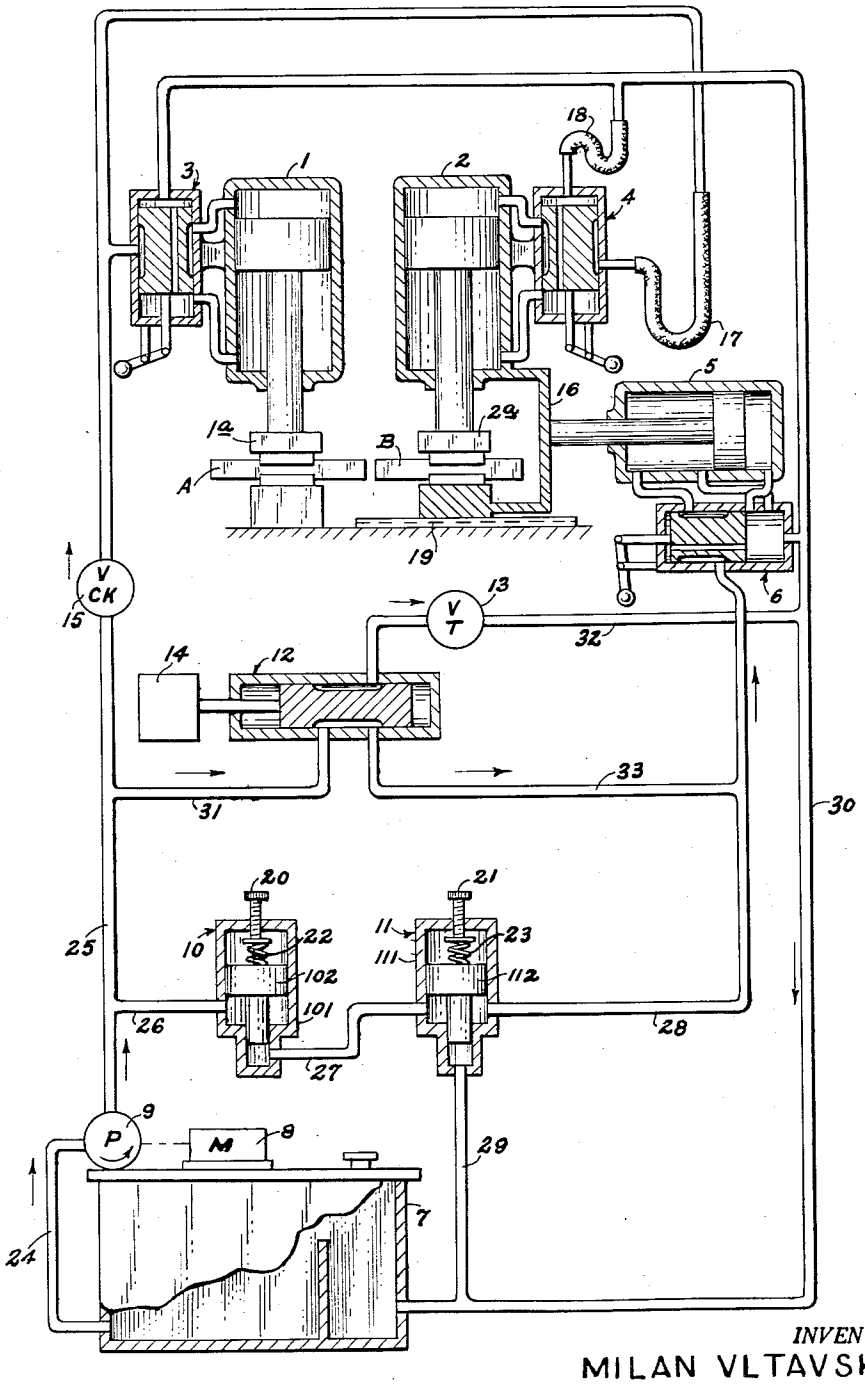
Dec. 27, 1960 M. VLTAVSKÝ 2,966,031

HYDRAULIC CONTROL APPARATUS

Filed July 26, 1955



INVENTOR.

MILAN VLTAVSKÝ

BY

Richard Cowan

AGENT.

United States Patent Office 2,966,031 Patented Dec. 27, 1960

2,966,031

HYDRAULIC CONTROL APPARATUS

Milan Vltavský, Bratislava, Czechoslovakia, assignor of one-half to ČKD Česká Lípa, národní podnik, Česká Lípa, Czechoslovakia, Česká Lípa, Czechoslovakia

Filed July 26, 1955, Ser. No. 524,434

Claims priority, application Czechoslovakia Aug. 19, 1954

3 Claims. (Cl. 60—97)

In hydraulically controlled machines with a plurality of working cylinders, it is frequently necessary to provide an increase in the operative pressure of a determined cylinder or of a determined group of cylinders a predetermined period of time prior to the functioning of another cylinder or group of cylinders. At the same time it is necessary that the above mentioned pressure increase should occur dependably and shortly before the following operation and that the initial operation can be preferably carried out at a reduced working pressure. The above control of the operative pressure is necessary in the case of hydraulic presses for casting under pressure wherein the mould is first closed by a reduced pressure in its operating cylinder and only shortly before injecting the metal through the action of another cylinder the mould is pressed home by an increased pressure.

As a rule, such control of the operative pressure is obtained by means of a pressure multiplier with an appropriate control device. In that case, the ratio of pressure increase is constant and determined by the construction of the pressure multiplier.

A similar procedure is required e.g. in automatic resistance butt welding machines. In this case the objects to be welded are clamped by one group of clamping cylinders at a reduced pressure. At such reduced pressure, resistance heating and melting of the clamped objects takes place. Thereupon follows the compression of the welded objects by an increased pressure which must be preceded by an increase of the clamping pressure. In order to prevent slipping in the clamping jaws, it is necessary to provide an increase of the clamping pressure that corresponds to the friction of the object undergoing welding. On the other hand, the clamping pressure ought not to be excessive, so as to avoid an undesirable wear of the clamping jaws which are usually made of copper. Therefore, it will be necessary to provide for the possibility of altering the ratio between the clamping and compressive pressures.

It is an object of the present invention to provide an hydraulic control system for hydraulic operated machines of the kind performing resistance butt welding, pressure molding and the like, and wherein the system comprises at least two working sections each having at least one working cylinder therein, a single source of hydraulic fluid under pressure with means for supplying the hydraulic fluid from the source to the sections for operating the cylinders of the latter, means altering the pressure of the hydraulic fluid supplied to one of the sections immediately prior to the working stroke of a cylinder in another of said sections, and at least two pressure regulating valves arranged in series in the means for supplying hydraulic fluid to the cylinders, the two pressure regulating valves being individually adjustable.

Another object is to provide an hydraulic control system of the described character, wherein the pressure regulating valve nearest to the source of hydraulic fluid is automatically rendered inoperative when the pressure in

the fluid supplying means attains the value at which that regulating valve is adjustably set to release, whereafter the valve of the pressure of hydraulic fluid supplied to said other section of the machine is determined exclusively by the other pressure regulating valves.

It is a further object of the invention to provide an hydraulic control system of the described character which further comprises bypass means connected in parallel with the series connected pressure regulating valves, slide valve means interposed in the bypass and through which the latter forms a connection between the means supplying hydraulic fluid to the different sections, throttle valve means interposed in the bypass and through which hydraulic fluid under pressure is returned to the source thereof in one position of the slide valve means, and electro-magnetic means operative to actuate said slide valve means to another position effecting blocking of the bypass and rendering inoperative the throttle valve means so that the pressure regulating valves then cooperate to determine the operating pressure of the hydraulic fluid.

The accompanying drawing illustrates, merely by way of example, in a diagrammatic manner an embodiment of the present invention on a hydraulically operated resistance butt welding machine.

The machine includes two clamping cylinders 1 and 2 with the respective distribution valves 3 and 4. These distribution valves 3 and 4 are mounted on the respective clamping cylinders 1 and 2. The clamping cylinders 1 and 2 are connected to clamping jaws 1*a* and 2*a* by which the plates or articles A and B to be butt welded are held during the welding operation. The clamping cylinder 1 and the related clamping jaws 1*a* are attached to the frame of the machine while the cylinder 2 and its clamping jaws 2*a* are attached to a separate body 16 which is shiftable on the frame of the machine within slides 19 for movement of the jaws 2*a* toward and away from the jaws 1*a*. In view of the body 16 being movable, it is necessary to provide an inlet and outlet for the operating liquid into, and out of, the distributor valve 4 formed of flexible or telescopic tubes 17 and 18. The moveable body 16 is connected to the piston rod of hte working cylinder 5. This cylinder 5 is controlled through a control valve 6 mounted on the cylinder 5. On a pressure liquid tank 7 are mounted an electric motor 8 driving a pump 9. The increased clamping pressure is determined by a pressure regulating valve 10 and the increased stamping pressure is determined by another pressure regulating valve 11. The respective release or regulated pressures of the valves 10 and 11 are determined by the forces of springs 22 and 23, respectively, which act upon the valve members, and the spring forces can be individually adjusted, to individually vary the release pressures of the valves 10 and 11, by rotating the hand wheels 20 and 21 of spindles bearing against the springs 22 and 23, respectively. The valves 10 and 11 are connected in series and, in parallel with both valves 10 and 11 are connected a switching slide valve 12 and a throttling valve 13. The slide valve 12 is controlled through an electromagnet 14. In the pipeline between the pump and the clamping cylinders, a check valve 15 is provided for permitting the feed of pressure fluid therethrough only in the direction toward the clamping cylinders 1 and 2 from the pressure source 9.

The pressure regulating valves 10 and 11 have respective valve housings 101 and 111 of stepped cylindrical shape. The high pressure connections to the housings are made in the wider cylinder portion of the housing and the low pressure connection is made to the cylindrical portion of the housing of reduced diameter. Differential pistons 102 and 112 are axially slidable respectively in the valve housings 101 and 111, and have each a cylin-

drical portion of greater diameter tightly fitting in the cylindrical portion of the housing having a larger diameter, and a portion of a smaller diameter matching the smaller housing portion. When in the closed position, the cylinder and piston define an annular space in the larger portion of the valve housing which communicates with the high-pressure connection. When in the open position, the valve pistons 102 and 112 are entirely contained within the larger portion of the valve housings 101, 111. For this reason, the opening or relieving pressure of the valves 10 and 11 is greater than the closing pressure. In other words, the valves 10 and 11 move from the closed to the open position at a relatively high pressure capable of overcoming the restraining force of the springs 22, 23, when acting on the annular surface of the larger piston portion. The valves close only when the pressure within the valve housings 101, 111 is low enough so that the springs 22, 23 can overcome the fluid pressure acting on an area corresponding to the full cross section of the cylindrical housings 101, 111.

More specifically, as shown in the drawing, the inlet of pump 9 draws hydraulic liquid from the tank 7 by way of a conduit 24, while the outlet of pump 9 is connected to a conduit 25 having the check valve 15 interposed therein and extending to the inlet ports of control valves 3 and 4 associated with clamping cylinders 1 and 2. A conduit 26 branches off from conduit 25 at a location intermediate pump 9 and check valve 15 and extends to the wider cylindrical portion of the housing 101 of pressure regulating valve 10. A conduit 27 extends from the relatively small diameter lower portion of valve housing 101 to the relatively large diameter portion of valve housing 111 to supply hydraulic liquid under pressure to housing 111 only when the pressure in conduit 26 is sufficiently high to lift piston 102 of valve 10 to its open position. A conduit 28 extends from the relatively large diameter portion of housing 111 of valve 11 to the inlet of control valve 6 associated with the working cylinder 5 and supplies hydraulic fluid under pressure to control valve 6 following the raising of the piston 102 of valve 10 to its open position. A conduit 29 extends from the lower relatively small diameter portion of housing 111 to a return conduit 30 extending back to tank 7 and is effective to dump hydraulic liquid back to the tank for relieving the pressure in conduit 28 when the pressure acting in the large diameter portion of housing 111 exceeds a predetermined pressure established by adjustment of the force of spring 23, which excessive pressure is effective to raise piston 112 to its open position.

A bypass conduit 31 extends from the conduit 25 at a location between conduit 26 and check valve 15 and connects to the inlet of slide valve 12, while the outlets of slide valve 12 are connected to a conduit 32 having the throttling valve 13 interposed therein and extending to the return conduit 30, and to an alternative flow path conduit 33 which extends to the conduit 28.

In a condition of rest of the machine, the slide valve 12 is in its extreme right-hand position, as shown in the drawing, and the pump 9 is operating at a relieved pressure of about 5 atm. caused by the frictional resistance to flow of the pressure fluid in the throttling passage leading through the conduit 31, the slide valve 12, the conduits 33 and 28, the control valve 6 and the return conduit 30 back to the tank 7. At such a low pressure, the clamping of the objects to be welded is carried out and thereupon the feed of the pressure liquid through the control valve 6 back into the tank 7 is stopped in a well known manner and the pressure is increased up to the basic operating valve of about 15 atm. by passing the pressure liquid from the pump 9 through the conduit 31, the slide valve 12, the conduit 32 and the throttling valve 13 therein, and the return conduit 30 back into the tank 7. The basic working pressure of about 15 atm. is attained by a proper adjustment of the throttling valve 13 which is always set for a pressure lower than the pressure

setting of the valve 10. At this pressure, the basic welding operations are carried out, that is, the resistance heating and melting of the clamped objects.

Shortly before finishing the melting operation, the electromagnet 14 shifts the slide valve 12 into its extreme left-hand position, thus stopping the passage of the pressure liquid through the slide valve 12 and throttling valve 13. The pressure liquid passing out of the pump 9 now has to overcome the resistance of the series connected pressure regulating valves 10 and 11. By adjusting the hand wheel 20 of the pressure regulating valve 10 the pressure of the liquid is first brought up to the adjusted clamping value and is retained within the clamping cylinders by the check valve 15. Thereafter, the pressure is altered to a value determined by the other pressure regulating valve 11 set for the increased pounding or stamping pressure.

It is thus obvious that after the increase of the clamping pressure acting in cylinders 1 and 2 to the value determined by the valve 10 there follows immediately the increase of the pounding pressure acting in cylinder 5 to the value determined by the valve 11, which pounding pressure is transmitted to control valve 6 by way of the conduits 26, 27 and 28, both pressure operations following immediately after each other, without any risk of confusion. Both pressure stages can be set independently of each other by the adjustment of the hand wheels 20 and 21 of the respective pressure regulating valves.

The hydraulic control apparatus according to the present invention enables substantial advantages to be obtained over the hitherto known devices. The apparatus according to the invention is characterized by its simple and dependable functioning, contributing in a high degree to savings in the cost of replacing or repairing the expensive tools (moulds) and clamping jaws.

What I claim is:

1. An hydraulic control system comprising first and second working cylinders, a source of fluid under pressure, first conduit means extending from said source to said first working cylinder and having check valve means therein permitting flow of fluid through said first conduit means only in the direction toward said first working cylinder, second conduit means branching-off said first conduit means between said source and said check valve means and extending to said second working cylinder, pressure relief means interposed in said second conduit means to establish a predetermined pressure of the fluid fed therethrough to said second working cylinder, and pressure responsive valve means interposed in said second conduit means between said pressure relief means and said first conduit means and opertive to close said second conduit means until the pressure in said first conduit means has reached a predetermined value higher than that of said predetermined pressure to be established by said pressure relief means, whereupon said pressure valve means opens and remains open at said predetermined pressure established by said pressure relief means while said check valve means ensures that said predetermined value of pressure at which said pressure responsive valve means opens continues to act in said first working cylinder.

2. An hydraulic control system as in claim 1; further comprising return conduit means, by-pass conduit means extending to said returnc onduit means from said first conduitm eans between said source and check valve means and by-passing said second conduit means, a shut-off valve and a throttling valve interposed in series in said by-pass conduit means and operative, when said shut-off valv is open, to establish a pressure in said first conduit means which is lower than said pressure at which said pressure responsive valve means opens.

3. An hydraulic control system as in claim 2; further comprising control valve means for said second working cylinder communicating with the latter and with said

second conduit means and said return conduit means, and means defining an alternative flow path for fluid from said shut-off valve through said control valve means to said returnc onduit means and interposing a smaller resistancet o flow than said throttling valve so that, so long as said shut-off valve and alternative flow path are simultaneously open, fluid acts in said second working cylinder at a pressure lower than said pressure established by said throttling valve.

References Cited in the file of this patent

UNITED STATES PATENTS

1,367,748	Knoles	Feb. 8, 1921
1,912,184	Ferris et al.	May 30, 1933
1,994,974	Wiedman	Mar. 19, 1935
2,103,984	Indge	Dec. 28, 1938
2,103,984	Indge	Dec. 28, 1937
2,278,713	Riddle	Apr. 7, 1942
2,301,028	Esch	Nov. 3, 1942
2,365,748	Curtis	Dec. 6, 1944
2,386,341	Pearne et al.	Oct. 9, 1945
2,550,529	Carson et al.	Apr. 24, 1951
2,659,206	Carlson	Nov. 17, 1953
2,676,462	Berry	Apr. 27, 1954
2,837,387	Greville	June 3, 1958

FOREIGN PATENTS

468,478	Great Britain	July 6, 1937