 34 and the liquid pressure in the pipes 9 and 28. According to the height of the liquid pressure for the time being the piston 33 occupies various positions in its casing 27. The lower

end of the piston-rod 33' is connected with one arm 35 of a two-armed lever 35, 37 fulcrumed at 36 on the frame of the machine. The other arm 37 of this two-armed lever is connected in such manner with the lever 2 that a change of position of the arm 37 causes a change of position of the lever 2 and its point of attachment 38 to the connecting-rod 39. Owing to the change of position of the lever 2 the stroke of the pump-plunger 3 is varied in such manner that when the pressure on the piston 33 increases, the stroke of the plunger piston decreases and consequently the velocity of the press-plunger 14 is diminished. Owing to the piston-rod 33' being equally thick at the two sides of its piston 33, when this piston changes its position an equally large change of volume occurs in the suction and delivery chambers of the machine. At the end of the suction pipe 4, thus at a place which is never subjected to pressure, is arranged that device which prevents an evacuated chamber being formed should a diminution of liquid occur inside the system, say in consequence of leaks. For receiving this device the top end of the body 40 of the pump is formed like a casing and contains a spring-pressed piston 41. When the circulation of the liquid is normal this piston does not move, because the volumes of liquid in the suction chamber and in the delivery chamber displaced by the movable members of the machine in the system are equally large. If a diminution of liquid occurs in the system owing to leakage, however, whereby an evacuated chamber disturbing the running of the machine would be formed, the piston 41 is automatically pushed forward so that an evacuated chamber cannot form. The piston-rod 41' is preferably graduated or provided with a mark in operative relation with a scale, so that the level of the liquid in the system is indicated by the position of this piston-rod. The piston 41 is so arranged that it can be removed together with its spring 41'' out of the casing, so that fresh liquid can be poured through the opening thus made into the system.

In contradistinction to Fig. 3 which shows the parts of the machine at the moment after the termination of the downward motion of the press-plunger, *i. e.* in the pressure position, Fig. 4 shows the machine at the moment after the press-plunger has begun to be lifted, *i. e.* when running idle. When the operating lever together with the pistons 11 and 12 connected with it are moved out of the position shown in Fig. 3 into that shown in Fig. 4, the liquid is led out of the pipe 28 through the pipe 20 to under the small piston 18 of the piston 18, 19. This is thereby lifted and elevates the plunger 14 with as much greater velocity as the

area of the piston 18 is smaller than the area of the plunger 14. The guide 64 of the piston is of such a length that as soon as the plunger 14 has reached its highest position the piston 18 leaves this guide 64, whereby the connection between the delivery and suction chambers, *i. e.* the connection between the pipes 20 and 22 and 13, is again established. By designing the guide 64 in this way I provide that the highest position of the plunger 14 is limited without the aid of a valve which, having regard to the rapid velocity of lift, results in a very simple plant certain of operation. The plunger 14 and the pistons 18 and 19 connected together remain in their upper position when the distributing members 11, 12 are in the position shown in Fig. 4, because the frictional resistance of the leather-collars of the plunger and pistons and of the packing of the rod 17 is so great that it cannot be overcome by the weight of the parts 14, 17, 18. The distributing pistons 11 and 12 together with their piston-rods are so constructed that their displacement does not result in a change of volume in either the suction chamber or in the delivery chamber.

The plate-closer comprised in the machine represented in Figs. 5 to 9 which compresses the plates before pressing a rivet comprises a casing 43 in which move the two plate-closing plungers 61 having the piston-rods 62 and the balancing piston 63. Between the chambers containing the plungers 61 and the pistons 63 are arranged valves 16 having the same function as the valve 16 described above with reference to Figs. 3 and 4. The two plungers 61 are connected below by the plate-holder or closing die 47 which imparts the total pressure to the plate to be compressed. The additional details of the plate-closer will now be explained with reference to their mode of operation and to Figs. 7, 8 and 9. In the position of the operating lever 53 shown in Fig. 7, *i. e.* in the idle position of the machine, the liquid supplied by the pump flows through the pipe 28 to between the pistons 11 and 12 in the distributing device and flows through the pipes 20 and 57 to under the two balancing pistons 63. As these pistons are already in their highest position a connection with the pipe 22 is established through the additional ducts 60. The space under the pistons 18, 19 is permanently connected with the pipe 22, and the liquid consequently returns through the pipe 23, duct 24, and pipe 25 to the pump without any pressure being produced. Thus when the operating lever is in the position shown in Fig. 7 the liquid circulates without exerting any appreciable pressure. Now when the operating lever 53 is tilted over out of its position shown in Fig. 7 into that shown in Fig. 8, in which the plate-closer operates,

the distributing pistons 11 and 12 occupy a different position relatively to the appertaining pipes. The pressure liquid then flows from the pipe 28 through the ports 59 in the middle distributing piston 58 (Fig. 7^a) provided in addition in a machine having a plate-closer, and through the pipes 54, 55, and 56 to over the two plate-closer plungers 61. These then move downward and simultaneously push the plate-holder or closing die 47 down until it impacts on the plates to be riveted. The balancing plungers 63 are driven through the medium of the rods 62 by the plungers 61, and the liquid displaced by these balancing plungers returns through the pipes 57, 20, 21, 23, duct 24 and pipe 25 into the suction pipe 4 of the pump. When the closing die 47 is stopped by striking on the plates to be compressed, the liquid above the plungers 61 and in the pipes 28, 54, 55 and 56 is subjected to pressure. As soon as the liquid in the pipes 54 and 55 is subjected to pressure the safety device *h* connected with the plate-closer for preventing improper operation is actuated. This safety device *h* comprises the casing 48 containing a piston 49 which is pressed by a spring 51, and has a piston-rod 50. The spring 51 presses the piston 49 so low down in the position of the parts of the machine shown in Figs. 7 and 8 that the piston-rod 50 projects into the path of the catch 52 of the operating lever 53. In this position of the piston-rod 50 the operating lever 53 cannot be moved out of the position shown in Fig. 7 by way of the position shown in Fig. 8 into the position shown in Fig. 9 which would cause disturbance in working. As soon as pressure occurs in the pipes 54 and 55 which open below the piston 49 of the hydraulic safety device, however, the piston 49 together with the piston-rod 50 is lifted and the catch 52 is released, so that it can now be returned into the position shown in Fig. 9 in which the rivet is closed. In this position of the operating lever according to Fig. 9, the pressure liquid delivered by the pump flows through the pipe 28 to between the distributing pistons 11 and 12 and through the pipe 13 to over the press-plunger 14 and drives the latter together with the piston 19, 18 downward. The closing die 47 remains under pressure as the pipe 54 is now closed by the piston 58. The liquid displaced when the press-plunger moves downward returns through the pipes 22, 23, and 25 to the pump. As soon as the press-plunger 14 and with it the closing plungers 61 have arrived at their lowest positions a connection is automatically established between the delivery and suction sides of the pump owing to the valves 16 opening. When the operating lever is returned out of its pressing position as shown in Fig. 9 into

its rest position as shown in Fig. 7, the pressure liquid flows out of the pipe 28 through the pipes 20, 57 to under the balancing plungers 63. These plungers are lifted together with the plungers 61 and the closing die 47, the closing die simultaneously driving the plunger 14 and the pistons 19, 18 upward. The liquid displaced by the two plungers 61 then returns through the pipes 56, 55, 54, duct 24 and pipe 25 to the pump, while the liquid displaced by the press-plunger 14 flows through the pipes 13, 23, 22, ducts 60 and 68 to under the pistons 18 and 19. The movement of the plungers 14 and 61 ceases as soon as the plungers 63 open the ports 60, because at this moment the liquid can circulate without exerting any material pressure, as described above with reference to Fig. 7. When the plungers 14 and 61 move backward the liquid pressure also ceases in the casing 48 of the safety device *k*, so that the spring 51 drives the piston 49 forward into its locking position shown in Fig. 7.

I claim:—

1. In a hydraulic power plant, the combination with a closed hydraulic system filled with liquid, shut off from the influence of the atmosphere and comprising a suction chamber, a delivery chamber, and a double-acting piston pump connected with said chambers, of a cylinder containing a pressure-chamber, and having a second chamber adapted to be connected with said suction chamber, a press-plunger movable in said pressure-chamber, a member rigidly connected with the press-plunger and movable in said second chamber, and distributing means for connecting the said pressure chamber either with the said delivery chamber or with the said suction chamber, the volumetric displacement of the liquid caused during two or more strokes of the double-acting piston-pump by the motion of the said member being equal to that caused by the motion of the press-plunger.

2. In a hydraulic power plant, the combination with a closed hydraulic system filled with liquid, shut off from the influence of the atmosphere and comprising a suction chamber, a delivery chamber, and a double-acting piston pump connected with said chambers, of a cylinder containing a pressure-chamber and a balancing chamber, a press-plunger movable in said pressure-chamber, a balancing piston rigidly connected with the press-plunger and movable in said balancing chamber, and distributing means for connecting the said pressure chamber either with the said delivery chamber or with the said suction chamber, and the said balancing chamber either with the said suction chamber or with the said delivery chamber; the volumetric displacement of the liquid caused during two or more strokes of the double-acting piston pump by

the motion of the said balancing piston being equal to that caused by the motion of the press-plunger.

3. In a hydraulic power plant, the combination with a closed hydraulic system filled with liquid, shut off from the influence of the atmosphere and comprising a suction chamber, a delivery chamber, and a double-acting piston-pump connected with said chambers, of a cylinder containing a pressure-chamber and a balancing chamber, a press-plunger movable in said pressure chamber, a balancing piston rigidly connected with the press-plunger and movable in said balancing chamber, distributing means for connecting the said pressure chamber either with the said delivery chamber or with the said suction chamber, and the said balancing chamber either with the said suction chamber or with the said delivery chamber, and means in the balancing chamber coacting with the said piston for automatically connecting the delivery chamber with the suction chamber in the outer end position of the press-plunger, the volumetric displacement of the liquid caused during two or more strokes of the double-acting piston-pump by the motion of the said balancing piston being equal to that caused by the motion of the press-plunger.

4. In a hydraulic power plant, the combination with a closed hydraulic system filled with liquid, shut off from the influence of the atmosphere and comprising a suction chamber, a delivery chamber, and a double-acting piston-pump connected with said chambers, of a cylinder containing a pressure-chamber and a balancing chamber, a press-plunger movable in said pressure-chamber, a balancing piston comprising a larger and a smaller piston rigidly connected with the press-plunger and movable in the said balancing chamber, and a wall or guide in said balancing chamber dividing the same into a smaller and a larger chamber, the said larger piston being movable only in the said larger chamber and the said smaller piston being movable in both the smaller and larger chambers, a pipe connected to said pressure chamber, a suction pipe connected to said larger chamber, a pipe connected to said smaller chamber, and a distributing device connecting said suction pipe to said suction chamber, and adapted to connect the former and latter pipes to said delivery and suction chambers, respectively, and reversely, the volumetric displacement of the liquid caused during two or more strokes of the double-acting piston-pump by the motion of the said balancing piston being equal to that caused by the motion of the press-plunger.

5. In a hydraulic power plant, the combination with a closed hydraulic system filled with liquid, shut off from the influence of

the atmosphere and comprising a suction chamber, a delivery chamber, and a double-acting piston-pump connected with said chambers, of a cylinder containing a pressure-chamber and a balancing chamber, a press-plunger movable in said pressure-chamber, a balancing piston comprising a larger and a smaller piston rigidly connected with the press-plunger and movable in the said balancing chamber, and a wall or guide in said balancing chamber dividing the same into a smaller and a larger chamber, the said larger piston being movable only in the larger chamber, and the smaller piston being movable in both the smaller and larger chambers, a pipe connected to said pressure chamber, a suction pipe connected to said larger chamber, a pipe connected to said smaller chamber, and a distributing device connecting said suction pipe to said suction chamber, and adapted to connect the former and latter pipes to said delivery and suction chambers, respectively, and reversely, a connection being between the two latter pipes in said balancing chamber when the smaller piston leaves said guide, for the purpose specified.

6. In a hydraulic power plant, the combination with a closed hydraulic system filled with liquid, shut off from the influence of the atmosphere and comprising a suction chamber, a delivery chamber and a double-acting piston-pump connected with said chambers, of a cylinder containing a pressure-chamber and a balancing chamber, a press-plunger movable in said pressure-chamber, a balancing piston rigidly connected with the press-plunger and movable in said balancing chamber, means for automatically connecting the pressure chamber with the balancing chamber in the outer end position of the press-plunger, and distributing means for connecting the said pressure chamber either with the said delivery chamber or with the said suction chamber, and the said balancing chamber either with the said suction chamber or with the said delivery chamber, the volumetric displacement of the liquid caused during two or more strokes of the double-acting piston-pump by the motion of the said balancing piston being equal to that caused by the motion of the press-plunger.

7. In a hydraulic power plant, the combination with a closed hydraulic system filled with liquid, shut off from the influence of the atmosphere and comprising a suction chamber, a delivery chamber, and a double-acting piston-pump connected with said chambers, of a cylinder containing a pressure-chamber and a balancing chamber, a press-plunger movable in said pressure-chamber, and a balancing piston rigidly connected with the press-plunger and movable in said balancing chamber, a port con-

necting the pressure-chamber with the balancing chamber, and a loaded valve normally closing said port, said valve having a valve rod extending into the balancing chamber and adapted to be driven by said piston, and distributing means for connecting the said pressure chamber either with the said delivery chamber or with the said suction chamber, and the said balancing chamber either with the said suction chamber or with the said delivery chamber, the volumetric displacement of the liquid caused during two or more strokes of the double-acting piston-pump by the motion of the said balancing piston being equal to that caused by the motion of the press-plunger.

8. In a hydraulic power plant, the combination with a closed hydraulic system filled with liquid, shut off from the influence of the atmosphere and comprising a suction chamber, a delivery chamber, and a double-acting piston-pump connected with said chambers, of a cylinder containing a pressure-chamber and a balancing chamber, a press-plunger movable in said pressure-chamber, a balancing piston rigidly connected with the press-plunger and movable in said balancing chamber, and distributing means for connecting the said pressure chamber either with the said delivery chamber or with the said suction chamber, and the said balancing chamber either with the said suction chamber or with the said delivery chamber, said suction chamber having a part formed as a cylinder, and a loaded, movable, closure piston in said cylinder, the volumetric displacement of the liquid caused during two or more strokes of the double-acting piston-pump by the motion of the said balancing piston being equal to that caused by the motion of the press-plunger.

9. In a hydraulic power plant, the combination with a closed hydraulic system filled with liquid, shut off from the influence of the atmosphere and comprising a suction chamber, a delivery chamber and a double-acting piston-pump connected with said chambers, of a casing comprising both a press-plunger chamber, a balancing piston-chamber, a closing-die-plunger chamber and a balancing plunger-chamber, a press-plunger movable in said press-plunger chamber, a balancing piston movable in said piston-chamber and rigidly connected with the press-plunger, a closing die plunger movable in said closing-die-plunger chamber, a closing die attached to the latter plunger, a port in the casing connecting the said piston-chamber with the said balancing plunger chamber, a balancing plunger movable in said balancing plunger-chamber normally closing said port and rigidly connected with said closing-die-plunger, and distributing means for connecting the chambers in said

casing to said suction and delivery chambers, the said closing-die-plunger chamber being first connected to the said delivery chamber, the press-plunger chamber being subsequently connected to the said delivery chamber, whereupon the press-plunger chamber is connected to the said suction chamber and the balancing plunger-chamber is connected to the said delivery chamber.

10 10. In a hydraulic power plant, the combination with a closed hydraulic system filled with liquid, shut off from the influence of the atmosphere and comprising a suction chamber, a delivery chamber and a double-
15 acting piston-pump connected with said chambers, of a casing comprising a press-plunger chamber, a balancing piston-chamber, a closing-die-plunger chamber and a balancing plunger-chamber, a press-plunger movable in said press-plunger chamber, a balancing piston movable in said piston-chamber and rigidly connected with the
20 press-plunger, a closing-die plunger movable in said closing-die-plunger chamber, a closing die attached to the latter plunger, a port in the casing connecting the piston chamber with the balancing plunger-chamber, and a balancing plunger movable in said balancing plunger chamber, normally closing said port and rigidly connected with said closing-die plunger, distributing means comprising a cylinder, three rigidly connected pistons in the cylinder, the middle piston of the said three pistons having ports in the same, and an operating lever connected to the said three pistons, and pipes, substantially as shown, connecting the said cylinder with the said chambers for actuating said plungers therein.

11. In a hydraulic power plant, the combination with a closed hydraulic system

filled with liquid, shut off from the influence of the atmosphere and comprising a suction chamber, a delivery chamber and a double-acting piston pump connected with said chambers, of a casing comprising both a
45 press-plunger chamber, a balancing piston-chamber, a closing-die-plunger chamber and a balancing plunger chamber, a press-plunger movable in said press-plunger chamber, a balancing piston movable in said piston-chamber and rigidly connected with the press-plunger, a closing-die plunger movable in said closing-die-plunger chamber, a closing die attached to the latter plunger, a port
50 in the casing connecting the said piston-chamber with the said balancing plunger chamber, a balancing plunger movable in said balancing plunger-chamber, normally closing said port and rigidly connected with said closing-die plunger, a distributing device connected to said suction and delivery chambers, said distributing device comprising a cylinder, and three rigidly connected
55 pistons of equal size in the cylinder, the middle piston of the said three pistons having ports in the same, an operating lever connected to the said three pistons; four pipes, substantially as shown, connecting the distributing device with the chambers in said casing, a hydraulic spring-pressed locking device connected in a pipe connecting the distributing device with the said closing-die-plunger chamber for locking said operating lever.
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In testimony whereof, I affix my signature in the presence of two witnesses.

HEINRICH SPILLMANN.

Witnesses:

CARL GUBLER,
HARRY A. McBRIDE.