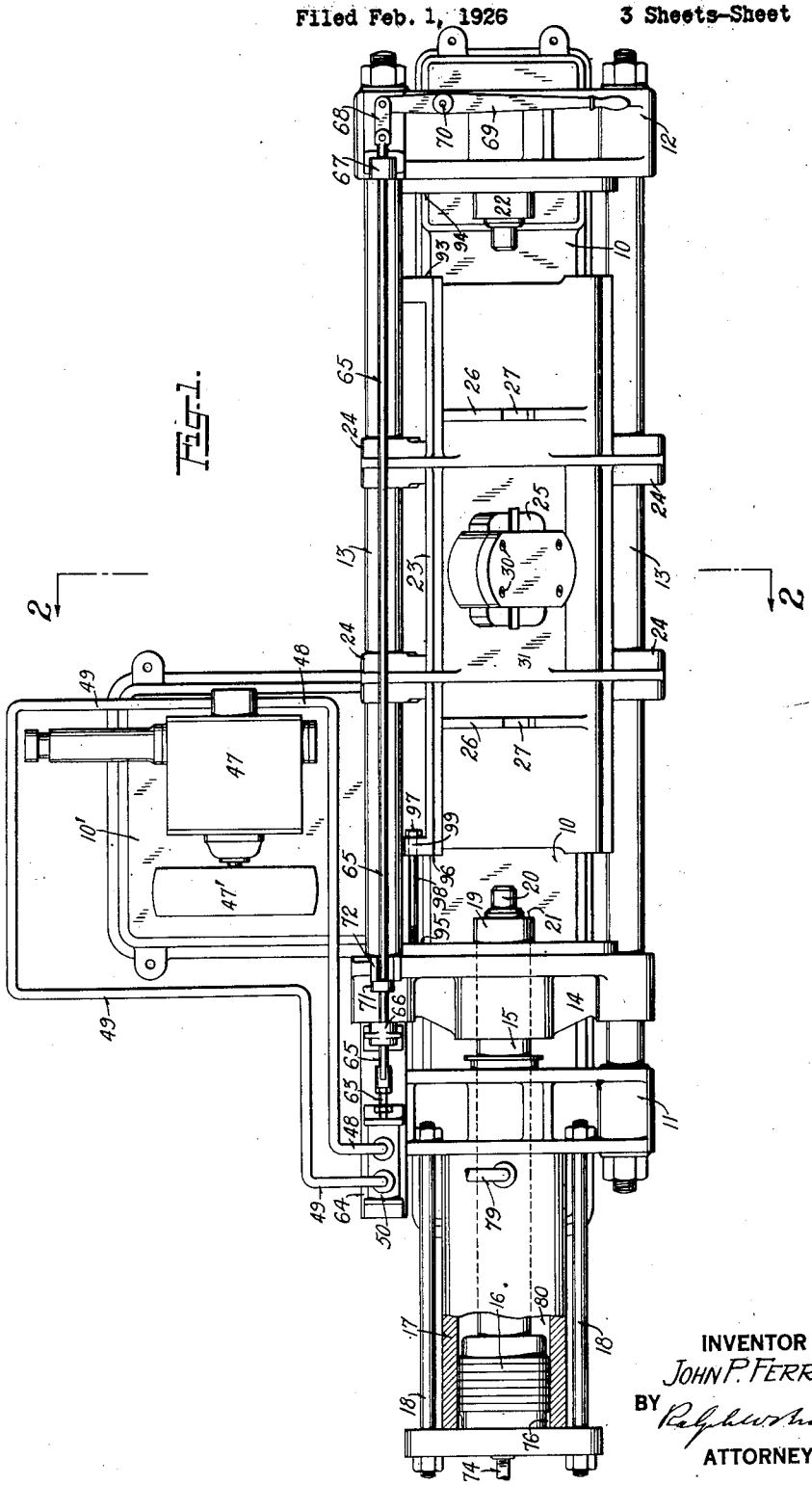
July 17, 1928. 1,677,860

J. P. FERRIS

ASSEMBLY PRESS

Filed Feb. 1, 1926 3 Sheets-Sheet 1

Fig. 1.



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July 17, 1928. 1,677,860

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ASSEMBLY PRESS

Filed Feb. 1, 1926 3 Sheets-Sheet 2

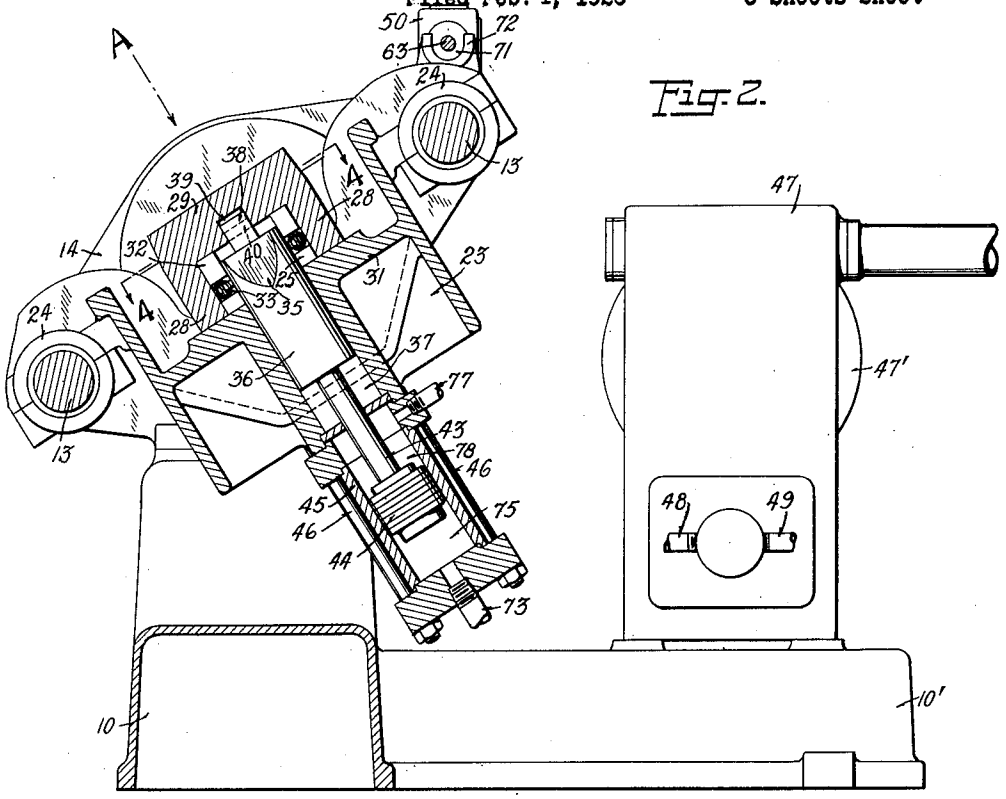

Fig. 2.

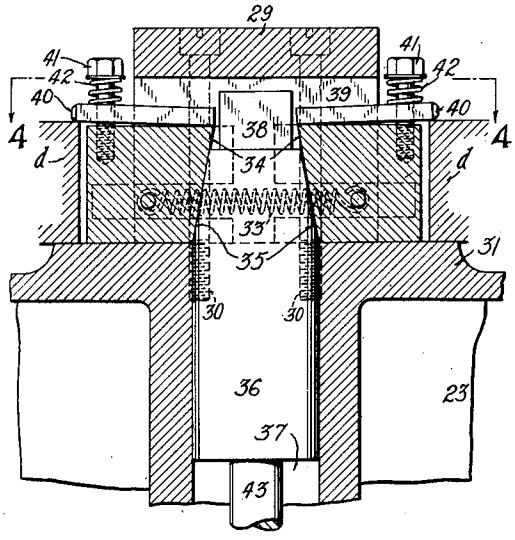

Fig. 3.

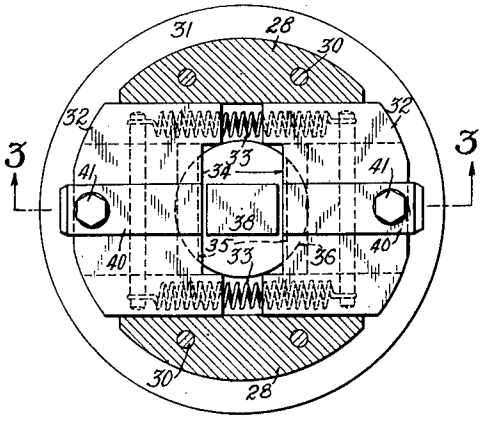

Fig. 4.

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Filed Feb. 1, 1926 3 Sheets-Sheet 3

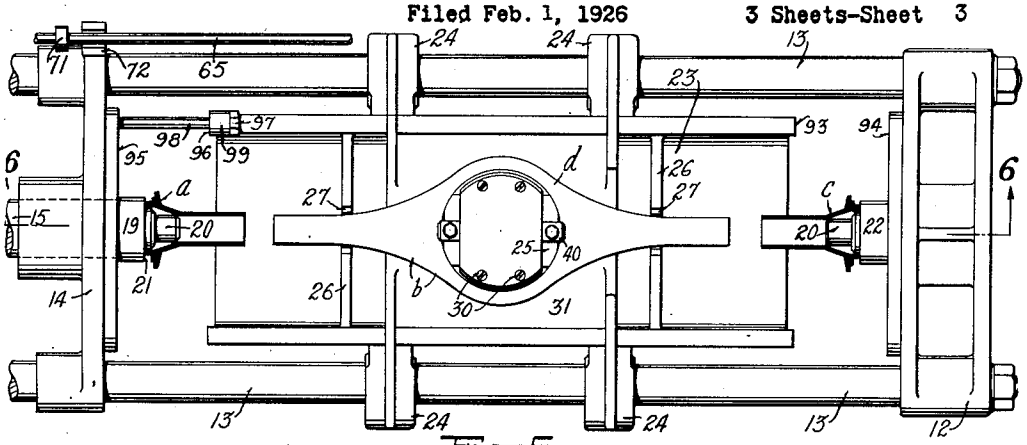

Fig. 5.

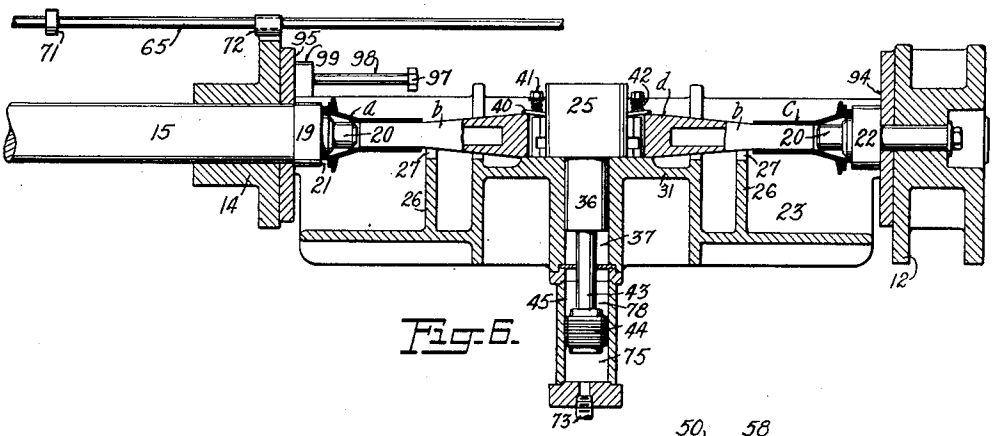

Fig. 6.

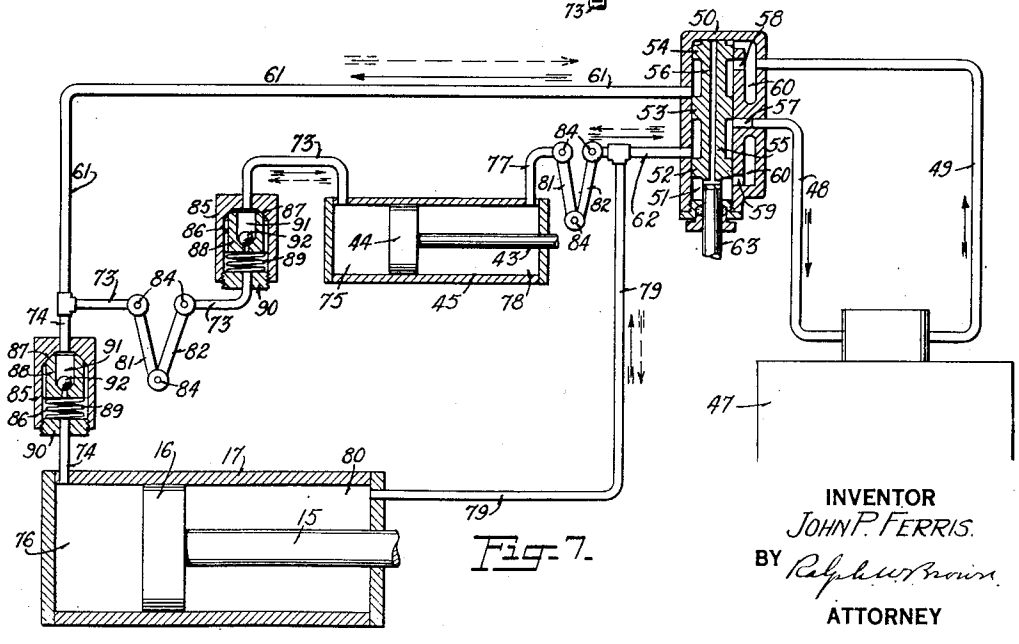

Fig. 7.

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Patented July 17, 1928. 1,677,860

UNITED STATES PATENT OFFICE.

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ASSEMBLY PRESS.

Application filed February 1, 1926. Serial No. 85,233.

This invention relates primarily to assembly presses and to hydraulic drives therefor, although certain novel features embodied therein may be employed to advantage in machines of other types.

For purposes of illustration and explanation the invention will be described as embodied in an assembly press designed to force brake drum hubs upon the opposite ends of automobile axles. With machines heretofore designed for this purpose it has been impossible to position each hub upon the axle end with the accuracy desired. It is important not only that the assembled hubs be accurately spaced, but that each hub be accurately positioned with respect to the center point of the axle.

One object of the present invention is the provision of an assembly press which will apply both hubs and accurately position each upon the axle.

Another object is the provision of a machine so constructed as to insure the successful assembly of the parts even in the hands of unskilled labor.

The machine hereinafter specifically described includes a work clamp which accurately positions and holds the axle, together with a power head for applying the assembly pressure. The clamp is first operated to apply and maintain a clamping pressure on the axle during the subsequent advance and retraction of the power head, and after the retraction of the head the clamp is released. The work clamp and power head in this machine are operated by separate hydraulic rams driven from a common pressure source.

Another object of the present invention is the provision of a hydraulic drive for the rams involving novel connections for automatically effecting the operation of the rams in definite sequence.

Other objects and advantages will appear from the following description of an illustrative embodiment of the present invention.

In the drawings:—

Figure 1 is a plan view of an assembly press constructed in accordance with the present invention.

Fig. 2 is a sectional view taken substantially along the line 2—2 of Figure 1.

Fig. 3 is a sectional view of the work clamp taken substantially along the line 3—3 of Figure 4.

Fig. 4 is a sectional view of the clamp taken substantially along the line 4—4 of Figures 2 and 3.

Fig. 5 is a top view looking into the work carrier in the direction of arrow A in Figure 2, and showing the work in position preparatory to an assembling operation.

Fig. 6 is a longitudinal sectional view taken substantially along the line 6—6 of Figure 5, illustrating the position of the parts at the completion of the assembly stroke.

Fig. 7 is a diagrammatic illustration of the hydraulic circuit employed.

The assembly press selected for illustration comprises a longitudinal base 10 having a laterally extended portion 10′ formed integral therewith. The base 10 supports a rigid frame comprising end heads 11 and 12 rigidly fixed upon the base at the opposite ends thereof, and connected by two heavy parallel rods 13, disposed in a plane at an angle to the horizontal. A cross-head in a form of a heavy casting 14 is mounted to reciprocate along the rods 13, and is actuated by a ram 15. The ram 15 extends through end head 11, and is connected at one end to the cross-head 14 and at the other end to a piston 16, traveling in a power cylinder 17. The power cylinder is supported by the end head 11 to which it is rigidly connected by tension rods 18.

The cross-head 14 carries a center element 19 constituting a continuation of the ram 15, and having reduced portion 20 shaped to snugly fit within the brake drum hub *a*, so as to support and accurately center the hub *a* in accurate alignment with the adjacent end of the axle *b*. The outer end face of the hub *a* bears against an annular shoulder 21 formed upon the element 19 so as to firmly sustain pressure required for the assembling operation. The end head 12 is provided with a center element 22 oppositely disposed with respect to the center element 19, and substantially identical in construction therewith, so as to exactly center and firmly hold the other brake drum hub *c*, which is, in this instance, identical with hub *a*.

A work carrier 23 is suspended between the rods 13, so as to travel lengthwise thereof between the cross-head 14 and end head 12. In this instance the carrier is provided with a pair of laterally extended supporting lugs at each side thereof, each having a

close sliding fit with one of the rods 13. Provision is made for accurately centering and firmly holding the axle within the carrier during the assembly operation. Although this may be accomplished in various ways, the mechanism about to be described has been found to be entirely successful for this purpose. This mechanism includes an expansible clamp 25 mounted centrally of the carrier 23 and adapted to engage within the central bow *d* of the axle and to firmly bind the axle at a definite position with respect to the carriage. The carrier is also provided with transverse webs 26 provided with openings 27 forming appropriate seats for the two ends of the axle, to insure accurate alignment thereof when placed into the machine by the operator.

The clamp 25 is shown in detail in Figures 2, 3, and 4. It comprises an open ended housing in the form of a yoke, having vertical leg portions 28 rigidly connected by an integral bridge portion 29. This housing is secured by any appropriate means, such as lag bolts 30, to a horizontal plate 31 formed as an integral part of the carrier 23. A pair of clamp shoes 32 are closely fitted within the housing between the opposed faces of the bridge portion 29 and plate 31, and between the opposed faces of the leg portions 28 so as to reciprocate in a direction parallel to the longitudinal axis of the work carrier. These shoes are connected by tension springs 33 to yieldably retain them in retracted position. The adjacent ends of the shoes 32 are provided with inclined surfaces 34 adapted to engage similar inclined surfaces 35, formed upon the end of a plunger 36 projecting between the shoes and mounted for reciprocation in the cylindrical bore 37 extending through the plate 31. The arrangement is such that as plunger 36 is forced upwardly the tapered end thereof forces the shoes 32 outwardly into clamping engagement with the internal surface of the bow *d* of the axle. Any appropriate means, such as an integral tongue 38 on the upper end of the plunger 36 snugly engaged within a slot 39 formed in the under surface of bridge portion 29, may be employed for preventing the plunger 36 from turning about its axis.

In this instance the slot 39 extends the full width of the bridge portion and constitutes a housing for a pair of clamp elements 40 resting upon the top faces of shoes 32. Each clamp element 40 is retained in position with one end projecting beyond the end face of the corresponding shoe 32 by means of a bolt 41 extending loosely therethrough and anchored in the shoe. A coil spring 42 interposed between the head of the bolt 41 and the clamp element 40 yieldably retains the clamp element against the top face of the shoe. The arrangement is such that as the clamp shoes are forced outwardly into gripping position against the internal face of bow *d*, the projected ends of the clamp elements 40 ride over the bow *d* and serve to press the bow downwardly against the face of the plate 31.

The plunger 36 is actuated by a ram 43 connected to a piston 44 reciprocating in a cylinder 45, rigidly fixed to the bottom of the work carrier 23, by means of tension bolts 46.

The piston 16 in the power cylinder 17 and the piston 44 in the auxiliary clamp operating cylinder 45, are both operated by liquid delivered from a single source. In this instance the driving liquid of both of these cylinders is supplied by a variable displacement pump 47 of the type described in the co-pending application of Walter Ferris, Serial No. 701,356, filed March 24, 1924. It will suffice here to say that this pump is driven at constant speed by a pulley 47' mechanically connected to any appropriate power source. This pump delivers liquid at a definite rate so long as the pressure in the hydraulic circuit fed thereby remains below a predetermined maximum limit, but upon reaching this maximum pressure the pump automatically responds to this pressure to so reduce the flow as to maintain the pressure substantially constant. Since the instrumentalities employed for effecting these functions are fully described in the co-pending application just referred to, a description thereof at this time is deemed unnecessary for a complete understanding of the present invention.

The pump 47 is connected to the main power cylinder 17 and to the auxiliary cylinder 45 thru hydraulic connections such as will now be described, reference being made to the diagram in Figure 7. The hydraulic circuit includes pipes 48 and 49 connected to the delivery and return sides, respectively, of the pump and to a reversing valve 50 of appropriate form. The valve shown comprises a valve casing having a cylindrical bore 51 therein. A piston valve, having three heads 52, 53 and 54 connected by reduced portions 55 and 56, is closely fitted for lengthwise reciprocation in the bore. Pipe 48 communicates with a port 57 disposed midway of the length of the bore 51 and controlled by the intermediate head 53 of the piston. Similar ports 58 and 59 adjacent the opposite ends of the bore are controlled by the end heads 54 and 52 respectively, of the piston, and are permanently connected thru a passage 60 extending longitudinally of the valve casing. Pipe 49 is in constant communication with passage 60 and hence with both ports 58 and 59. A pipe 61 communicates at all times with the annular space surrounding the reduced portion 56 of the piston, and a pipe 62 com-

municates at all times with the annular space surrounding reduced portion 55 of the piston. The piston is operated and controlled through a stem 63 by mechanism to be hereinafter described. The arrangement is such that when the piston valve is in the upper extreme position shown in Figure 7, liquid delivered by the pump through pipe 49 is free to pass through port 58, through the annular space surrounding the reduced portion 56 and into and through pipe 61; and liquid from pipe 62 entering the annular space surrounding the reduced portion 55 is free to flow through port 57 and pipe 48 to the pump. When the valve is shifted into the lower extreme position, liquid discharged by the pump through pipe 49 passes through passage 60 and port 59 into the annular space surrounding the reduced portion 55 and thence into pipe 62; and liquid from pipe 61 entering the annular space surrounding portion 56 is free to pass through port 57 into and through pipe 48 back to the pump. It will thus be noted that by shifting the valve from one extreme position to the other, the flow of liquid in pipes 61 and 62 is reversed. With the valve in intermediate or neutral position, ports 57, 58 and 59 are covered by the heads 53, 54, and 52, respectively, so that the flow of liquid through pipe 49 is blocked, and the pressure built up in pipe 49 under such conditions automatically reduces pump displacement to zero.

The reversing valve 50 is supported upon an appropriate bracket 64 fixed to the frame of the machine, and the stem 63 thereof is operatively connected to one end of a rod 65 extending lengthwise of the machine and mounted for lengthwise reciprocation in fixed lugs 66 and 67. The other end of the rod is connected through a link 68 with one end of a hand lever 69 pivotally supported intermediate its ends upon a fixed vertical pin 70. A collar 71 is fixed to the rod 65 at one side of a fork 72 projecting upwardly from the cross-head 14 and embracing the rod 65. The collar 71 is so positioned as to be engaged by the fork 72 as the cross-head 14 approaches the left hand limit of its travel to thereby automatically force the collar 71, and consequently the rod 65 and valve stem 53, toward the left, so as to adjust the valve 50 into the neutral position and bring the cross-head 14 to rest.

Pipe 61 is connected to a branch pipe 73 leading to one end 75 of the auxiliary cylinder 45, and to a branch pipe 74 leading to one end 76 of the main power cylinder 17. Similarly pipe 62 is in open communication with a branch pipe 77 leading to the other end 78 of the auxiliary cylinder and with a branch pipe 79 leading to the other end 80 of the main power cylinder. The two cylinders 17 and 45 are thus connected in parallel in the hydraulic circuit. Any appropriate form of flexible connections may be provided within the pipe lines 73 and 77 in order to permit movement of the auxiliary cylinder 45 during the travel of the work carrier 23. In this instance such flexibility is provided by inserting two lengths of pipe 81 and 82 within each of these pipe lines, these pipe lengths being connected to each other and to the pipe line through appropriate swivel connections 84.

As hereinabove pointed out, it is highly desirable in the machine described that the auxiliary piston 44 be first operated to apply a clamping pressure to the work and thereafter the main pressure piston 16 be operated to effect the assembly stroke. It is also desirable that after the completion of the assembly stroke, the main piston 16 be first actuated to begin a return stroke and that the auxiliary piston 44 be thereafter actuated to relieve the clamping pressure, so that the work may be firmly clamped during the entire assembly stroke and thereafter released. To accomplish this, provision is made for yieldably resisting the advance of the main piston 16 until the auxiliary piston 44 has applied the desired clamping pressure to the work and for yieldably resisting the retraction of piston 44 until the assembly stroke is completed. This is effected in this instance by inserting valves in branch pipes 73 and 74 which serve to resist the flow in each of these pipes in one direction but permit a free flow in the opposite direction.

The valves shown are substantially identical in construction and operation so that a description of one will suffice for both. Each includes a housing 85 having a cylindrical bore 86 provided at one end with a conical valve seat 87. A hollow valve 88 is yieldably maintained in closed position against seat 87 by a spring 89 interposed between the valve and a closure element 90, threaded into one end of the housing. The hollow valve 88 is provided with a port 91 normally closed by a ball 92. The arrangement is such that liquid is always free to pass upwardly through the hollow valve lifting the ball valve 92 before it, but reverse flow is prevented by the seating of the ball 92 over the port 91. However, liquid under pressure sufficient to lift the valve 88 from its seat 87 against the pressure of the spring 89, may flow downwardly through the housing around the valve 88.

A description of a complete operating cycle will now be given. The pump 47 is operated continuously. With the hand lever 69 in the intermediate position shown in Figure 1 the valve 50 is in neutral position and communication is blocked between pipes 48 and 49 and pipes 61 and 62 so that there is no pressure in the main cylinder 17 or the

auxiliary clamp cylinder 45. The cross-head 14 is fully retracted and the work clamp 25 is in contracted position ready to receive the work. The axle *b* is then placed in the carrier 25 with the end portions thereof resting in the seats 27 of the webs 26 and with the bow *d* surrounding the clamp 25. Hubs *a* and *c* are then placed in position over the centers 19 and 22, in alinement with the ends of the axle, as indicated in Figure 5.

The operator then swings the hand lever 69 toward the right to thereby shift the rod 65 toward the left. This causes the valve 50 to be adjusted into the position shown in Figure 7 so as to open communication between pipes 49 and 61. The liquid thus caused to enter pipe 61 from pipe 49 flows freely through the pipe 73, up through the hollow valve 88 to the lower end of the clamp cylinder 45 to force the ram 36 upwardly and thus expand the clamp so as to firmly grip the axle. This action of the clamp insures an accurate centering of the axle within the carrier 23. Flow through pipe 74 from pipe 61 is yieldably resisted by the spring loaded valve 88, the pressure of the spring 89 being such as to prevent such flow until the pressure in pipe 61 has increased sufficiently to insure a good grip of the clamp 25 upon the axle. When such pressure has been established the liquid from pipe 61 forces the valve 88 downwardly and flows around the valve into the left end of the main cylinder 17. The piston 16 and cross-head are thus advanced toward the right on an assembly stroke, and at a definite rate determined by the rate at which the pump delivers liquid through the pipe 49.

During the advance of the cross-head 14 the hub *a* engages over the adjacent end of the axle, and then forces the axle and carrier 23 ahead of it until the the other end of the axle is engaged within the other hub *c*. Thereafter both the cross-head 14 and carrier 23 continue to advance forcing the hubs *a* and *c* onto the ends of the axle until the end 93 of the carrier has struck the face 94 of the end head 12 and the face 95 on the cross-head 14 has struck the other end 96 of the carrier. The carrier thus clamped between the cross-head 14 and end head 12 provides a positive stop for the cross-head 14 and accurately limits the advance thereof. Since the axle is accurately centered lengthwise of the carrier, the final position of each hub on the axle is accurately determined.

The instant that the cross-head 14 is thus arrested the flow of liquid in pipe 61 is also arrested causing a sudden building up of pressure therein which reacts on the pump to automatically reduce the stroke thereof substantially to zero.

The operator then swings the hand lever 69 toward the left to reverse the valve 50 and thus open communication between pipes 48 and 62 and between pipes 49 and 61. Fluid thus flows from pipe 62 through pipe 79 to the right end of the main cylinder 17 causing the piston 16 and cross-head 14 to begin a return stroke toward the left. During this movement of the piston 16, fluid from the left end of cylinder 17 flows freely through pipe 74 and hollow valve 88 into pipe 61 and back to the pump through pipe 48.

Although the right end 78 of cylinder 45 is in open communication with pipe 62 through pipe 77, the piston 44 is yieldably held against movement by virtue of the resistance offered by the valve 85 against the discharge of liquid through pipe 73. As above pointed out the check valve 92 prevents flow downwardly through the hollow valve 88 and this valve 88 is not forced from its seat until sufficient pressure has been established in pipe 62 and pipe 73 to overcome the resistance of the spring 89. The fluid pressure in pipe 62 required to start the piston 16 and cross-head 14 toward the left is less than that required to force the valve 88 from its seat. The axle is thus held by the clamp 25 as the cross-head 14 begins the return stroke.

During the return stroke of the cross-head 14 the center element 19 withdraws from the hub *a* through a distance determined by the engagement of a head 97 of a rod 98 with a lug 99 of the carrier 23, the rod 98 being anchored on the cross-head and projecting loosely through the lug 99. Thereafter the carrier 23 moves with the cross-head, withdrawing the hub *c* from the center element 22. The increase in fluid pressure in pipe 62 required to continue the movement of the cross-head against the added resistance offered by the drag of the carrier 23, is transmitted to pipe 73 and is sufficient to overcome the resistance of spring 89, so that hollow valve 88 is forced open and piston 44 is actuated to release the clamp 25.

The cross-head 14 and carrier 23 continue this movement until they approach the limit of their return stroke, at which point the fork 72 on the cross-head engages the collar 71 on the control rod 65, and adjusts the valve 50 into the intermediate position. Communication is thus blocked between pipes 49 and 62 and between pipes 48 and 61 and the cross-head and carrier come to rest. The axle, with the hubs assembled thereon, is then lifted out of the carrier, and the machine is ready to receive fresh work.

Various changes may be made in the embodiment of the invention hereinabove specifically described without departing from or sacrificing any of the advantages of the invention as defined in the appended claims.

I claim:

1. In an assembly press the combination of a

frame, a pressure applying head at one end of said frame, a pressure sustaining head at the other end of said frame, a work support freely movable along said frame between said heads, and means for fixing the work in position on said support between said heads.

2. In an assembly press the combination of a pressure applying head, a pressure sustaining head, a work support freely movable in the direction of pressure between said heads, and means for fixing the work in position on said support between said heads.

3. In an assembly press the combination of a pressure applying head, a pressure sustaining head, and means for supporting a work piece in position between said heads for movement in the direction of the applied pressure.

4. In a press for applying elements to the opposite ends of a piece of work the combination of a pressure applying head for engaging one of said elements, a pressure sustaining head for engaging the other of said elements, and means for supporting the work in position between said heads to receive said elements, said means permitting movement of said work in the direction of the applied pressure.

5. In a press for applying elements to the opposite ends of a piece of work the combination of a pressure applying head for engaging one of said elements, a pressure sustaining head for engaging the other of said elements, a support freely movable between said heads in the direction of the applied pressure, and means for fixing the piece of work in definite position on said support.

6. In a press for applying elements to the opposite ends of a piece of work the combination of a pressure applying head for engaging one of said elements, a pressure sustaining head for engaging the other of said elements, a support freely movable between said heads in the direction of the applied pressure, means for fixing the piece of work in definite position on said support, and means for limiting the assembly movement between said support and heads to determine the final position of each element on the work.

7. In a press for applying elements to the opposite ends of a piece of work the combination of a pressure applying head for engaging one of said elements, a pressure sustaining head for engaging the other of said elements, means for supporting the piece of work between said heads for movement in the direction of applied pressure, and means for limiting the assembly movement between the work and said heads to determine the final position of each element on the work.

8. In a press for applying elements to the opposite ends of a piece of work the combination of a pair of cooperating pressure heads for engagement with said elements respectively, means for supporting the piece of work between said heads, means for producing relative movement between said heads and work to assemble the elements on the work, and means for limiting such relative movement between each of said heads and the work to determine the final position of each element on the work.

9. In a press for applying elements to the opposite ends of a piece of work the combination of a pair of cooperating pressure heads for engagement with said elements respectively, means for supporting the piece of work between said heads, and means for effecting relative movement between said heads to force said elements on the work under substantially equal driving pressures.

10. In a press for applying elements to the opposite ends of a piece of work the combination of a pair of cooperating pressure heads for engagement with said elements respectively, a support for the piece of work, means for securing the work in definite position on said support, means for effecting relative movement between said heads and support to force the elements on the work, and means on said support cooperating with each head for positively arresting the relative movement between each head and support to definitely determine the final position of each element on the work.

11. In a hydraulic press the combination of a pressure applying head, a pressure sustaining head, a work support, means for securing the work to said support, and hydraulically actuated means for operating said securing means and for effecting relative movement between said heads in predetermined sequence.

12. In a hydraulic press the combination of a pair of cooperating pressure heads, a work support, hydraulically actuated means for securing the work to said support, hydraulically actuated means for effecting relative movement between said heads, and means automatically operable to determine the sequence of operation of said securing and moving means.

13. In a hydraulic press the combination of a reciprocating pressure head, hydraulically actuated means for driving said head, a work support, hydraulically actuated means for securing the work to said support, and means automatically operable to determine the sequence of operation of said securing and driving means.

14. In a hydraulic press the combination of a hydraulically actuated ram, a work support, hydraulically actuated means for securing the work to said support, a pump for delivering a driving liquid to said ram and securing means to actuate the same, and means responsive to the pressure of said

driving liquid for determining the sequence of operation of said ram and securing means.

15. In a hydraulically operated machine the combination of a pump, a driven member, a clamp, hydraulic connections between said pump and said member and clamp for operating said member and clamp, and means responsive to the pressure in said connections for determining the sequence of operation of said member and clamp.

16. In a hydraulically operated machine the combination of a pump, two hydraulically actuated motors driven by liquid discharged by said pump, and means responsive to the pressure of the driving liquid for determining the sequence of operation of said motors.

17. In a hydraulically actuated machine the combination of a pump, a plurality of motors driven by liquid discharged by said pump, and means responsive to the pressure of the driving liquid for determining the sequence of operation of said motors.

18. In a hydraulically actuated machine the combination of a pump, a plurality of motors driven by liquid discharged by said pump, and yieldable means for resisting the movement of one of said motors until another of said motors has been actuated.

19. In a hydraulically actuated machine the combination of a pump, a plurality of motors driven by liquid discharged by said pump, and a valve for yieldably resisting the delivery of driving liquid to one of said motors until another of said motors has been actuated.

20. In a hydraulically actuated machine the combination of a pump, two separate hydraulically actuated motors connected in parallel with said pump, and a valve interposed between said pump and one of said motors for yieldably resisting the delivery of driving liquid thereto until said other motor has been actuated.

21. In a fluid actuated machine the combination of a plurality of fluid actuated motors, a fluid pressure source, and a valve for yieldably resisting the application of fluid pressure to one of said motors until the other of said motors has been actuated.

22. In a fluid actuated machine the combination of a plurality of fluid actuated motors, a fluid pressure source, and means for yieldably resisting the operation of one of said motors until the other has been actuated to thereby determine the sequence of operation of said motors.

23. In a fluid actuated machine the combination of two fluid actuated motors, a fluid pressure source, and pressure responsive means for determining the sequence of operation of said fluid actuated motors.

In witness whereof, I hereunto subscribe my name this 30th day of December, 1925.

JOHN P. FERRIS.