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HYDRAULIC SYSTEM FOR POWER SHEARS AND LIKE MACHINES

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5 Claims. (Cl. 60—51)

This invention relates to hydraulically operated power shears and like machines. Devices of this character are frequently required to work upon heavy metal, such for example as the shearing of steel plates of considerable thickness and it is of importance that they be capable of exerting very great power and that the work be firmly held in place during the cutting operation.

It is a primary object of the invention to provide a plurality of hydraulic work clamping plungers arranged in a free and unobstructed fluid supply circuit with the main operating cylinders of a hydraulic shear in such way that the pressure exerted upon the work clamping plungers is always directly proportioned to the power required to shear the particular piece of material being operated upon.

It is a further object to so arrange the fluid supply circuit of the main power cylinders and the work clamp that said circuit will always be filled with pressure fluid and upon the closing of a valve in the circuit to interrupt the oil flow therein pressure will immediately begin to be imposed upon the main cylinders and pistons and the work clamping pistons, whereby the work clamping pistons having less resistance to their movement than the main pistons will quickly and quietly move to work clamping position, the main pistons moving only after the pressure builds up to a point to cause them to move to do the work at hand.

It is a further object of the invention to provide double acting main power cylinders and pistons in a circuit of the above described character and in which the pressure fluid on one side of the main pistons acts to effect the cut while at the same time the pressure fluid upon the other side of the main pistons is ejected into an accumulator against the resistance of a compressible fluid to there store up pressure to effect the return stroke of the ram or knife after the cutting stroke is completed.

Further objects and advantages of the invention will be set forth in the detailed description which follows.

In the accompanying drawing:

Fig. 1 is a diagrammatic view illustrating the hydraulic circuit of the machine;

Fig. 2 is a view partly in section and partly in side elevation showing the construction of the work clamping cylinders and plungers; and

Fig. 3 is a transverse vertical sectional view through a hydraulic press having the invention applied thereto.

Like numerals designate corresponding parts in all of the figures of the drawing.

In the drawing 5 designates the work table of a hydraulic shear. A fixed knife 6 cooperates with a movable knife 7, the latter being carried by a vertically reciprocatory head or ram 8. In accordance with known practice, vertical reciprocatory movement is imparted to head 8 by links 9, crank arms 10 on oscillatory torque tube 11 and crank arms 12, from the piston rods 13 of hydraulic cylinders 14 there being one of these cylinders at each end of the shear and said cylinders acting in unison upon the head through the medium of the heavy connecting torque tube 11.

A fluid pressure circuit line 15 is connected to the outer or work performing end of the cylinders 14 and this circuit includes a fixed manifold 16 that is carried by and may be a part of a heavy face plate 17 of the machine frame.

A port 18 leads through the manifold and is a part of the fluid circuit. Small cylinders 19 threaded into the

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manifold are in communication, at their upper ends with port 18. Springs 20 within the cylinders bear between collars 21 which are threaded into the lower ends of the cylinders and collars 22 of ring like form that are engaged in annular grooves 23 of work clamping plungers 24. The plungers are moved into engagement with the work to be held by the action of pressure fluid, such as oil, which enters cylinders 19 from port 18 of the manifold and they are returned to elevated positions by said springs. An electric motor 25 drives an oil pump 26 that is mounted upon a wall 27 of an oil tank or reservoir 28. Oil is delivered directly from the pump through branch line 15a to line 15 and port 18 of the manifold. An oil return line 15b leads from line 15 back to the tank, the said tank being under atmospheric pressure.

Located in the oil return line 15b is a conventional electrically operated shut off valve 29 the actuating solenoid casing of which is indicated at 30. A conventional pressure relief valve 31 is located in line 15a within the tank and guards against an excess of pressure being built up within the line 15 and associated elements.

An oil pressure line 32 is connected to the outer or non-working end portions 14a of the cylinders 14 and when the pistons move outwardly they not only actuate the ram as described to effect a shearing action but they also expel oil from the outer ends of said cylinders into and through line 32 to an accumulator 33. Accumulators of this type are well known. They comprise a heavy and strong shell 34, containing an inflatable bladder 35. By inflating this bladder with compressible fluid such as air, to a determined pressure, the forcing of the oil from cylinders 14 into said shell between the shell and exterior of the bladder, will further compress the air or like compressible fluid in the bladder and thereby store up such power that the return stroke of the ram and pistons on piston rods 13 may be effected by such stored power in the accumulator whenever the opening of valve 29 releases the pressure in line 15. The operation of the device is as follows.

When shearing is to be done the motor and pump are started and they run continuously. The entire freely connected, unobstructed circuit, represented by the lower ends of cylinders 14, the interiors of cylinders 19, conduit 18 and lines 15, 15a and 15b, is filled with oil which is being circulated by the pump from and to reservoir 28. When it is desired to effect the cutting or shearing of a sheet of metal said sheet is placed on the work table in proper position and the operator presses a pedal (not shown) to energize the solenoid shut off valve, to close the same. This causes a pressure rise in the oil lines, such pressure rise being immediately and equally imposed upon the work clamping plungers and the underside of the pistons in cylinders 14. Since the return springs of the work clamping plungers are merely strong enough to return the plungers to elevated position and since the force required to start the ram on its downward stroke against the accumulated pressure in accumulator 33 is far greater than the force required to set the work clamping plungers 24 down upon the work to be held, it follows that just as soon as valve 29 closes these plungers move quietly and without a striking blow down upon the work and that the pressure upon these plungers builds up until it equals the pressure required to move the pistons outwardly in cylinders 14. This pressure is the pressure required to overcome the power stored in the accumulator plus the pressure required to shear metal of the particular nature and thickness that is being cut. Thus the pressure on the clamping plungers varies in direct proportion to the work being done. The result of the arrangement described is that the shear operates at the most economical speed. This is because no more pressure has to be built up on the work clamping plungers than is necessary, all excess pressure being expended in useful work in the main cylinders. Therefore the expression freely open, unobstructed circuit, as used in the claims is to be understood to mean a circuit free of valves or other impediments designed to create a pressure on the work clamping cylinders ahead of the time that pressure starts to build up in the main cylinders 14. By permitting flow of oil to the main cylinders as soon as any pressure is created

anywhere the building up of the pressure on the clamping pistons is less abrupt than if all available pressure were first imposed on the work clamping pistons. One of the important advantages of this device is that while it is adapted to do quite heavy work it is also very speedy in action. This arises largely from the fact that I utilize the time employed by the operator in positioning the work beneath the clamps, to set the pressure fluid in motion by the continuously moving pump. When the solenoid valve 29 snaps shut the kinetic energy of the flowing oil is quickly delivered to the clamps and power cylinders. Thus I am able to cause my shear to make many strokes per minute with consequent economy in operation. Further it is to be noted that all of the parts which I employ are of very simple construction. Thus I am able to produce a shear much more economically than has heretofore been done in presses of like capacity.

This freely open unobstructed circuit effects a saving of time in that while the work clamping plungers are moving to engage the work the pressure is being built up in the much larger area main cylinders 14 so that movement of the ram on its cutting stroke follows almost immediately after the clamping of the work.

Air under pressure may be admitted to bladder 35 through air inlet 35a and by the mere adjustment of this air pressure the power to return the ram to elevated position and the pressure to be created in the operating fluid circuit lines 15 etc. may be easily adjusted and controlled.

The setting of the clamping plungers gently down upon the work renders their operation almost noiseless and it avoids damage to the work such as might result from too forcible movement of said plungers. This damage is likely to occur when thin stock or soft metals such as brass, copper, aluminum, etc. are being worked upon. Further the abolition of excessive noise is of itself highly desirable. The noise made by some types of hydraulic shears, brakes and like presses, equipped with hydraulic work clamping plungers is exceedingly great, being of the order of that which would be created by a number of hammers forcibly striking the heavy metal work table of the shear. With a number of these machines in operation the resultant din is terrific and imposes severe nerve strains upon workmen forced to endure it over long periods of time.

Efficiency experts and psychologists are agreed that the creation of pleasant working conditions increases the efficiency and health of the individual workers. This invention will contribute to that result.

While the invention is especially useful in power shears it may also be utilized in hydraulic brakes and other types of machines where work is to be clamped ahead of the hydraulic operation of work performing members.

A pressure relief valve 37 in line 38 prevents leakage past the pistons from building up an excess of pressure in the accumulator.

While I have stated that the cylinders 14 are double acting the two ends of the cylinders each perform their separate functions and the provision of two single acting cylinders would be the equivalent thereof. In that case one single acting cylinder would move the ram and the ram would move the plunger of another single acting cylinder to compress oil into the accumulator. The continuing flow of oil through a completely open circuit that is unobstructed by valve casings or dead ends insures that any air in the oil will be immediately returned to the tanks. Thus it is not necessary to provide a special air bleed valve.

It is to be understood that the invention is not limited to the precise construction set forth but that it includes within its purview whatever changes fairly come within either the terms or the spirit of the appended claims.

What I claim is:

1. A fluid pressure system for use in conjunction with machines of the type performing such heavy duty as to require power means for holding work during the operation of the machines thereon and which machines comprise a reciprocatory working head, a pair of primary hydraulic power cylinders and pistons therein for moving said head upon its working stroke and a plurality of fluid pressure operated work holding clamps comprising secondary cylinders and pistons therein, the pistons of all of said clamps being operable simultaneously under the same degree of pressure and at a materially lower pres-

sure than that required to actuate the pistons of the primary power cylinder; said system consisting of a freely open and unobstructed circuit for pressure fluid in which the primary and secondary cylinders are included, said secondary cylinders being of uniform size and connected in parallel into said circuit to have their pistons all simultaneously and uniformly actuated by said pressure fluid, said primary cylinders being likewise disposed in parallel in the said circuit, a continuously operating pump in the circuit, for maintaining a continuous flow of pressure fluid therethrough from and back to said pump, and a shut off valve in the return line to the pump located at a point beyond all of said cylinders, the closing of which causes the pump pressure to first simultaneously actuate all of the more easily actuated secondary pistons and thereafter build up pressure in the primary cylinders to actuate the primary piston therein.

2. A structure as recited in claim 1 wherein the primary cylinders are double acting cylinders with the named circuit communicating with the space at one side of the primary piston, a fluid pressure line communicating with the space within the primary cylinder upon the other side of the primary piston, a fluid pressure accumulator to which the last named fluid pressure line leads and pressure relief means for relieving any excess pressure imposed upon the accumulator by high pressure fluid from the working side of the primary cylinder, passing the piston therein.

3. A structure as recited in claim 1 wherein the primary cylinders and their pistons are double acting with the space upon one side of the primary pistons constituting the working end of the cylinder and to which the said power fluid circuit is connected, a second fluid circuit connected to the primary cylinders upon that side of the primary pistons remote from the working end of the primary cylinders, a fluid pressure power accumulator comprising a casing and an inflatable body therein and to which casing the last named fluid circuit is connected, means for inflating the inflatable body to a predetermined and set degree and a settable relief valve for relieving the pressure in the casing whenever pressure from the power side of the primary pistons, passing said primary pistons, builds up the pressure in the accumulator to a point greater than that for which the relief valve has been set.

4. A fluid pressure system for use in conjunction with work performing machines of the type comprising a primary work performing, hydraulic, cylinder and piston, and a plurality of hydraulic secondary power cylinders and pistons which exercise a uniform and simultaneous preparatory function for the action of the primary cylinder and piston, said secondary pistons all being operable under a same degree of lower pressure than the primary piston, said system comprising a freely open and unobstructed circuit for pressure fluid flow in which circuit both the primary and secondary cylinders and pistons are all included, a continuously operating pump in the circuit for maintaining a continuous flow of pressure fluid therethrough from said pump and back to said pump and a shut off valve in the return line to the pump located at a point beyond all of said cylinders, the closing of which causes the pump pressure to first simultaneously actuate all of the more easily actuated secondary pistons and thereafter build up pressure in the primary cylinder to actuate the primary piston therein.

5. A fluid pressure system for use in conjunction with machines of the type performing such heavy duty as to require power means for holding work during the operation of the machines and which machines comprise a reciprocatory working head, a primary hydraulic power cylinder and piston therein acting to move said head upon its working stroke and a plurality of fluid pressure operated work holding clamps comprising secondary cylinders and pistons therein, the pistons of all of said clamps being operable simultaneously under the same degree of pressure and at a materially lower pressure than that required to actuate the piston of the primary power cylinder, said system consisting of a freely open and unobstructed circuit for pressure fluid in which the primary cylinder and secondary cylinders are included, said secondary cylinders being of uniform size and connected in parallel into said circuit to have their pistons all simultaneously and uniformly actuated by said pressure fluid, said primary cylinder being likewise disposed in parallel in said circuit with the secondary cylinders, a continuously operating pump

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in the circuit, for maintaining a continuous flow of pressure fluid therethrough from and back to said pump, and a shut off valve in the return line to the pump located at a point beyond all of said cylinders, the closing of which causes the pump pressure to first simultaneously actuate all of the more easily actuated secondary pistons and thereafter build up pressure in the primary cylinder to actuate the primary piston therein.

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