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Feucht

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[54] **METHOD AND APPARATUS FOR CONTROLLING HYDRAULIC DRIFTERS**

[75] Inventor: **Jacob Edward Feucht,** Sidney, Ohio

[73] Assignee: **Dresser Industries, Inc.,** Dallas, Tex.

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[58] **Field of Search** 173/1, 2, 8, 11, 9

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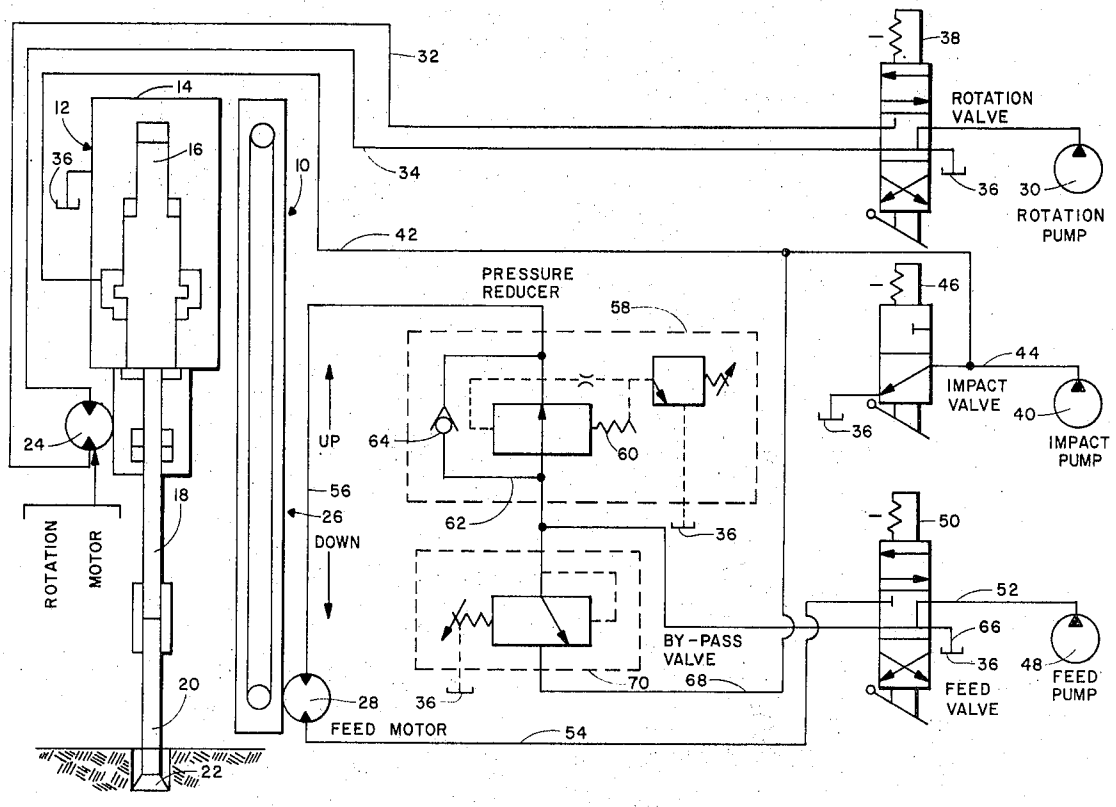
Primary Examiner—David H. Brown

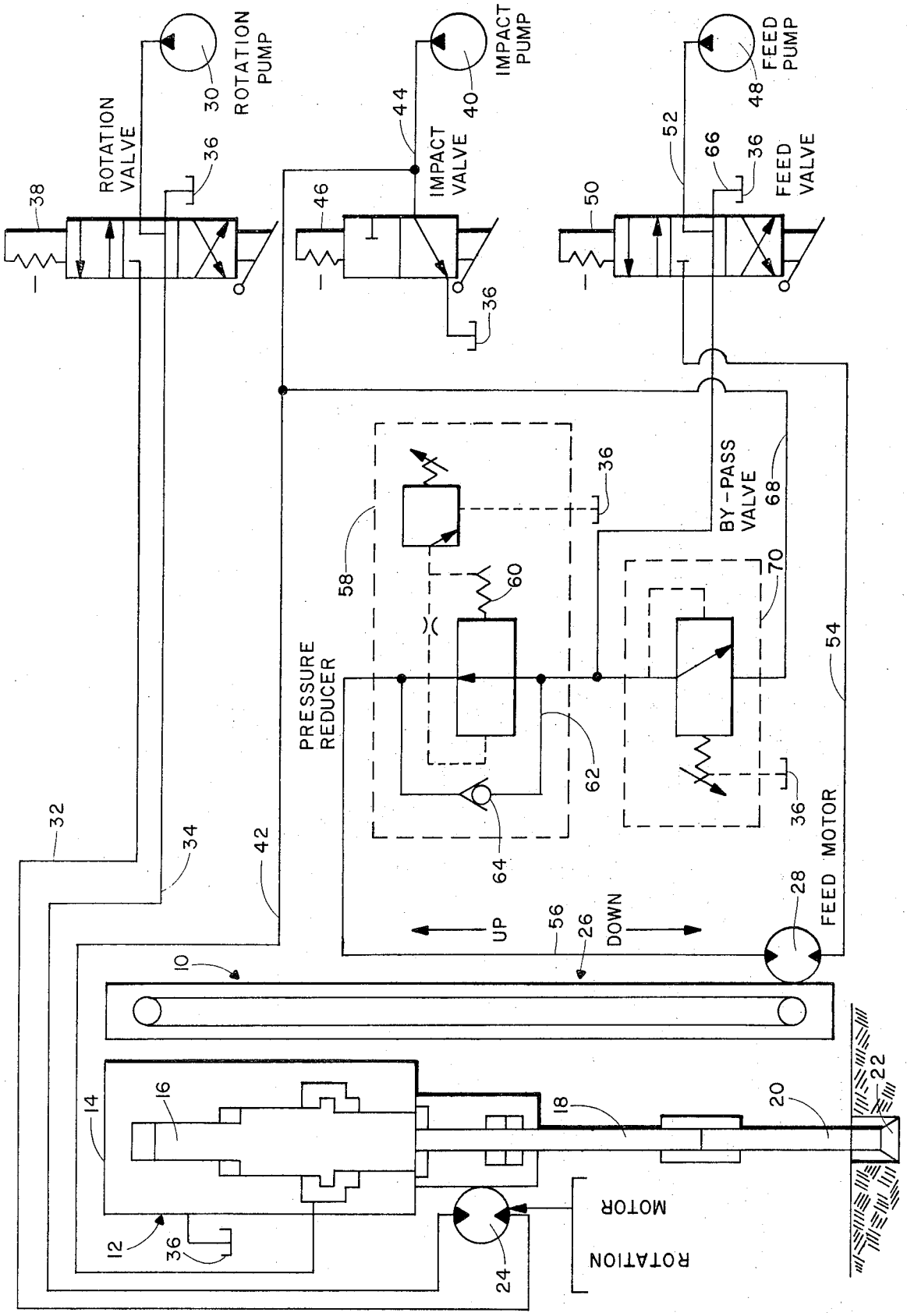
Attorney, Agent, or Firm—Roy L. Van Winkle

[57] **ABSTRACT**

Disclosed herein is a hydraulic circuit for use in conjunction with a hydraulic drifter or impact mechanism used for drilling holes in connection with mining or the like. The hydraulic circuit described is arranged to provide for the rotation of the drill, to supply hydraulic fluid to the drifter for causing reciprocation of the bit, and to supply hydraulic fluid to a feed mechanism to maintain the drifter in engagement with the formation to be drilled. The circuit is arranged to provide for the automatic diversion of a portion of the feed mechanism fluid supply when the pressure in the feed mechanism exceeds a predetermined value. The diverted fluid is supplied to the impact mechanism to provide additional power when the feed mechanism is at or near the stall condition.

9 Claims, 1 Drawing Figure




ROTATION PUMP
30
ROTATION VALVE
36
38
IMPACT PUMP
40
IMPACT VALVE
44
46
FEED PUMP
48
FEED VALVE
52
66
50
BY-PASS VALVE
68
70
PRESSURE REDUCER
58
60
62
64
54
FEED MOTOR
28
UP
DOWN
56
26
10
32
34
42
12
14
16
18
20
22
24
ROTATION MOTOR

METHOD AND APPARATUS FOR CONTROLLING HYDRAULIC DRIFTERS

BACKGROUND OF THE INVENTION

This invention relates generally to hydraulically actuated percussion drills or, as they are known in the art, hydraulic drifters. More particularly, but not by way of limitation, this invention relates to an improved control circuit for use with such drills that is arranged to provide the maximum fluid power to the impact mechanism when the drill is being used in formations that are extremely difficult to drill.

In the past, it has been known to provide an independent means for rotating the drill bit during drilling to promote even drilling and to promote even wear on the drill bit. It has also been known to provide a separate power source for causing reciprocation of the impact mechanism. One example of a hydraulic drifter may be found in U.S. Pat. No. 3,701,386, issued Oct. 31, 1972 to Jacob E. Feucht. That patent fully describes the structure and operation of the impact mechanism shown schematically herein.

In addition to the foregoing, a separate power supply source has been provided for driving the feed mechanism which moves the impact mechanism and the bit toward the formation to be drilled and applies a continual force thereto so that the drill will drill more rapidly. The same source of fluid supply is also used to move the impact mechanism relatively away from the formation for the purpose of changing drill bits, adding or removing drill steels, etc.

During such drilling operations, and particularly when formations that are very difficult to drill are encountered, the feed mechanism will exert a force on the impact mechanism. When the feed mechanism approaches or reaches the stall condition, a relief valve is provided so that the pressure in the hydraulic feed circuit will not exceed some predetermined value. Normally the pressure will exceed the predetermined value when the stall condition is approached and fluid will be circulated back to the hydraulic reservoir. The constant displacement pump utilized in such circuits is then operating very inefficiently because considerable fluid is simply being circulated through the circuit without doing any additional work.

One object of this invention is to provide an improved hydraulic circuit for powering hydraulic drifters that will utilize the excess pressure built up by the pump in the feed mechanism to impart additional power to the impact mechanism.

Another object of the invention is to provide an improved hydraulic circuit wherein the control circuit automatically prevents the diversion of fluid in the event that a relatively easy formation to drill is encountered.

Still another object of the invention is to provide an improved hydraulic circuit for drifters that automatically closes to prevent the diversion of fluid during movement of the impact mechanism toward and away from the formation so that the full fluid flow to the feed mechanism is provided.

One additional object of the invention is to provide an improved control circuit for hydraulic drifters wherein both full flow to the impact mechanism and full flow to the feed mechanism is available when the formation encountered or the conditions of operation

are such that full flow conditions are required to both mechanisms.

SUMMARY OF THE INVENTION

In one aspect, this invention provides an improved hydraulic circuit for controlling the feed force and impact force exerted by a hydraulic drifter that includes an impact mechanism including a hydraulically actuated reciprocating piston causing the impact force and a feed mechanism powered by hydraulic motor for moving the impact mechanism toward and away from the formation being drilled, the improvement comprising: first means for supplying pressure fluid to the impact mechanism; second means for supplying pressure fluid to the feed mechanism; and, third means interconnecting the first and second means for fluid communication, the third means including normally-closed valve means, presettable to open in response to a predetermined pressure in the second means permitting fluid flow from the second means to the first means when the pressure in the second means exceeds the predetermined pressure, whereby the impact mechanism receives fluid under pressure from the feed mechanism.

In another aspect of the invention, there is contemplated a method for automatically controlling the application of hydraulic power between the impact force and feed force in a hydraulic drifter that includes an impact mechanism having a hydraulically actuated reciprocating piston for causing the impact force, the impact pump for supplying hydraulic fluid to the impact mechanism, a feed mechanism powered by a hydraulic motor for moving the impact mechanism toward and away from the formation being drilled, a feed pump for supplying hydraulic fluid to the feed mechanism, and pressure-responsive valve means operably disposed between said impact mechanism and feed mechanism, the method comprising the steps of: supplying fluid under pressure to cause reciprocation of the piston in the impact mechanism by means of an impact pump; supplying fluid to the feed mechanism to force the impact mechanism into engagement with the formation by means of a feed pump; and, opening the valve means to divert a portion of the pressure fluid from the feed pump and feed mechanism to the impact mechanism through the valve means to increase the power available to the impact mechanism when the pressure in the feed mechanism exceeds a predetermined value.

The foregoing and additional objects and advantages of the invention will become more apparent as the following detailed description is read in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE of the drawing is a schematic illustration of a hydraulic circuit constructed in accordance with the invention and utilized to control a hydraulic drifter.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The single FIGURE of the drawing schematically illustrates a hydraulic drifter **10** and the hydraulic power circuit associated therewith. The hydraulic drifter **10** includes an impact mechanism **12** having a housing **14** which encompasses a reciprocating piston or striker **16**. The housing **14** is appropriately arranged with ports

and passageways to cause reciprocation of the piston or striker **16.** A shank bar **18** extends from the housing **14.** One end of the shank bar **18** is arranged to be impacted by the piston **16** and the other end thereof is adapted to be connected with a drill steel **20** that is connected at its lower end to a drill bit **22.** It will, of course, be understood that a plurality of the drill steels **20** may be utilized if needed. The member is a function of the depth of the hole to be drilled by the drifter **10.**

A hydraulic rotation motor **24** is mounted on the housing **14.** The purpose of the motor **24** is to cause rotation of the shank bar **18,** the drill steels **20** and the bit **22** during the drilling of the formation.

The impact mechanism **12** is mounted on a feed mechanism **26.** The feed mechanism is arranged to move the impact mechanism **12** toward and away from the formation to be drilled. A feed motor **28,** which is also hydraulically powered, is mounted on the feed mechanism **26** and arranged to cause movement of the impact mechanism **12** in the desired direction.

As previously mentioned, the rotation motor **24** is arranged to provide rotation of the bit **22.** Power for the rotation motor **24** is derived from a rotation pump **30** that is connected to the rotation motor **24** by a conduit **32.** The rotation motor **24** is also connected by a conduit **34** with a hydraulic reservoir **36.**

Operably disposed in the conduits **32** and **34** is a three-position valve **38** that, in one position, prevents flow from the pump **30** to the motor **24,** and a second position permits flow from the pump **30** to the motor **24** through the conduit **32.** When in the second position, fluid returns from the motor **24** through the conduit **34** to the reservoir **36.** In the third position of the valve **38,** fluid flows from the pump **30** through the line **34** to the motor **24** and returns through the conduit **32** to the reservoir **36.** It will be appreciated that the first and third positions of the valve **38** will cause the motor **24** to rotate in opposite directions.

Power to drive the reciprocating piston or striker **16** is derived from an impact pump **40** through a conduit **42** that is connected to a conduit **44.** The conduit **44** extends from the pump **40** to the reservoir **36** through a two-position impact valve **46.** In the position of the impact valve **46** illustrated, fluid from the pump **40** flows through the valve **46** to the reservoir **36** and thus is not directed through the conduit **42** to the reciprocating piston **16.** In the other position of the impact valve **46,** the conduit **44** extending to the reservoir **36** is blocked by the valve **46** and, consequently, fluid is directed from the conduit **44** through the conduit **42** to the impact mechanism **12** causing reciprocation of the piston **16.**

Power for driving the feed motor **28** is provided by a feed pump **48.** The feed pump **48** is connected to a three-position feed valve **50** by a conduit **52.** The feed valve **50** is connected to one side of the feed motor **28** by a conduit **54** and to the opposite side of the feed motor **28** by a conduit **56.** As can be seen in the drawing, the conduit **54** extends directly from the feed valve **50** to the feed motor **28.** A pressure reducing device **58** is disposed in the conduit **56.**

The pressure reducing device **58** includes an adjustable pressure responsive reducing mechanism **60** and a bypass **62** that has a check valve **64** located therein. The check valve **64** is arranged to freely permit fluid flow through the bypass **62** as fluid flows through the conduit **56** from the feed motor **28,** but to prevent flow therethrough when the flow is through the conduit **56** to the feed motor **28.** Thus, the pressure reducing mechanism **60** is effective only when flow is through the conduit **56** toward the feed motor **28.** It should be pointed out that flow through the conduit **56** to the feed motor **28** will cause the feed motor **28** to rotate in a direction to drive the feed mechanism **26** and the impact mechanism **12** toward the formation to be drilled.

The feed valve **50** is arranged so that in one position fluid will flow through the conduit **52** from the feed pump **48** through the valve **50** directly into the conduit **54** to the feed motor **28.** When receiving fluid from the conduit **54,** the feed motor **28** rotates in a direction to move the impact mechanism **12** relatively away from the formation to be drilled. As the fluid flows from the conduit **54** through the feed motor **28,** it returns through the conduit **56** through the feed valve **50** where it is directed through a conduit **66** to the reservoir **36.**

A conduit **68** extends from the conduit **56** between the pressure reducing valve **58** and the feed valve **50** to an intersection with the conduit **42** which leads to the impact mechanism **12.** Operably disposed in the conduit **68** is an adjustable, pressure-responsive, bypass valve **70** that is normally closed but that permits the flow of fluid through the conduit **68** to the conduit **42** when the pressure in the feed motor **28** and the conduit **56** exceeds a predetermined and preset value. The valve **70** is preferably set to open at a pressure slightly higher than the highest expected or desired feed pressure in the conduits **52** and **56.**

It will be appreciated from the foregoing that the feed motor **28** drives the impact mechanism **12** and bit **22** into engagement with the formation. The feed motor **28** continues to exert a force thereon until the pressure builds up in the feed motor **28** due to the resistance of the formation until the pressure exceeds the preset, predetermined value. At this point, the bypass valve **70** opens permitting excess fluid pressure flowing through the conduit **56** to flow through the conduit **68** into the impact mechanism **12** via the conduit **42.** This additional fluid flow and pressure increases the power available to the impact mechanism **12** whereby greater efficiency can be obtained in the drilling of the formation.

DESCRIPTION OF THE OPERATION OF THE PREFERRED EMBODIMENT

For the purpose of explaining the operation of the hydraulic drifter **10,** it is assumed that the drifter is positioned adjacent the formation to be drilled. With the pumps **30, 40** and **48** running, the rotation valve **38** will be moved to the position wherein fluid flows from the pump **30** through the conduit **32** to the rotation motor **24** and returns therefrom through the conduit **34** to the reservoir **36.** If it is desired to rotate the bit **22** in the opposite direction, the valve **38** can be repositioned so that the flow will be in the opposite direction through the conduits **32** and **34.**

Reciprocation of the piston **16** can be started if desired before the bit **22** is in engagement with the formation to be drilled. Reciprocation of the piston **16** is accomplished by closing the impact valve **46** so that fluid flows from the pump **40** through the conduits **44** and **42** to the impact mechanism **12.** A detailed description of the operation of one from of drifter **10** that can be

utilized may be found in previously mentioned U.S. Pat. No. 3,701,386. With the impact mechanism **12** in the up position on the feed mechanism **26**, the reciprocating piston **16** will not strike the shank bar **18** because the shank bar **18**, drill steels **20** and bit **22** have sufficient weight to retain those members in a position in the housing **14** wherein the bar **18** cannot be engaged by the piston **16**.

Movement or traverse of the impact mechanism **12** toward the formation is accomplished by moving the feed valve **50** to the position wherein fluid flow from the feed pump **48** to the feed motor **28** occurs through the conduits **52** and **56**. Fluid from the feed motor **28** returns through the conduit **54**, the feed valve **50** and the conduit **66** to the reservoir **36**. With flow in this direction, the feed motor **28** has the proper rotational direction so that the impact mechanism **12** is moved downwardly, that is, toward the formation to be drilled.

After the drill bit **22** is in engagement with the formation, fluid pressure through the conduit **56** is exerted on the feed motor **28** maintaining a force downwardly to hold the impact mechanism against the formation. During this time, the piston **16** is reciprocating and engaging the striker bar **18** and, thus, exerting an impact force on the drill bit **22**. If the drilling is relatively easy, that is if the bit **22** penetrates the formation without undue difficulty, the system continues to operate as described.

If, on the other hand, the formation is extremely difficult to drill, the feed motor **28** continues to exert a downward force on the impact mechanism **12** but little or no movement of the impact mechanism occurs and, thus, the feed motor **28** approaches stall condition. As this condition is approached, pressure builds up in the feed motor **28** and the conduit **56** until it exceeds the preset pressure of the bypass valve **70**. When this occurs, the bypass valve **70** opens permitting flow from the conduit **52** into the conduit **68** which, as previously mentioned, is connected with the conduit **42**. It will be appreciated that the feed pump **48** is now supplying fluid under pressure through the conduit **42** to the impact mechanism **12** to augment the fluid being supplied to the impact mechanism **12** by the impact pump **40**. Thus, under circumstances where extreme difficulty in drilling is encountered, the system described provides a means for supplying additional power to the impact mechanism **12** to provide a greater rate of formation penetration.

When it is necessary or desirable to remove the bit **22** from the formation, the feed valve **50** is returned to the position wherein the feed pump **48** supplies fluid to the feed motor **28** through the conduit **54**. As this flow occurs, the rotational direction of the feed motor **28** is reversed and the bypass valve **70** closes so that return fluid from the feed motor **28** flows through the conduit **56**, the bypass line **62** of the pressure reducing valve **58** and into the reservoir **36** through the conduit **66**. Rotation of the feed motor **28** in this direction moves the impact mechanism **12** upwardly or away from the formation to be drilled. The drifter **10** is now returned substantially to its starting position. If desired, the rotation valve, impact valve and feed valve can be moved to the closed positions.

From the foregoing, it will be appreciated that the system described provides the maximum volume of hydraulic fluid at the maximum pressure to the reciprocating piston **16** of the impact mechanism **12** at the time when the most force is required in the impact mechanism. The system also provides the feed motor with sufficient volume of fluid to maintain the feed force on the drifter **10** during the maximum difficulty of drilling. The volume and pressure fluid from the pump **48** is automatically diverted when needed and, yet, providing maximum fluid volume to the feed motor **28** when it is desired to move the impact mechanism **12** rapidly along the feed mechanism **26** in either direction.

It will be understood that the foregoing embodiment is presented by way of example only and that many modifications and changes can be made thereto without departing from the spirit or scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an improved hydraulic circuit for controlling the feed force and impact force exerted by a hydraulic drifter that includes an impact mechanism including a hydraulically-actuated, reciprocating piston for causing the impact force and a feed mechanism powered by a hydraulic motor for moving the impact mechanism toward and away from the formation being drilled, the improvement comprising:

first means for supplying pressure fluid to the impact mechanism;

second means for supplying pressure fluid to the feed mechanism; and,

third means interconnecting said first and second means for fluid communication, said third means including normally-closed valve means, presettable to open in response to a predetermined pressure in said second means permitting fluid flow from said second means to said first means when the pressure in said second means exceeds the predetermined pressure, whereby the impact mechanism receives fluid under pressure from the feed mechanism.

2. The hydraulic circuit of claim **1** wherein said second means includes pressure reducing means for limiting the maximum fluid pressure applied to the hydraulic motor.

3. The hydraulic circuit of claim **2** wherein said valve means is preset to open at a pressure above maximum pressure in said second means.

4. The hydraulic circuit of claim **2** wherein said second means also includes bypass means providing a fluid flow path around said pressure reducing means, said bypass means having a one-way valve disposed therein permitting flow around said pressure reducing means in one direction and preventing flow around said pressure reducing means in the opposite direction.

5. The hydraulic circuit of claim **4** wherein said one-way valve is oriented to prevent flow through said bypass means when said second means is supplying pressure to the feed mechanism in a direction to cause the feed mechanism to move the impact mechanism toward the formation to be drilled.

6. In an improved hydraulic circuit for controlling the feed force and impact force exerted by a hydraulic drifter that includes an impact mechanism including a hydraulically-actuated, reciprocating piston for causing the impact force and a feed mechanism powered by a hydraulic motor for moving the impact mechanism

toward and away from the formation being drilled, the improvement comprising:

an impact pump connected in fluid communication with the impact mechanism;

impact valve means arranged to interrupt the fluid communication between said impact pump and impact mechanism;

feed valve means;

a feed pump connected in fluid communication with said feed valve means;

first and second conduits providing fluid communication between said feed valve means and the hydraulic motor; pressure-reducing valve means located in said second conduit for limiting the fluid pressure in the hydraulic motor to a predetermined value;

a third conduit connecting said second conduit in fluid communication with the impact mechanism; and,

pressure-responsive valve means in said third conduit for providing fluid flow through said third conduit to the impact mechanism from said feed pump when the pressure in said second conduit and pressure-reducing valve means exceeds said predetermined value to provide additional fluid power from the feed pump for operation of the impact mechanism when the hydraulic motor of the feed mechanism is at or near stall condition.

7. A method for automatically controlling the application of hydraulic power between the impact force and feed force in a hydraulic drifter that includes an impact mechanism having a hydraulically-actuated, reciprocating piston for causing the impact force; an impact pump for supplying hydraulic fluid to the impact mechanism; a feed mechanism powered by a hydraulic motor for moving the impact mechanism toward and away from the formation being drilled; a feed pump for supplying hydraulic fluid to the feed mechanism; and pressure-responsive valve means operably disposed between said impact mechanism and feed mechanism, the method comprising the steps of:

supplying fluid under pressure to cause reciprocation of the piston in the impact mechanism by means of an impact pump;

supplying fluid to the feed mechanism to force the impact mechanism into engagement with the formation by means of a feed pump; and,

opening the valve means to divert a portion of the pressure fluid from the feed pump and feed mechanism to the impact mechanism through the valve means to increase the power available to the impact mechanism when the pressure in the feed mechanism exceeds a predetermined value.

8. The method of claim **7** wherein the step of diverting a portion of the pressure fluid includes presetting the valve means to open when the hydraulic motor is at or near stall.

9. The method of claim **7** including the step of closing the valve means to prevent the diversion of the pressure fluid when the pressure in the feed mechanism is below the predetermined value.

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