Dec. 8, 1959 J. H. SCHWARZ 2,916,171

HYDRAULIC CLAMP OPERATING CIRCUIT

Filed Aug. 1, 1955 2 Sheets-Sheet 1

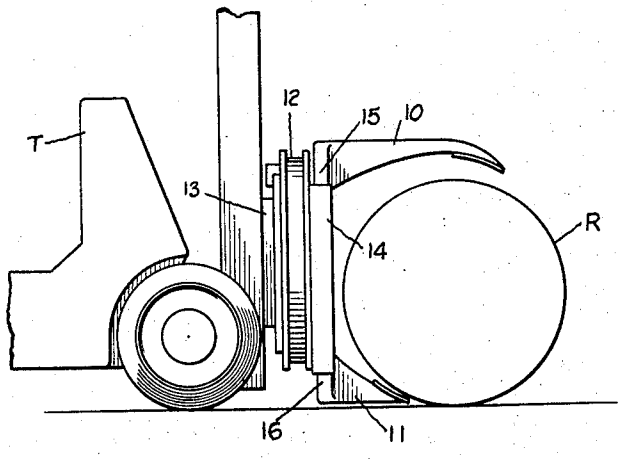

Fig. 1.

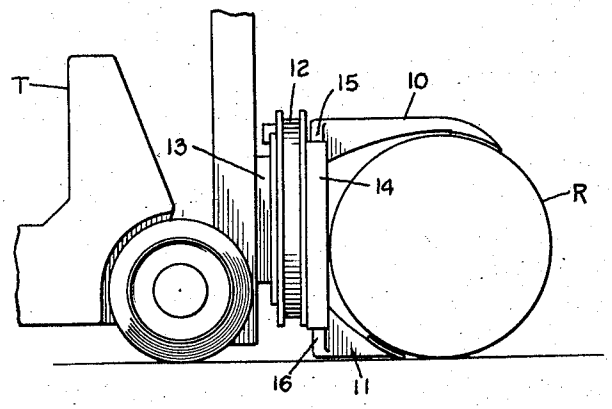

Fig. 2.

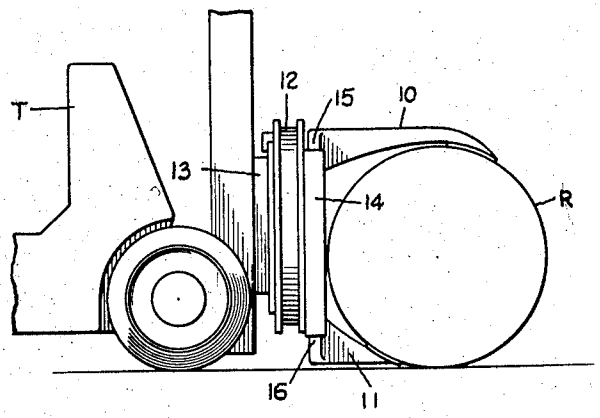

Fig. 3.

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Fig. 4.

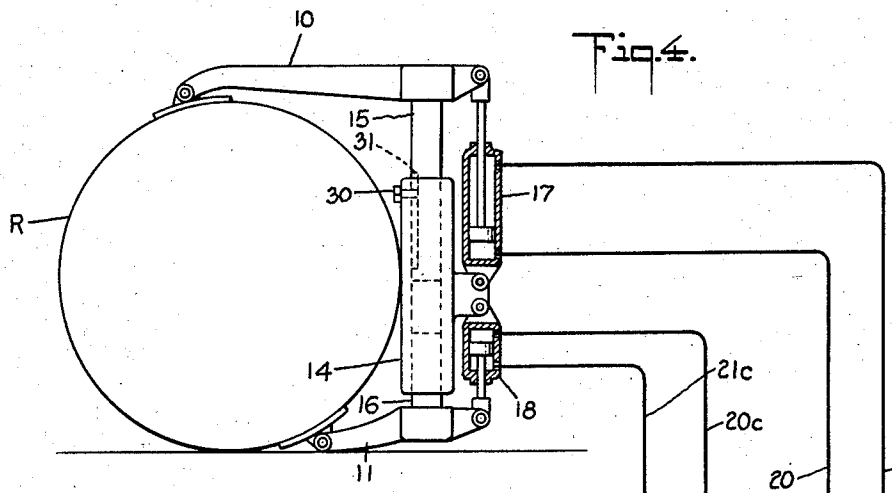


Fig. 5.

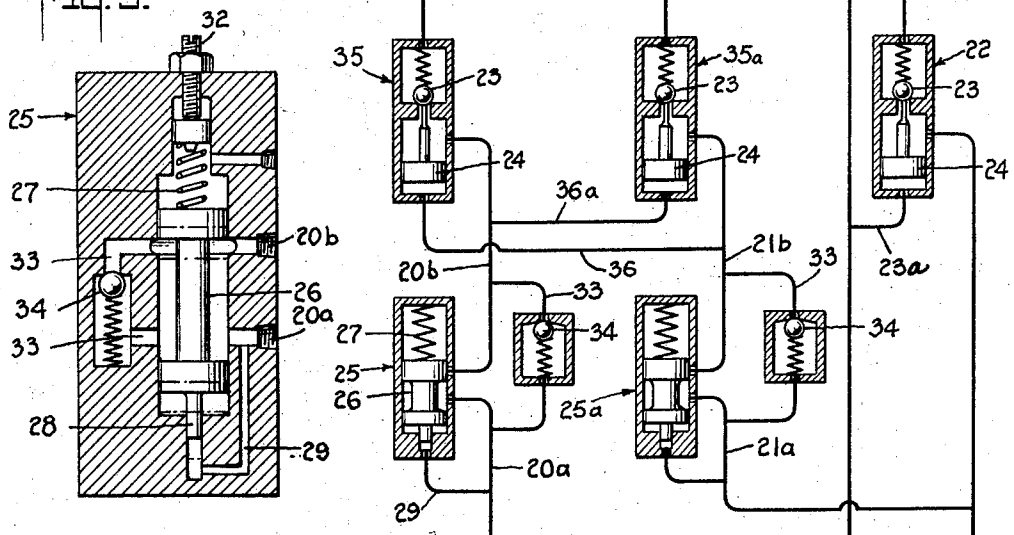
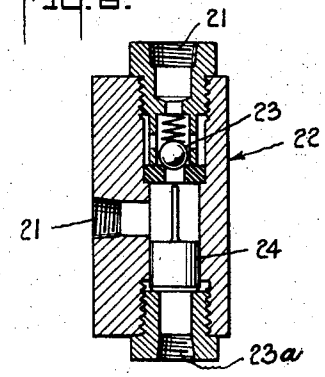
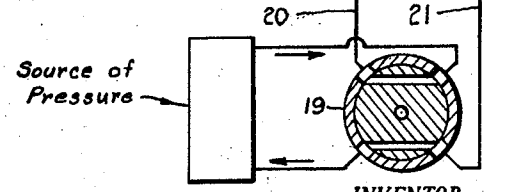


Fig. 6.





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HYDRAULIC CLAMP OPERATING CIRCUIT

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9 Claims. (Cl. 214—653)

This invention relates to the control and adjustment of clamping or similar means employed in an industrial truck. In industrial trucks, there frequently is utilized a pair of clamps for clamping a load that is then lifted and transported. Frequently, one of the clamps is adjusted manually so that it may be in a particular position for accepting a particular type of load, the other clamp being then moved relatively to the adjusted clamp for clamping and releasing the load under the direction of the operator. My invention relates particularly to the adjustment of one clamp through the actuation of the other clamp. At this point, it will be well to emphasize that while I shall use the words "clamp" and "clamping member" and I show clamping members, my invention may be utilized very frequently for the control of other devices such as forks and booms.

As a feature of my invention, I utilize a pair of hydraulic rams, one hydraulic ram for each of the two clamping members. The secondary ram as I call it, that operates one of the clamps, is so arranged in my hydraulic system that it is not in communication with the source of hydraulic pressure until the other or primary ram as I shall call it, has moved the other clamp against the load or to one of its extreme positions. Thus, in the event the primary ram is against a stop, such as a load, or at its limit of movement, the pressure in the hydraulic system will be increased beyond a particular degree. This increase in hydraulic pressure is utilized by me for effecting application of hydraulic pressure to the secondary ram.

Thus, when it is desired to adjust one of the clamps, where the moving members are clamps, its ram, called the secondary ram, will not be operable because it is not in communication with the source of hydraulic pressure. The other ram, or primary ram, can be operated to bring its clamp against a stop in either of opposed directions. The development of increased hydraulic pressure thereafter will be such as to place the secondary ram in communication with the source of hydraulic pressure to move it in a particular direction. After that, the primary ram may be moved away from its stop and the secondary ram will continue to hold its clamp in a fixed adjusted position so long as the primary ram moves back and forth and does not reach one or the other of its extreme positions. Of course, once the primary ram brings its clamp against a load, the secondary ram will be once again placed in communication with the source of hydraulic pressure so that both rams will grip the load. Those skilled in the art will appreciate that I have provided an entirely new concept for the operation of a pair of rams, and for the control by said rams of clamping members, forks, booms, or the like.

I have thus outlined rather broadly the more important features of my invention in order that the detailed description thereof that follows may be better understood, and in order that my contribution to the art may be better appreciated. There are, of course, additional features of my invention that will be described hereinafter and which will form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception on which my disclosure is based may readily be utilized as a basis for the designing of other structures for carrying out the several purposes of my invention. It is important, therefore, that the claims be regarded as including such equivalent constructions as do not depart from the spirit and scope of my invention, in order to prevent the appropriation of my invention by those skilled in the art.

Referring now to the drawings:

Figs. 1, 2, and 3 illustrate the movements of a pair of clamping members that are operated through my novel means.

Fig. 4 shows schematically the features of my novel hydraulic circuit.

Fig. 5 shows in detail one of the sequence valves that I utilize in my circuit.

Fig. 6 shows one of the pilot check valves.

In order to facilitate an understanding of my novel clamp operating means, I show in Figs. 1, 2 and 3, a pair of upper and lower clamp arms **10**, **11** that are mounted through a rather conventional load rotating attachment **12** on a lifting carriage **13** of a lift truck T. When these clamp arms **10**, **11** clamp a load such as a roll of paper R, the truck can lift and rotate that load in a longitudinal axis relatively to the truck, as will be appreciated by those skilled in the art.

The clamps of the type that I illustrate are so constructed that the truck can place the lower clamp arm **11** below a lower surface of the roll R when the roll is resting on the ground, as shown in Fig. 1, and the upper clamp **10** can then move to clamp the roll against the lower arm **11**, as in Fig. 3. Generally, the lower arm **11** does not have clamping movement. However, lower arm **11** in clamps of the particular type does have movement of adjustment. Through that adjusting movement, the lower clamp arm **11** can be so positioned that each roll R, when clamped by upper arm **10**, will be held with its center substantially in the axis in which the roll will rotate on the attachment **12**, despite the fact that the rolls may vary in diameter. Merely for the purpose of disclosing a movable mounting for the clamping arms **10**, **11**, I show the load rotating attachment **12** formed with a vertical support **14** on which portions **15**, **16** of the arms can slide independently.

I shall now describe the extremely novel means that I utilize for moving the clamp arms **10**, **11**. Because the upper arm **10** will normally be the arm that moves to effect clamping, I shall refer to that arm as the primary clamp, and I shall term the lower arm **11** the secondary clamp. Referring particularly to Fig. 4 of the drawings, I utilize a hydraulic ram **17** that acts between the primary clamp **10** and its mounting for moving that clamp, and a hydraulic ram **18** arranged similarly for moving the secondary clamp **11**. I supply fluid pressure for actuating the rams **17**, **18** through a manually operated control valve **19**, indicated in Fig. 4. I believe it to be unnecessary to show the details of the valve **19** because that valve is of a merely conventional type that will control the fluid pressure in a hydraulic circuit, and that can supply the pressure in either direction in that circuit.

I connect the control valve **19** to the opposed ends of primary ram **17** through two hydraulic lines **20**, **21**. Thus, valve **19** can direct fluid pressure to either end of ram **17** while accepting return fluid from the other end of the ram **17**. Through this arrangement, the control valve **19** will effect direct control over the clamping and release movements of the primary clamp **10**. I do prefer to interpose in the hydraulic line **21** a pilot check valve **22** that will be effective to hold the primary clamp **10**

in clamping position when the control valve 19 cuts off pressure relatively to the line 21. As best seen in Fig. 6, check valve 22 has a rather usual spring-pressed ball 23 and a plunger 24 adapted to move the ball 23 from its seat. The ball 23 normally prevents a return flow of fluid through line 21, as will be understood from Fig. 4. When the valve 19 directs the pressure through line 20 positively to move the primary clamp 10 in a release direction, this pressure will act also through a branch line 23*a* against plunger 24 whereby to allow low pressure fluid to return through line 21.

Proceeding now to a description of the means through which I apply fluid pressure to secondary ram 18, I utilize a series of hydraulic lines 20*a*, 20*b*, 20*c* leading from line 20 to one end of ram 18, I further utilize a series of lines 21*a*, 21*b*, 21*c*, that lead from line 21 to the opposed end of the ram 18. I shall describe in detail the application of fluid pressure through these lines, but it may be observed first that the lines are so arranged relatively to the rams 17, 18 that the pressure, when effective in the lines, will press both clamps 10, 11 in complementary directions. For example, referring to Fig. 4, fluid pressure that is applied to hydraulic line 20 will be directed to the lower end of primary ram 17 and may also be directed through lines 20*a*, 20*b*, 20*c* toward the upper end of secondary ram 18, whereby to press both clamps 10, 11 in a release direction. Similarly, pressure when applied to hydraulic line 21 may press both clamps 10, 11 in a clamping direction.

I connect the lines 20*a* and 20*b* to one another through a sequence valve 25, and I similarly connect lines 21*a*, 21*b* through a sequence valve 25*a*. The sequence valve 25*a* is like the valve 25, and it will therefore be sufficient merely to describe the details of valve 25. Moreover, the valves 25 and 25*a* act in the same way, but it will be understood that each valve controls the fluid pressure relatively to a corresponding end of the secondary ram 18.

The sequence valve 25 has a spool 26 that is shown in Fig. 4 in its closed position. This same spool 26 is shown in solid lines in Fig. 5 in its open position, the dash and dotted lines in Fig. 5 showing the spool in its closed position. The pressure developed in line 20*a* operates through a passage 29 against a pilot portion 28 of the spool 26 urging it to its full line open position of Fig. 5. To maintain the spool in its closed position of Fig. 4 there is utilized a spring 27 adjusted by a part 32, the adjustment of the spring being such that the spool 26 is held in its closed position at all times when the ram 17 is free to move the clamp 10. When the pressure increases in line 20, as through the movement of the ram 17 against a limit stop, then the pressure developed will be great enough to act through line 20*a* and passage 29 against pilot portion 28 to move the valve spool 26 from its closed position of Fig. 4 to its full line open position of Fig. 5. Thereby sequence valve 25 will direct the fluid pressure in lines 20, 20*a* through lines 20*b*, 20*c* toward the upper end of secondary ram 18. Merely for the purpose of disclosing a limit stop for ram 17, I show in Fig. 4 a stop screw 30 that is adapted to coact with either end of a slot 31 in the clamp mounting portion 15.

I have already stated that the sequence valve 25*a* acts like the valve 25. It will be understood therefore that valve 25*a* will be closed while primary clamp 10 has substantially free downward movement, and will thereafter open to direct fluid pressure from lines 21, 21*a* through lines 21*b*, 21*c* toward the lower end of secondary ram 18. To enable low pressure fluid to return from either end of secondary ram 18 past sequence valve 25 or 25*a*, I equip each of those valves with a bypass 33, shown in Fig. 4. Each bypass 33 has a spring pressed check valve 34 that prevents bypassing of the corresponding sequence valve 25 or 25*a* when high pressure fluid is directed through the valve. This check valve 34 is not important as to its details, but I do prefer to construct each valve 34 together with its bypass 33 as an integral part of the corresponding sequence valve 25, or 25*a*, as is well shown in Fig. 5.

Through the arrangement that I have thus far described, the control valve 19 can apply fluid pressure to move the primary clamp 10 in clamping and release directions without moving the secondary clamp 11. Nevertheless, the fluid pressure can adjust the position of secondary clamp 11 when the movement of primary clamp 10 is opposed, as by its limit stop 30, since one of the sequence valves 25, 25*a* will then direct the pressure to secondary ram 18. Naturally, the low pressure fluid will return past the opposed sequence valve through the bypass 33 of that valve.

I further utilize in my extremely novel hydraulic system a pair of pilot check valves 35, 35*a* that lock the secondary clamp 11 in adjusted position when fluid pressure is not applied positively to move that clamp. Each pilot check valve 35, 35*a*, may very well have the same construction as the valve 22 that I have already described. I connect the valve 35 between the lines 20*b* and 20*c* in such a way that the fluid always can move through those lines toward secondary ram 18, but cannot normally return toward control valve 19. I place the pilot plunger 24 of check valve 35 in communication with the line 21*b* through a cross-connecting line 36. Thus, when positive fluid pressure is applied to secondary ram 18 through the lines 21*a*, 21*b*, 21*c*, that pressure will move check valve 35 to open position to allow low pressure fluid to return through lines 20*a*, 20*b*, 20*c*. Pilot check valve 35*a* is similarly connected between lines 21*b*, 21*c*, with a cross-connecting line 36*a* between pilot plunger 24 of that valve and the line 20*b*. Thereby the pilot check valves 35, 35*a* will normally prevent a flow of fluid relatively to secondary ram 18, and will lock secondary clamp 11 against movement unless positive pressure is applied through one sequence valve or the other for moving secondary ram 18. Through the particular arrangement, the secondary clamp 11 will always remain in an adjusted position during the normal clamping and release movements of primary clamp 10.

I believe that it will be well to review now the operation of my novel clamp operating means. Of course, the truck T will first approach the roll R, as shown in Fig. 1, to place the secondary clamp 11 below a part of the roll. Secondary clamp 11 will at that time be locked against vertical movement adjustment through the action of pilot check valves 35, 35*a*, Fig. 4. If we assume that secondary clamp 11 is properly adjusted, the truck movement may place it against the roll surface in a position like that shown in Fig. 3. The control valve 19 will now be manipulated to move primary clamp 10 in clamping relation to the roll R, as shown in Fig. 3. During that movement, the fluid pressure in line 21 will act only at the upper end of primary ram 17, since the sequence valve 25*a* will prevent the application of pressure from line 21 to the lower end of secondary ram 18. When primary clamp 10 is actually against the roll R, the pressure in lines 21, 21*a* will rise and will open sequence valve 25*a*. The pressure then will act through lines 21*b*, 21*c* to press secondary clamp 11 in a clamping direction, but will not actually move clamp 11 since it is against the roll R. The pressure in line 21*b* will incidentally act through line 36 to open the pilot check valve 35, but because clamp 11 does not move at this time, there will be no return flow through valve 35. It will be seen that in the circumstances I have just described, the secondary clamp 11 will not change its adjustment.

If we assume that the secondary clamp 11 when approaching the roll R is too low, as shown in Fig. 2, that clamp will not then engage the roll R. Therefore, the driver will move the truck away from the roll and the fluid pressure will be applied through line 21 to cause

primary clamp **10** to move to its inner limit. The pressure in line **21** will then be great enough to actuate sequence valve **25***a*, thus acting through lines **21***b*, **21***c* to move secondary clamp **11** upwardly, so that the operator by manipulating control valve **19** can place secondary clamp **11** in properly adjusted position.

During that movement of clamp **11**, the pressure naturally will act through line **36** to open pilot check valve **35** to allow low pressure fluid to flow from ram **18**. Now the operator will direct pressure in the opposed direction through line **20** to the upper clamp **10** to put it into its position of Fig. 1. Since upper clamp **10** does not then move against means that limit its movement, the pressure in line **20** will not be great enough to open sequence valve **25** and both pilot check valves **35**, **35***a* remain effective to lock lower clamp **11**. The operator will then move the truck to place secondary clamp **11** against the roll, and will apply pressure to bring clamp **10** against the load with the load between it and clamp **11**, as in Fig. 3.

If a roll of larger diameter is to be handled, a downward adjustment of secondary clamp **11** may be desired in order that the roll may be carried with its center near the axis of the load rotating attachment **12**. To effect this downward adjustment of clamp **11**, it is necessary merely to apply fluid pressure through hydraulic line **20** for moving primary clamp **10** upwardly, with the pressure continued after clamp **10** moves against its stop. The sequence valve **25** and pilot valve **35***a* will then open so that the pressure in line **20** will adjust secondary clamp **11** downwardly to the desired position, all under the control of the manually operated valve **19**. Of course, through a movement of primary clamp **10** downwardly against its stop, secondary clamp **11** can be adjusted upwardly when that is desired.

I have described my novel hydraulic operating means applied to a particular pair of clamps, but it is to be understood that my invention is not limited to clamps, and can be utilized for controlling other types of members. Thus, for example, I can very well utilize my invention for adjusting a pair of lifting forks where it is desired to shift each fork to an individually adjusted position. One fork will be adjusted through movement of the second fork against its stop, and the second fork will then be adjusted while the first fork remains in adjusted position. Whatever the particular type of member, I very effectively control both members through a single manually operated valve, with merely one pair of hydraulic lines leading from that valve. I believe that the construction and operation of my novel system will now be understood, and that those skilled in the art will appreciate the very considerable value of my invention.

I now claim:

1. In a combination of the class described, a pair of opposed clamps, a support for said clamps, means mounting each clamp on said support for movement relatively to the opposed clamp, a hydraulic ram for each clamp, means for directing fluid from a source of hydraulic pressure to one end or the other of one of said hydraulic rams to move it and its clamp in opposed directions, means for simultaneously opening communication between the opposed end of said ram and the low pressure side of said source of hydraulic pressure, pressure responsive means whereby the development of increased fluid pressure in said first ram, due to the holding of said first ram against movement while it is in communication with said source of fluid pressure, then directs the fluid to one end of said second ram to move its clamp in a predetermined direction complementary to the direction of movement of said first ram, and means for simultaneously opening communication between the other end of said second ram and the low pressure side of said source of hydraulic pressure.

2. In a combination of the class described, a secondary clamp, a secondary hydraulic ram for moving said clamp in either of opposed directions, a source of hydraulic pressure, valve means between said source of hydraulic pressure and said ram holding said ram normally out of communication with said source of hydraulic pressure, a primary clamp, a primary hydraulic ram for moving said primary clamp in either of opposed directions, means for placing said primary ram in communication with said source of hydraulic pressure to move said primary clamp, and pressure responsive means whereby the development of increased fluid pressure in said primary ram, as when its clamp is brought against a load or stop, actuates said valve means to place said secondary hydraulic ram in communication with said source of hydraulic pressure.

3. In a combination of the class described, a secondary clamp, a secondary hydraulic ram for moving said clamp in either of opposed directions, a source of hydraulic pressure, valve means between said source of hydraulic pressure and said ram acting normally to block fluid flow relatively to the ram whereby to hold the secondary clamp in an adjusted position, a primary clamp, a primary hydraulic ram for moving said primary clamp in either of opposed directions, means for placing said primary ram in communication with said source of hydraulic pressure to move said primary clamp, and pressure responsive means through which the development of increased fluid pressure in said primary ram, as when its clamp is brought against a load or stop, actuates said valve means to place said secondary hydraulic ram in communication with the source of hydraulic pressure for adjusting the position of the secondary clamp.

4. In a combination of the class described, a secondary clamp mounted for movement, a secondary hydraulic ram for moving said clamp on its mounting in either of opposed directions, a source of hydraulic pressure, valve means between said source of hydraulic pressure and said ram normally blocking fluid flow relatively to the ram whereby to hold the secondary clamp in an adjusted position on its mounting, a primary clamp mounted for clamping movement relatively to the secondary clamp, a primary hydraulic ram for moving said primary clamp on its mounting, stops limiting the movements of the primary clamp in opposed directions, means for placing said primary ram in communication with said source of hydraulic pressure to move said primary clamp, the fluid acting under a normal pressure when moving said primary ram and developing increased pressure when the primary ram is held against movement, as when its clamp is brought against one of said stops or against a load, and pressure responsive means through which said increased pressure actuates said valve means to place said secondary hydraulic ram in communication with the source of hydraulic pressure whereby to adjust the position of the secondary clamp.

5. In a combination of the class described, a pair of clamps, means mounting each clamp for movement toward and away from the opposed clamp, a hydraulic ram for each clamp, a source of hydraulic pressure, a manually operated valve for directing fluid from said source of hydraulic pressure to one of said hydraulic rams to move it and its clamp in a predetermined direction on its mounting, the fluid so directed acting under normal pressure when moving said one ram and developing increased pressure in said one ram when said one ram and its clamp are held against movement as through contact with a load or stop, means normally locking the second ram against movement, pressure responsive valve means actuated by the development of said increased pressure in said first ram to direct the fluid also toward said second ram, with the fluid acting in a direction for moving the second ram and its clamp in the direction opposite to that in which the first clamp was moved, and means through which said increased pressure releases the second ram from said locking means so that the fluid will move the

second ram and its clamp while said first ram remains stationary.

6. In a combination of the class described, a pair of clamps, means mounting each clamp for movement toward and away from the opposed clamp, a hydraulic ram for each clamp, a source of hydraulic pressure, a manually operated valve for directing fluid from said source of hydraulic pressure to one of said hydraulic rams to move it and its clamp in a predetermined direction on its mounting, the fluid so directed acting under normal pressure when moving said one ram and developing increased pressure when said one ram and its clamp are held against movement as through contact with a load or stop, means normally locking the second ram against movement, pressure responsive valve means actuated by the development of said increased pressure in said first ram to direct the fluid also toward said second ram, with the fluid acting in a direction for moving the second ram and its clamp in the direction opposite to that in which the first clamp was moved, and means through which the fluid so directed toward the second ram releases that ram from said locking means, so that the fluid will act under the control of the manual valve while the first ram remains stationary to move the second ram and its clamp.

7. In a combination of the class described, a pair of clamps, means mounting each clamp for movement toward and away from the opposed clamp, a hydraulic ram for each clamp, a source of hydraulic pressure, means for directing fluid from said source of hydraulic pressure to one of said hydraulic rams to move it and its clamp in a predetermined direction on its mounting, the fluid so directed acting under normal pressure when moving said one ram and developing increased pressure in said one ram when said one ram and its clamp are held against movement as through contact with a load or stop, valve means normally blocking fluid flow relatively to the second ram to lock that ram against movement, pressure actuated means responsive to the development of said increased pressure in said first ram to direct the fluid also toward said second ram, with the fluid acting in a direction for moving the second ram and its clamp in the direction opposite to that in which the first clamp was moved, and means through which the fluid directed toward the second ram by said pressure actuated means moves said blocking valve means to release said second ram for movement so that the fluid will move the second ram and its clamp while the first ram remains stationary.

8. In a combination of the class described, a pair of clamps, means mounting each clamp for movement toward and away from the opposed clamp, a hydraulic ram for each clamp, a source of hydraulic pressure, means for directing fluid from said source of hydraulic pressure to one of said hydraulic rams to move it and its clamp in a predetermined direction on its mounting, the fluid so directed developing increased pressure in said one ram when said ram and its clamp are held against movement as through contact with a load or stop, means for directing fluid from said source to the second ram to move the second clamp in a direction opposed to the direction in which the first clamp was moved, including valve means normally closing fluid communication between the source of pressure and second ram, and pressure responsive means actuated by said increased pressure that is developed in the first ram to open the normally closed valve means whereby to effect movement of the second ram and clamp while the first ram is held stationary.

9. In a combination of the class described, a pair of clamps, means mounting each clamp for movement toward and away from the opposed clamp, a hydraulic ram for each clamp, a source of hydraulic pressure having a high pressure side and a low pressure side, means including a manually operated valve for directing fluid from the high pressure side of said source of hydraulic pressure to one end or the other of one of said hydraulic rams to move it and its clamp in opposed directions, while simultaneously directing fluid from the opposed end of said one ram to the low pressure side of said source of pressure, the fluid directed to said one ram acting under normal high pressure when moving that ram and developing increased pressure when said ram and its clamp are held against movement as through contact with a load or stop, means for placing opposed ends of said second ram in communication with the high and low pressure sides of said source of pressure for moving said second ram and its clamp in a direction complementary to the direction of movement of the first clamp, including valve means acting when in a normal position to block fluid flow relatively to each end of the second ram to lock that ram against movement, pressure actuated means responsive to the increased pressure developed when the first ram is held against movement to direct the high pressure fluid toward said second ram, and means through which the fluid directed toward the second ram actuates said valve means to release said second ram for movement so that the fluid then will move the second ram and its clamp.

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