June 4, 1963 B. THIELE ETAL 3,091,928

HYDRAULIC LOAD DEVICE

Filed March 28, 1961 2 Sheets-Sheet 1

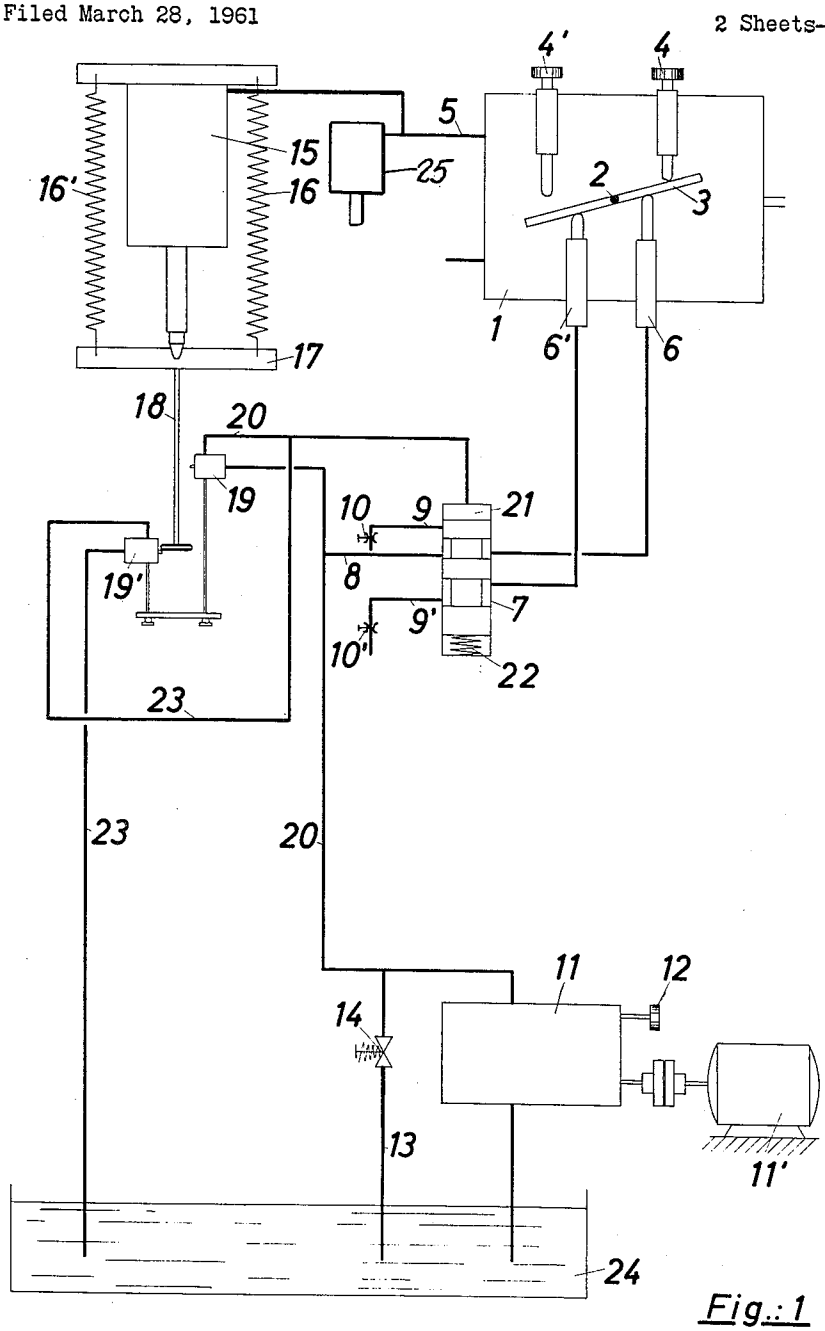


Fig.: 1

Berthold Thiele,
Wilhelm Fey,
Siegfried Handel,
INVENTORS

BY

Jones, Darby & Robertson,
Attorneys

June 4, 1963 B. THIELE ETAL 3,091,928

HYDRAULIC LOAD DEVICE

Filed March 28, 1961 2 Sheets-Sheet 2

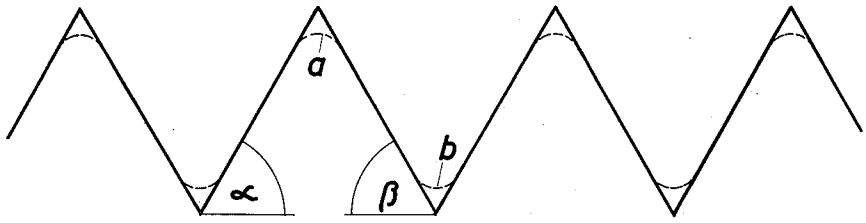


Fig.:3

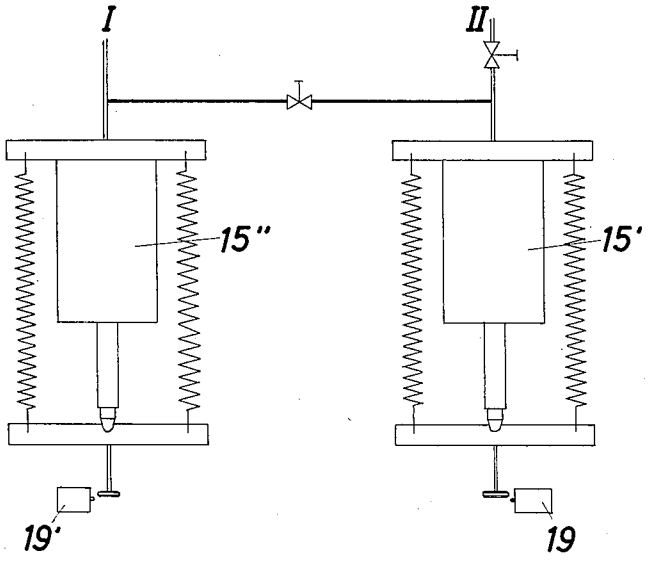


Fig.:2

Berthold Thiele,
Wilhelm Fey,
Siegfried Handel,
INVENTORS

BY

Jones, Darby & Robertson
Attorneys

United States Patent Office 3,091,928 Patented June 4, 1963

3,091,928

HYDRAULIC LOAD DEVICE

Berthold Thiele and Wilhelm Fey, Dusseldorf, and Siegfried Hendel, Hilden, Germany, assignors to Losenhausenwerk, Dusseldorfer Maschinenbau A.G., Dusseldorf-Grafenberg, Germany

Filed Mar. 28, 1961, Ser. No. 98,877
Claims priority, application Germany Apr. 2, 1960
11 Claims. (Cl. 60—52)

This invention relates to a hydraulic load device for material-testing units having a loading pump with variable delivery volume, which pump can be reversed by auxiliary force as a function of a load measuring device. Such load devices may be used both for repetitive stress and for alternating stress. As it is well known, the reversible loading pump delivers fluid into a testing cylinder during the loading period and runs as a hydraulic motor under the influence of the excess pressure prevailing in the testing cylinder, during the relief period.

With alternating stress operation, pressure is generated by the reversible loading pump alternately in two testing cylinders counteracting each other or on the two sides of a double cylinder, the fluid being pumped from one testing cylinder into the other.

It will be known to those skilled in the art that the rate of increase and decrease of the load depends upon the fluid volume delivered per time unit in positive or negative direction. The rate of load increase or decrease, therefore, depends on the position of the pump adjustment member determining the delivery per time unit. By providing stops for the adjustment member of the pump with positive and negative direction of delivery, which stops are adjustable independently of each other, the slopes of the load increase and decrease may be adjusted by such stops independently of each other. In this way triangular or saw-tooth load wave forms may be obtained the steepness of the sides of which can be varied by adjusting the stops for the adjustment member. The amplitude of such load wave depends upon the adjustable load limits, the pump being reversed as soon as these limits are reached. Therefore, the load measuring device is provided with adjustable contacts which may be adjusted to the specific desired upper and lower load limits.

Over and above this, in prior art load devices, it is not possible without difficulties to influence the load wave form.

This invention has for its object, in a hydraulic load device of the type described, to gain a greater influence on the shape of the load waves, in order to be able to make them, for example, sine-shaped or to adapt them in some other way to the required test conditions.

According to this invention, this is achieved in that the loading pump is controlled by a hydraulic control device with variable characteristics, which device is fed by an auxiliary pump. The characteristic of the hydraulic load device may be varied independently from the pressures produced by the loading pump, so that in combination with the forces of reaction which are a function of the load pressure and to which the adjustment member of the loading pump is subjected, any desired adjustment characteristic of this pump adjustment member can be achieved and thereby the load wave form can be considerably affected.

The characteristic of the control device can be changed in various manners. Advantageously the control pressure produced by the auxiliary pump is adjustable by a variable throttling of a secondary outlet. Furthermore the delivery of the auxiliary pump may be adjustable. Also adjustable throttling devices may be provided in

the fluid outlet duct of an appropriate reversing member. These various adjustment means of the control device may be balanced with respect to each other and to the restoring force of the adjustment member in such a manner that any desired movement characteristic of this adjustment member is obtained.

An embodiment of this invention is shown schematically in FIG. 1. FIG. 2 shows a further modification of this embodiment with alternating stress operation. FIG. 3 shows a load wave.

Referring now to FIG. 1, reference numeral 1 designates a hydraulic loading pump, which is reversible in a well known manner by means of a lever shaped adjustment member 3 pivoted at 2. In the position shown of the adjustment member 3, in which it abuts an adjustable stop 4, the loading pump 1 delivers fluid into a pressure pipe 5, which is connected to one or more testing cylinders 25 through a pressure distributor (not shown), so that a load pressure is produced therein. If, however, the adjustment member 3 abuts the adjustable stop 4' after a rotating motion, the direction of delivery of the loading pump has been reversed. In this case, pump 1 runs as a hydraulic motor, under the influence of the excess pressure produced in the testing cylinder 25. Thus a repetitive stress is produced in the testing cylinders by cyclic reversal of the adjustment member 3. Two opposing hydraulic control cylinders 6, 6' engage the adjustment member 3, which cylinders can be connected alternately to a control pressure pipe 8 and fluid outlets 9, 9' through a distributing slide valve 7. The fluid outlets 9, 9' are provided with adjustable throttle valves 10, 10'. The fluid pipe 8 is fed by an auxiliary pump 11 driven by an electric motor 11', the delivery of the pump 11 being adjustable by means of an adjustment member 12. An adjustable throttle valve 14 connected into an outlet pipe 13 permits an adjustment of the control presure produced by the auxiliary pump 11.

A measuring piston 15 is connected to the pressure distributor of testing cylinders 25 by pipe 5 wherein the pressure produced by the loading pump 1 prevails. This piston abuts a yoke 17 loaded by tension springs 16, 16'. An actuating member 18 is connected with the yoke 17, which member actuates two fluid valves 19, 19' arranged at an adjustable distance from each other. The fluid valve 19 is provided in a pressure pipe 20 which is connected to the auxiliary pump 11 and leads to a control chamber 21 of the distributing slide valve 7. The pressure in the control chamber 21 is opposed by a restoring spring 22 of the distributing slide valve 7.

The fluid valve 19' is connected into an outlet pipe 23 which leads from the control chamber 21 to a fluid sump 24.

The mode of operation of the described load device is as follows:

By the load pressure produced by the loading pump 1, the measuring piston 15 is moved outwards (downwardly in FIGURE 1) against the action of the tension spring 16, 16' until the actuating member 18 actuates the fluid valve 19'. This fluid valve is so adjusted in the direction of movement of the actuating member 18 that it is actuated as soon as the desired upper load limit is reached. By opening of the fluid valve 19' the pressure is removed from the control chamber 21 of the distributing slide valve so that the restoring spring 22 can change over the distributing slide valve. Thereby, the control pressure pipe 8 is connected to the hydraulic control cylinder 6', and the control cylinder 6 is connected with the outlet 9. By this process, the adjustment member 3 is rotated to the stop 4' and the loading pump is consequently, reversed. The load pressure decreases and the

measuring piston is moved inwards (upwardly in FIGURE 1) by the tension springs 16, 16' until the actuating member 18 actuates the fluid valve 19. This valve is adjusted to the desired lower load limit. Upon opening of the fluid valve 19 a pressure is produced in the control chamber 21, by which pressure the distributing slide valve 7 is changed over again against the action of the restoring spring 22. Thereby the control cylinder 6 is connected to the pressure pipe 8, and the control cylinder 6' is connected to the outlet 9', and consequently the loading pump 1 is again reversed to positive direction of delivery so that the loading process described is repeated.

In FIG. 3, a repetitive stress wave is shown for the purpose of explaining the adjustment means. If it is assumed that the adjusting speed of the control cylinders 6, 6_2 is very large and their setting forces overcome all restoring forces of the loading pump 1, a sudden reversal of the loading pump takes place. Thereby, a triangular load wave form is obtained, which may consist of equilateral triangles or of saw-tooth waves depending upon the adjustment of the stops 4, 4'. The angles α and β are functions of the adjustment of the stops 4, 4' by which the delivery of the pump is determined. The minima and maxima of the load wave depend upon the positions of the fluid valves 19, 19'.

By adjusting by means of the throttle valve 14 the control pressure produced by the auxiliary pump 11, provision can be made that the forces of reaction of the loading pump 1, which forces increase as the pressure increases, balance the setting force of the control cylinder 6, before the upper load limit has been reached, so that no sudden reversal of the loading pump 1 takes place. Thereby, the load wave form gets the rounding off shown in dashed lines at *a*, the shape of which depends on the adjustment of the control pressure at the throttle valve 14. A similar rounding off *b* of the load wave in the range of the lower load limit can be achieved by adjustment of the delivery at the control member 12 of the auxiliary pump 11, whereby in combination with the outlet throttle valves 10, 10' the adjustment speed of the control cylinders 6, 6' can be varied. Thus it is possible to influence the shape of the load waves in any manner and to adapt them to the testing conditions by proper balancing of the auxiliary force adjustment means 14, 12, 10, 10' with respect to the present force of reaction of the pump adjustment member 3.

With alternating stress tests, two separate measuring pistons 15', 15'' for actuating the fluid valves 19, 19' are provided as shown schematically in FIG. 2, which pistons are operative alternately corresponding to the alternating directions of load.

Instead of the hydraulic control of the distributing slide valve 7 shown here, this control can also be effected for example by electric switches and magnet forces.

What we claim is:

1. In a testing apparatus having a load device the improvement including: a loading pump-motor connected to said device and having control means movable between two positions, in one position of said control means said loading pump-motor acting as a pump to deliver fluid to said device at a first rate, in the other position of said control means said pump-motor acting as as motor in response to fluid under pressure from said device at a second rate; and actuating means connected to said loading pump-motor to move said control means to said one position when the fluid pressure at said load device is at a predetermined minimum and to move said control means to the other position when the fluid pressure at the load device has reached a predetermined maximum.

2. In an apparatus as set forth in claim 1 including: means to vary the speed at which the actuating means moves said control means from said other to said one position upon said fluid pressure reaching said predetermined minimum, and to vary the speed at which said actuating means moves said control means from said one to said other position upon said fluid pressure reaching said predetermined maximum.

3. A testing apparatus for use with a load device and comprising in combination: a loading pump-motor means having a pressure pipe and control means movable between a first position at which fluid under pressure is delivered to the pressure pipe at a first rate and a second position at which fluid is withdrawn from the pressure pipe at a second rate, said pressure pipe being connected to the load device; and pressure responsive actuating means connected to said loading pump-motor means to move said control means to said one position when the fluid pressure in said pressure pipe is at a predetermined minimum and to move said control means to the other position when the fluid pressure in the pressure pipe has reached a predetermined maximum.

4. In an apparatus as set forth in claim 3 including: means to vary the speed at which the actuating means moves said control means from said other to said one position upon said fluid pressure reaching said predetermined minimum, and to vary the speed at which said actuating means moves said control means from said one to said other position upon said fluid pressure reaching said predetermined maximum.

5. A testing apparatus for use with a load device and comprising in combination: a loading pump-motor means having a pressure pipe and control means movable between a first position at which fluid under pressure is delivered to the pressure pipe at a first rate and a second position at which fluid is withdrawn from the pressure pipe at a second rate, said pressure pipe being connected to the load device; fluid cylinder means operatively connected to said control means to move said control means between said two positions; fluid supply means; and pressure responsive means connected to said pressure pipe and including valve means actuated first upon occurrence of a predetermined minimum fluid pressure in said pressure pipe and actuated second upon occurrence of a predetermined maximum fluid pressure in said pressure pipe, said responsive means being connected to said fluid supply means and to said fluid cylinder means to move said control means to said one position when the fluid pressure in said pressure pipe is at a predetermined minimum and to move said control means to the other position when the fluid pressure in the pressure pipe has reached a predetermined maximum.

6. A testing apparatus for use with a load device and comprising in combination: a loading pump-motor means having a pressure pipe and control means with a pivotable control shaft movable between a first position at which fluid under pressure is delivered to the pressure pipe at a first rate and a second position at which fluid is withdrawn from the pressure pipe at a second rate, said pressure pipe being connected to the load device; a first fluid cylinder operatively connected to said shaft to move said shaft from said first to said second position; a second fluid cylinder operatively connected to said shaft to move said shaft from said second to said first position; fluid supply means; pressure responsive means connected to said pressure pipe and including valve means actuated first upon occurrence of a predetermined minimum fluid pressure in said pressure pipe and actuated second upon occurrence of a predetermined maximum fluid pressure in said pressure pipe; and a distributing valve device connected to said fluid supply means, to said two fluid cylinders and to said responsive means to supply fluid to the second cylinder when said valve means is first actuated and to unload the first cylinder, and to supply fluid to the first cylinder when said valve means is secondly actuated and to unload said second cylinder.

7. In an apparatus as set forth in claim 6 wherein, said fluid supply means includes an auxiliary fluid pump with means to adjust the fluid delivery thereof.

8. In an apparatus as set forth in claim 7 wherein, said means to adjust the fluid delivery includes a bleeder

valve connected to the pressure side of the pump to bypass a portion of the fluid from the pump.

9. In an apparatus as set forth in claim 7 wherein, said apparatus includes means to control the rate at which each fluid cylinder is unloaded when said valve means is actuated.

10. A testing apparatus for use with double acting load applying means, said apparatus comprising in combination: a loading pump-motor means having two pressure pipes and control means movable between a first position at which fluid under pressure is delivered to one pressure pipe and returned from the other pressure pipe at a first rate and a second position at which fluid is delivered to the other pressure pipe and returned from the one pressure pipe at a second rate, said pipes being connected to said load applying means; and pressure responsive actuating means connected to said loading pump-motor means to move said control means to said one position when the fluid pressure in one pressure pipe is at a predetermined maximum and to move said control means to the other position when the fluid pressure in the other pressure pipe has reached a predetermined maximum.

11. In an apparatus for operating a hydraulic load device from a pump-motor connected to said device and having control means movable between a first position at which fluid under pressure is delivered to the device at one rate and a second position at which fluid is withdrawn from the device at a second rate, the improvement comprising: fluid cylinder means operatively connected to said control means to move said control means between said two positions; fluid supply means; and pressure responsive means connected to said load device and including valve means actuated first upon occurrence of a predetermined minimum fluid pressure at said load device and actuated second upon occurrence of a predetermined maximum fluid pressure at said load device, said responsive means being connected to said fluid supply means and to said fluid cylinder means to move said control means to said one position when the fluid pressure at said load device is at a predetermined minimum and to move said control means to the other position when the fluid pressure at the load device has reached a predetermined maximum.

References Cited in the file of this patent

UNITED STATES PATENTS

1,638,653	Cannon	Aug. 9, 1927
2,211,483	Tyler	Aug. 13, 1940
2,389,164	Payne	Nov. 20, 1945
2,391,996	Muller	Jan. 1, 1946
2,455,837	Waldie	Dec. 7, 1948
2,602,294	Sedgwick	July 8, 1952
2,627,815	Bunting	Feb. 10, 1953
2,945,449	Le Febvre et al.	July 19, 1960