Nov. 4, 1969 K. O. FRISK ET AL 3,476,017

POWER-LIMITING DEVICE FOR A MACHINE PROVIDED WITH TWO OR MORE WORKING COMPONENTS

Filed April 3, 1967 4 Sheets-Sheet 1

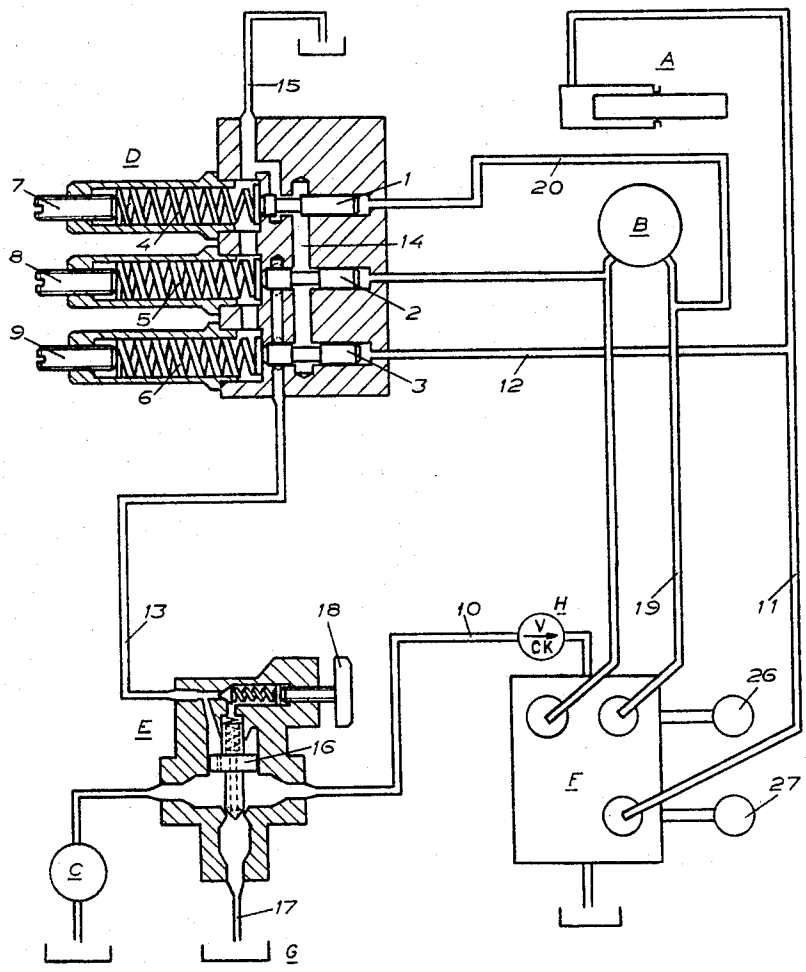


FIG. 1

Nov. 4, 1969 K. O. FRISK ET AL 3,476,017
POWER-LIMITING DEVICE FOR A MACHINE PROVIDED WITH TWO OR MORE WORKING COMPONENTS
Filed April 3, 1967 4 Sheets-Sheet 2

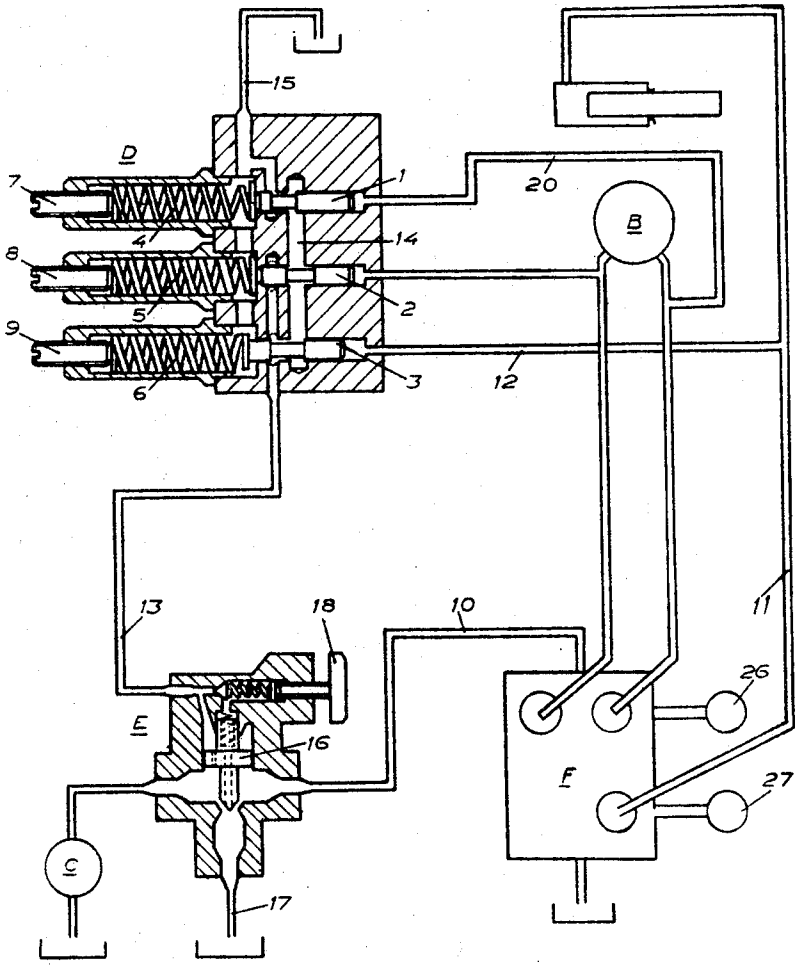


FIG. 2

Nov. 4, 1969 K. O. FRISK ET AL 3,476,017
POWER-LIMITING DEVICE FOR A MACHINE PROVIDED WITH TWO OR MORE WORKING COMPONENTS
Filed April 3, 1967 4 Sheets-Sheet 3

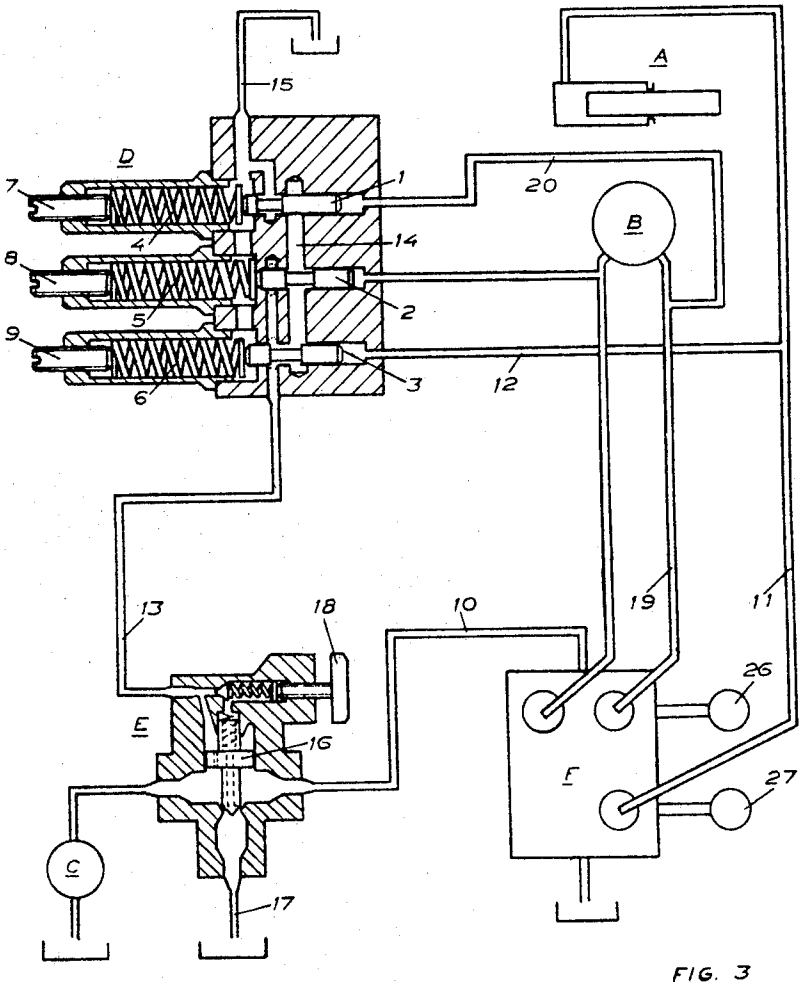


FIG. 3

Nov. 4, 1969 K. O. FRISK ET AL 3,476,017
POWER-LIMITING DEVICE FOR A MACHINE PROVIDED WITH TWO OR MORE WORKING COMPONENTS
Filed April 3, 1967 4 Sheets-Sheet 4

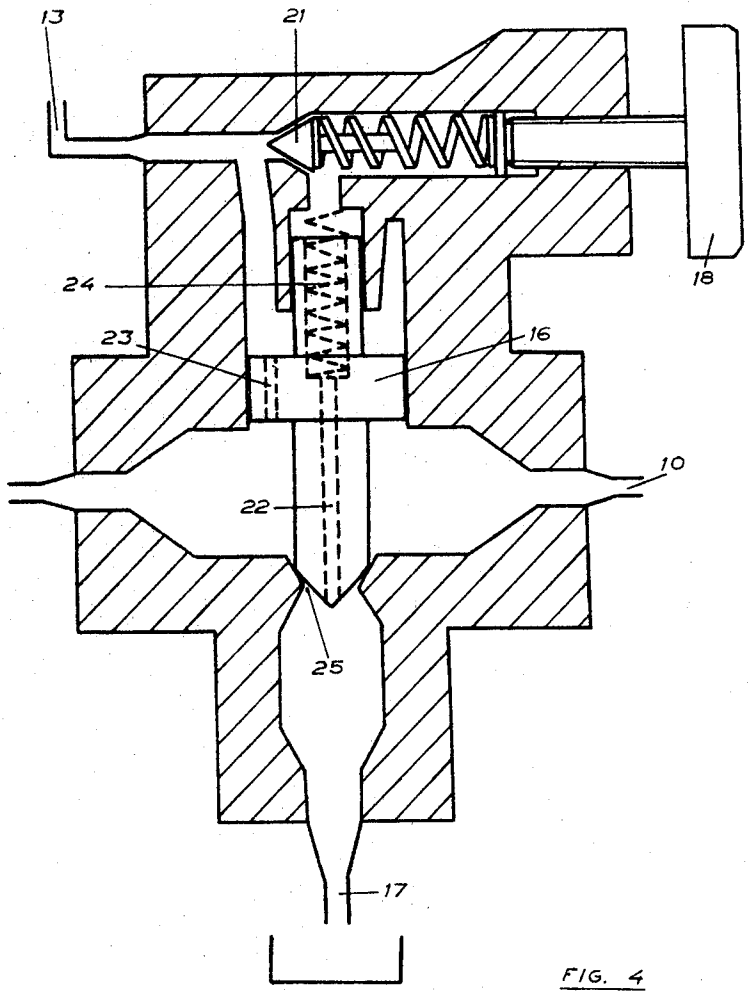


FIG. 4

United States Patent Office

3,476,017
Patented Nov. 4, 1969



3,476,017

# POWER-LIMITING DEVICE FOR A MACHINE PROVIDED WITH TWO OR MORE WORKING COMPONENTS

Knut Olov Frisk and Karl Paul Gustafsson, Bracke, Sweden, assignors to AB Tico, Bracke, Sweden, a corporation of Sweden

Filed Apr. 3, 1967, Ser. No. 627,916
Claims priority, application Sweden, Apr. 29, 1966, 5,886/66
Int. Cl. F15b *11/08, 13/00;* F01b *21/00*
U.S. Cl. 91—412 7 Claims

## ABSTRACT OF THE DISCLOSURE

Pressure sensing means are provided in a hydraulic power circuit that can cut the supply of hydraulic power to all hydraulically operated actuators provided in the circuit in case of overload. The pressure sensing means are capable of preventing overload at any desired pressure while maintaining sufficient hydraulic power to prevent uncontrolled movement of the hydraulically operated actuator.

For instance in hydraulic powered loading cranes comprising a hydraulically operated telescopic boom and/or a hydraulically operated luffing end-jib and/or a winch, an overload of the crane jib may occur under the following conditions. With a crane provided with a short jib it is possible to lift heavier loads than with a longer crane jib or with an extended jib. A loading crane thus can lift a maximum load when the jib is retracted to its shortest outreach. If while lifting the length of the jib is increased while the load is suspended on the jib, for instance, by extending the hydraulic operated telescopic boom or raising the luffing end-jib there then occurs the possibility of overloading the control devices of the crane.

In prior art systems in which the hydraulic lifting power is limited by means of a pressure limiting device characterized by an unloading- or a relief valve, the occurrence of this type of overload cannot be prevented. Such devices are further dangerous in that in case of the above overload the load may start to move downwards in an uncontrollable way which might cause both injuries and damages.

Even if the jib has been dimensioned so that it can support overloads at the maximum outreach of the jib there remains the fact that it is possible to lift a considerably heavier load when the lifting is performed with a short outreach and that the risk of overload can arise when the outreach is increased subsequently. Under unfavorable conditions the overload may even cause the tipping of the crane.

The increase of the outreach can be achieved in different ways, for instance by the extension of the telescopic boom after lifting the load or by raising the luffing end-jib to which the load is suspended.

In cranes provided with a winch it is on the other hand not possible to adjust the lifting capacity to a value exceeding the permissible load at maximum outreach. There is no possibility to adjust the lifting power of the winch in regard to the actual outreach, but the lifting power can be increased by using tackles which again may lead to an overload condition.

The present invention has for its object to overcome the above drawbacks by providing a device for limiting the power which may be produced by the working components of the hydraulic system.

The invention will be more particularly described hereinafter with reference to the accompanying drawings, in which:

FIGURES 1–3 illustrate sectional schematic view of the preferred embodiment of the invention shown in three different working positions,

FIGURE 4 illustrates a sectional view of a prior art pilot-controlled and loading valve.



As apparent in FIGURES 1–3, the illustrated embodiment of the device according to the invention comprises the following main parts: an adjustable sensing means D, a pilot-controlled unloading- or relief valve E and a control valve means F. The device may for instance operate in a loading crane provided with a luffing end-jib which can be raised and lowered by means of a hydraulic cylinder A, a hydraulic operated winch B and a hydraulic pump C.

The sensing means D is arranged to sense the variable output of the working fluid—the hydraulic fluid in the present case—in the working components, that is to say in the hydraulic operated lifting cylinder A and the winch B. The sensing means described comprises three sensing plungers **1**, **2** and **3**, which are spring-biased by means of helical springs **4**, **5** and **6**. The spring-bias is adjustable by means of adjusting screws **7**, **8** and **9**, so that the sensing plungers **1**, **2** and **3** can be biased to a suitable value in order to limit the power of the associated working component.

The prior art pilot-controlled valve E is connected to the hydraulic pump C and via a line **10** to the control valve F which at the inlet is provided with a check valve H. The pilot valve of the valve E is connected to the pressure sensing means D via a line **13**. A return line **17** leads to the hydraulic fluid tank.

As already mentioned, the control valve F is provided with a check valve H, which prevents hydraulic fluid from flowing back to the connection line **10**. The winch B and the lifting piston A of the crane end-jib can be placed in the following three operating positions: lifting, stop and lowering by the appropriate positioning of operating levers **26** and **27**, respectively.

The device according to the embodiment shown operates as follows:

From the pump C hydraulic fluid is conveyed through the unloading valve E via a line **10** to the control valve F. If both operating levers **26** and **27** are in neutral position, the hydraulic fluid is conveyed right through the control valve F and back to the fluid tank G, that is to say, the hydraulic fluid circulates practically without pressure from the pump C through the valve E and the valve F to the fluid tank G.

When the operating lever **27** of the control valve F is actuated said circulation is blocked, the hydraulic pressure increases and the hydraulic pressure fluid is conveyed via the line **11** to a piston A which in the embodiment shown is the lifting piston of a crane end-jib or the like. The line **11** communicates via a line **12** with one of the sensing members and actuates the plunger **3** which the pressure of the hydraulic fluid strives to displace to the left in the figure, against the action of the spring **6**. As long as the power of the spring **6** is greater than the hydraulic pressure applied on the plunger **3**, that is to say, as long as there is no load exceeding the pressure set by means of the adjusting screw **9** the components are in the position shown in FIGURE 1.

When the maximum fluid pressure value set by means of the adjusting screw **9** is reached in the lines **11** and **12**, that is to pay, when the cylinder A begins to overload, the plunger **3** is displaced to the left in the figure and opens a port so that the pressure fluid may return to the fluid tank G via a channel **14** and a return line **15**. In this case there is no pressure in the pilot line **13** so that the valve plug **16** of the pilot-controlled valve is displaced upwards and opens a discharge port **25** leading to the return line **17** and the hydraulic fluid tank G. This position is shown in FIGURE 2. The hydraulic fluid is conveyed from the

pump C to the pilot-operated valve E back to the hydraulic fluid tank via the return line **17**. The lifting travel of the piston A stops and the overload cannot increase any further. As long as the piston A is fully loaded the same pressure will prevail in the lines **11** and **12**, even after the piston travel has stopped. As long as this pressure prevails the plunger **3** of the associate sensing member is displaced to the left and the pilot line **13** remains continuously in connection with the fluid tank via the channel **14** and there is no pressure in the line. Simultaneously the hydraulic fluid delivered by the pump C will continuously return to the tank. The pressure in the line **10** will be very low and substantially depend upon the pressure drop between the delivery side of the pump C and the discharge opening of the return line **17**. There is of course a certain overpressure in the line **10** which is, however, appreciably lower than in the lines **11** and **12**, since due to the check valve H provided in the control device, the pressure prevailing in the two latter lines cannot be transmitted backwards to line **10**. In this position there is no possibility to power-operate any further working component of the system such as a hydraulic operated telescopic boom or a hydraulic operated luffing end-jib which can also be considered represented by B. It is not until the outreach has been reduced, for instance by retraction of the telescopic boom or a change of the elevation of the luffing end-jib, that the pressure exerted by the lifting piston A will decrease and other working components can be actuated.

In a loading crane provided with a hydraulic operated telescopic boom or a winch, it is a desirable feature that the load can be lowered by means of the winch or the telescopic boom can be hydraulically retracted without the operation being influenced by the unloading valve E. The latter valve can therefore be pre-adjusted to a suitable maximum pressure by means of a knob **18**. If the adjusted pressure is reached or exceeded, for instance in the valve chamber of the pilot-controlled unloading valve, the valve plug **16** is raised against the action of a spring **24** (FIGURE 4) and the return port **25** is partially opened until the pressure has again dropped to the preset value.

In the case of a lowering movement or a retraction of the boom by means of the extension cylinder which in the figure can, for instance, be represented by the actuator B, pressure is admitted to the line **19** when the lever **26** of the control valve F is moved in the corresponding direction. The pressure also progresses through the line **20** and actuates the plunger **1** in the sensing means. The plunger is arranged to entirely shut off the connection between the channel **14** and the return line **15** when displaced to the left against the action of the spring **4**. This causes, however, the fluid flow through the pilot line **13** to be blocked and the same pressure prevails again on both sides of the valve plug **16** in the valve E. Under the action of the spring **24**, the valve plug **16** thus will entirely shut off the port **25** leading to the return line **17** and the fluid tank G. The hydraulic pressure, which may rise to a maximum value set by means of the knob **18**, will travel via line **10** to the control valve F and be admitted to the hydraulic motor B or the extension cylinder which in the present case can also be considered as represented by B. The component B thus can be operated so as to lower the load or reduce the jib outreach. As long as this movement progresses, the plunger **1** will remain displaced to the left and the unloading valve will remain out of operation, this situation is illustrated in FIGURE 3.

If for instance a load is lifted by means of the winch B or even the lifting piston A at a short outreach whereupon the outreach is increased, for instance by extension of the telescopic boom, the extension can only be carried out until the outreach has increased so that the pressure on the piston A, and consequently in the lines **11** and **12** as well as on the plunger **3** has reached such a value that the plunger **3** is displaced to the left in the FIGURE 1–3, the pilot line **13** becomes pressureless and the valve plug **16** opens the return port **25** so that the line **10** is unloaded. Therefore, it is not possible to overload the crane jib by securing a tackle instead of a single wire at the outer end of the crane jib. As soon as the lifting power transmitted by the tackle to the load exceeds that value at which the pressure on the piston **18** becomes higher than permissible, the sensing element associated with piston A operates and blocks any further supply of hydraulic pressure to the winch. For instance if the load to be lifted is heavier than the permissible load to which the crane jib may be subjected for the actual outreach, the load cannot be lifted and the operator thus realizes that he has to reduce the outreach. The load can be lifted as soon as the outreach has been sufficiently decreased. The device according to the invention thus provides the possibility of allowing the winch to be operated at a loading capacity corresponding to the actual crane jib outreach.

From the drawing figures it can be seen that a single-acting cylinder, for instance the end-jib lifting cylinder, can be connected up in the same way as the cylinder A. A double-acting cylinder, for instance, for extending and retracting the telescopic section of the crane jib can be connected in the same way as the winch B, that is to say, with a sensing element connected in parallel with a sensing element for the lifting cylinder A, the second sensing element for the retraction power being connected in the same way as the plunger **1**. All unloading functions, for example, the lowering of the load, the decrease of the outreach and possibly the lowering of the luffing end-jib can thus be connected in the same way as the plunger **1** while the load-developing functions are connected in the same way as the plungers **2** and **3**.

In order to avoid overload it is further suitable to provide a control device F which allows the operation of only one lever at a time.

With the information given above a person skilled in the art could further modify the above-described device within the scope of the invention. As mentioned, further sening elements for each additional hydraulic cylinder added to the loading crane can be arranged in a similar way, for instance, a hydraulic operated extension and retraction of a telescopic boom, raising or lowering of a luffing end-jib, etc. Care should be taken to control and possibly limit the extension of the telescopic boom or the raise of the luffing end-jib; while the retraction or the lowering, usually does not cause an overload and therefore will not require any regulation. It may be desirable that in case of an actual overload means be provided to lower the luffing end-jib or to retract the telescopic boom or to lower the load by means of the winch. In the first case only the opening of a return port would be required, while the retraction of the telescopic boom would require a certain amount of power and the lowering of the load by means of the winch would in addition require a hydraulic pressure surge in order to trip the winch brake.

The sensing means D can also be arranged in another manner from that shown in the illustrated embodiment within the scope of the invention. Thus the plungers **1**, **2** and **3** instead of directly opening the channel leading to the return line **15** may consist of plungers actuating check valves admitting the fluid pressure to the line **13** whereby the fluid pressure would actuate a pressure-controlled check valve which would open and admit the fluid discharged from the pump C to the fluid tank G via a return line **17** and in this way limit the supply of hydraulic fluid to the working component, which supply would otherwise cause a load increase on an already overloaded component.

Knowing the principle of the invention a person skilled in the art can by applying common professional knowledge conceive modifications which have not been mentioned above. A substantial feature of the invention is that when a certain component is subjected to a maximum load there is no possibility to operate any additional components than those which are to be operated for either

lowering the load or reducing the outreach or lowering the luffing end-jib.

What we claim is:

1. In a hydraulic system for controlling hydraulically actuated working components comprising a reservoir tank, a source of hydraulic pressure connected thereto, a pilot control valve means with an inlet port connected to the source of hydraulic pressure, a fluid control valve means connected to the working components, a first fluid connection means between the pilot control valve means and the fluid control valve, means for simultaneously and individually sensing the pressure in each of the hydraulically actuated working components, a pilot fluid connected means between the pilot control valve and the pressure sensing means, and a second fluid connection means between the pilot control valve means and the reservoir tank whereby the pressure sensing means can at a predetermined pressure in the working components cause the pilot control valve to unload and thereby maintain a constant pressure below overload in at least one of the working components.

2. A hydraulic system as in claim 1 wherein the means for sensing the pressure in the hydraulic actuated working components is capable of loading and unloading the pilot control valve by the closing and opening of the fluid path in the pilot fluid connection means.

3. A hydraulic system as in claim 2, wherein the means for sensing the pressure in the hydraulic actuated working components includes at least one plunger with one side in fluid communication with the working hydraulic fluid and the other side in communication with the pilot fluid from the pilot control valve.

4. A hydraulic system as in claim 3 wherein the means



for sensing the pressure in the hydraulic actuated working components includes a second plunger with one end in fluid communication with the hydraulic fluid being supplied a second working component, the second plunger being capable of closing the fluid path in the pilot fluid connection means for the purpose of loading the pilot control valve to provide a source of hydraulic pressure for the second working component while maintaining pressure in another working component.

5. A hydraulic system as in claim 3 wherein an adjustable spring means biases the plunger.

6. A hydraulic system as in claim 4 wherein the pilot control valve means includes a pressure limiting means.

7. A hydraulic system as in claim 1, wherein the pilot control valve means includes a movable piston containing a restrictive orifice for establishing an operative fluid connection with the pressure sensing means.


**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,568,528 | 9/1951 | Welte | 60—97 XR |
| 3,073,331 | 1/1963 | Faisandier | 137—108 |
| 2,318,851 | 5/1943 | Griffith | 60—97 XR |
| 2,465,758 | 3/1949 | Sedgwick et al. | |
| 2,495,669 | 1/1950 | Cannon | 60—52 XR |
| 2,527,943 | 10/1950 | Lee | 91—414 XR |



EDGAR W. GEOGHEGAN, Primary Examiner

U.S. Cl. X.R.

60—53, 97; 91—414; 137—115