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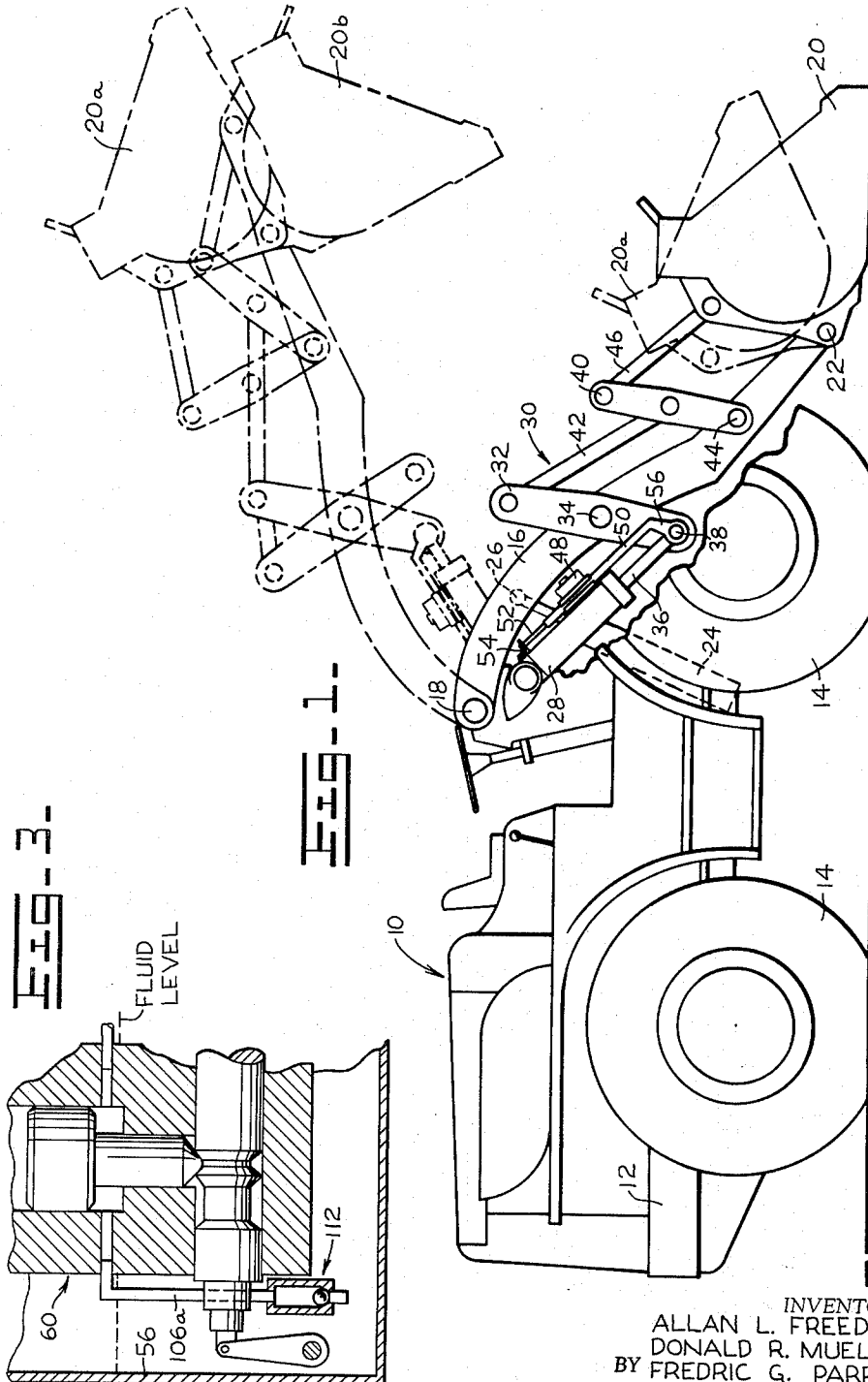
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3,234,855

HYDRAULIC SYSTEM

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2 Sheets-Sheet 1



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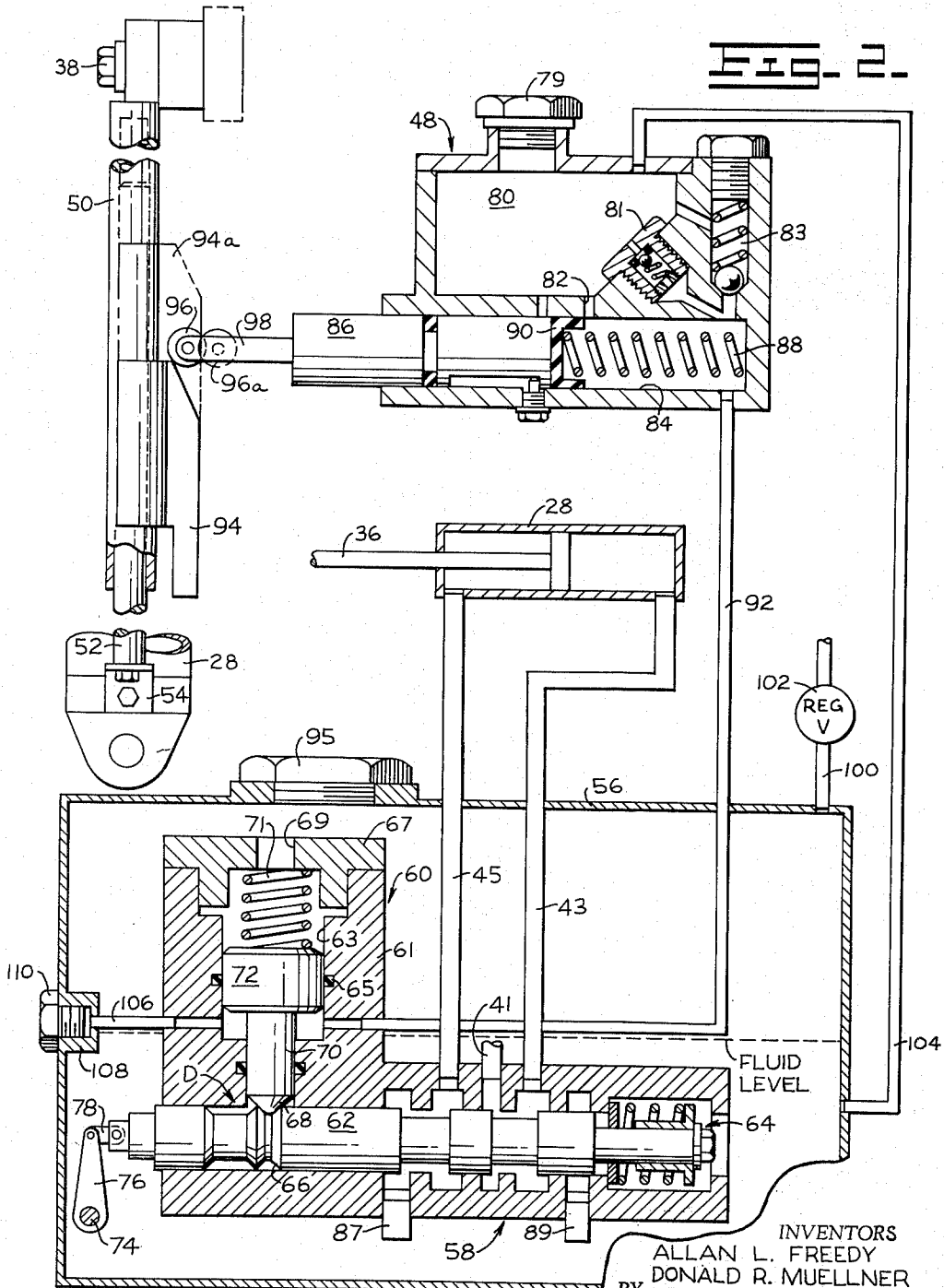
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## HYDRAULIC SYSTEM

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4 Claims. (Cl. 91—41)

This invention relates to a hydraulic system and more particularly to the manner in which hydraulic components are related in order to prevent the induction of air into the system.

Although this invention is applicable to hydraulic systems generally, it is disclosed with a bucket loader of the type disclosed in U.S. Patent No. 3,122,247, application Serial No. 208,303 filed July 9, 1962, and application Serial No. 286,320 filed June 7, 1963, now Patent No. 3,155,252 issued November 3, 1964, all of which are assigned to assignee of the present invention.

The principles of this invention are disclosed in connection with a hydraulic circuit comprising a master valve and a valve detent means operating to position articulated members, such as supporting booms and material containing devices, at a desired location. In insuring dependable operation of hydraulic systems, one of the primary concerns is to insure that induction of air, or for that matter any other gaseous fluid, into the hydraulic fluid is dependably prevented. In fulfilling this need, this invention equalizes the pressure in the various components of the system so that flow of fluid therebetween is prevented during periods of inactivity. In addition to such an equalization of pressures, the valve detent means is located in a hydraulic tank which is supplied with a pressurized gaseous fluid, preferably air, being effective to force the fluid from the tank through an equalizing line to the master valve reservoir. In this manner the pressure throughout the system is maintained at the same value thus preventing introduction of air into the hydraulic fluid.

Accordingly, it is a primary object of this invention to provide a new and improved hydraulic system.

Another object of this invention is to maintain equal values of pressure in a hydraulic system in order to prevent air locking thereof.

Another object of this invention is to provide an improved means for purging the master-detent circuit.

These and other objects of this invention will become more apparent when taken in connection with the following description.

In the drawings:

FIG. 1 is a side elevation of a material handling device incorporating the novel hydraulic system of this invention.

FIG. 2 is a diagrammatic representation of the major components of the hydraulic system.

FIG. 3 is a fragmentary of FIG. 2 showing a modification of the hydraulic system shown in FIG. 2.

As shown in FIG. 1, a vehicle incorporating the novel hydraulic system of this invention is generally indicated by the numeral 10 and it includes a vehicle frame or body 12 mounted on forward and rearward sets of wheels 14 and carrying on the forward end thereof a pair of laterally spaced elongated lift arms 16 pivotally mounted by means of a pivot shaft 18 supported by the vehicle frame. The forward ends of the lift arms 16 pivotally support a loader bucket 20 at a pivot connection 22 with the bucket being adapted to assume a lowered carrying position indicated by 20a and a load dump position indicated by 20b. Movement of the arms 16 from the full line position to the dotted outline position is accomplished by providing a hydraulic jack mechanism 24 having the cylinder portion thereof pivotally connected to the frame

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12 and the end of the outwardly extending rod pivotally connected to the arms 16 at 26. Rotation of the loader bucket 20 to the positions indicated by the numerals 20, 20a, and 20b is effected by another jack mechanism 28 and a linkage mechanism 30 being arranged to convert the rectilinear reciprocable movement of the piston associated with the jack 28 to oscillating movement of the loader bucket 20 about the pivot 22.

The linkage mechanism 30 comprises a lever 32 pivotally connected substantially at its mid-portion to the arms 16 by a pivot pin 34 and the lower end thereof pivotally connected to the end of the piston rod 36 by another pivot pin 38. A second lever 40 interconnected to the lever 32 by a connecting rod 42 has a lower end pivotally connected to the arms 16 at 44 and is interconnected by another connecting rod 46 to the loader bucket 20. By this arrangement it will be apparent that when the jack mechanism 28 is extended, the bucket 20 will assume a loading or carrying position indicated by the numerals 20 and 20a and when the jack 28 is retracted, the loader bucket will assume a dump position (shown in dotted outline) indicated by 20b.

As disclosed in the above referred to patent and applications, the hydraulic system for actuating the jacks 24 and 28 incorporates master valve and valve detent means operating to position the arms 16 at a desired elevation and to position the loader bucket to its load position relative to the lift arms 16. As shown in FIG. 1, the hydraulic jack 28 supports a master valve 48 arranged to be actuated by a cam (hereinafter more fully described) mounted on a tubular rod 50 slidably receiving a rod 52 having its outwardly extending end secured to the cylinder of the jack 28 by a bracket 54. The tubular rod 50 has a bent portion 56 connected to the pivot pin 38 so that during the extension and retraction of the hydraulic jack 28, the tubular rod 50 and the cam carried thereby are translated with the piston rod 36.

Referring now to FIG. 2, there is shown a hydraulic tank 56 within which is mounted cooperating valve member 58 and valve detent means 60 being, respectively, a spool valve for controlling the flow of pressure fluid to the jack 28 and a valve detent means 60 which is adapted to hold the spool of the valve 58 in an adjusted position permitting pressure fluid to be communicated to the jack 28 and to hold valve 58 in a position to interrupt flow of pressure fluid to the jack in response to the position of the loader bucket 20. Although the manner in which this is accomplished is disclosed in the above referenced patent, it will be briefly described herein. The valve 58 comprises a spool 62 associated with a spring centering mechanism 64 operating to urge the spool to a centered position blocking communication of pressure fluid from a supply line 41 to either of the conduits 43 and 45 which are connected, respectively, to the head end and the rod end of the jack 28. This spool is associated with a detent mechanism D being operable to hold the spool 62 in an adjusted position and it comprises a V-shaped groove 66 for receiving a conical end 68 formed on the rod portion 70 of a piston 72 which is part of the valve detent means 60. The spool 62 is connected to a manually rotated shaft 74 by means of a link 76 fixed to the shaft 74 and a link 78 pivotally connected to the end of the spool and the link 76. Accordingly, rotation of the shaft 74 effects reciprocation of the spool 62 and thus controls admission of pressure fluid to the head end or the rod end of the jack 28.

The valve detent means 60 also includes a body portion 61 having a cylindrical bore 63 within which is reciprocably mounted the piston 72. A seal 65 establishes sealing engagement with the periphery of the piston 72 and prevents flow of hydraulic fluid from the rod end to the head end of the bore 63. A cap 67, vented

at 69, is secured in any suitable manner to the upper end of the body portion 61. The piston 72 is urged downwardly (in the orientation shown in FIG. 2) by a spring 71 seated against the cap 67 and the upper surface of the piston 72.

The master valve 43 comprises a reservoir 80 communicating, by means of a port 82, with a cylindrical bore 84 within which is mounted for limited reciprocation a plunger 86. Make-up and relief valves 81 and 83, respectively, are provided between the reservoir 80 and the bore 84 operating to maintain a desired value of pressure in the bore. The plunger 86 is urged in the position shown in FIG. 2 by a spring 88, located in the bore 84, and having one end in engagement with a rubber cup 90 which is seated against the inner end of the plunger 86. The fluid admitted to the bore 84 through the port 82 is communicated to the valve detent means 60 by a conduit 92 with the pressure fluid communicated by this conduit being effective to cause upward movement of the piston 72 and accordingly, disengaging the conical point or end 68 from the V-shaped groove 66. Such action renders the spring centering mechanism 64 effective to position the spool 62 to block communication between the source of pressure fluid in the line 41 and the hydraulic jack 28, accordingly, interrupting actuation of this jack.

In order to effect inward reciprocation of the plunger 86, a cam 94 is rigidly mounted on the tubular rod 50 and engages a roller 96 rotatably mounted on an extension 98 rigidly secured to the plunger 86. The position assumed by the cam 94 when the jack 28 is extended is shown in dotted outline and is indicated by the numeral 94a with the corresponding position of the roller 96 being indicated by the numeral 96a. Movement of the roller 96 by the cam 94 to the position indicated by 96a causes inward movement of the plunger 86 increasing the pressure of the hydraulic fluid in the bore 84 and in the line 92 which in turn increases the pressure in the rod end of the bore 63 biasing the piston 72 upwardly and disengaging the detent mechanism D thereby allowing the spring centering mechanism 64 to shift the spool 62 to a position blocking communication between the conduits 41 and 43. With the plunger 86 fully retracted, the port 82 permits fluid in the reservoir 80 to flow in the bore 84, and from the bore through the line 92 to the rod end of the bore containing the piston 72 of the valve detent means 60.

It has been found that after a relatively short period of operating time the master-detent circuit, shown and described in Patent No. 3,122,247, malfunctioned due to induction of air into such circuit. Although it is not shown and described in the referenced patent, the valve detent means is mounted in an air-tight hydraulic tank and the filler cap for the reservoir 80, corresponding to the filler cap 79 of the present invention, is provided with holes venting the master valve reservoir to the atmosphere so that any increases in pressure of the air in the tank causes the air in the tank to flow across the valve detent means seal 65 through the line 92, into the reservoir 80 and out the vented cap. Under these conditions oil in the reservoir 80 is forced out of the cap depleting the supply of fluid. Accordingly, it can be appreciated that induction of air into the master-detent circuit would render the action of the circuit erratic or possibly inoperative. It is apparent that before normal operation of the master detent circuit is again achieved all the air must be purged, and the master valve reservoir must be filled with hydraulic oil.

In positively precluding induction of air into the master valve detent circuit, it is a feature of this invention to equalize the pressures in the tank 56 and in the master valve reservoir 80. To this end, a conduit 104 extending below the level of the fluid of the tank 56 (as shown in FIG. 2) establishes communication of the hydraulic oil in the tank 56 with the reservoir 80. The master valve 48 is provided with a non-vented filler cap 79 which seals

the reservoir preventing the loss of hydraulic fluid through the cap. It will be seen that the line 104 maintains the same value of pressure in the tank 56 and in the reservoir 80 since any increases in the pressure of the air above the fluid level in the tank 56 is effective to force the fluid to the reservoir 80.

As shown in FIG. 2, when the piston 86 is fully retracted, the port 82 communicates the fluid in the reservoir 80 to the bore 84 which is connected to the rod end of the valve detent 60 by the line 92. It will be seen, therefore, that the same value of pressure is maintained in the tank 56, in the reservoir 80, and in the rod end of the valve detent 60.

In accordance with another important feature of this invention, the master valve detent circuit is very simply and quickly vented to the atmosphere in order to completely fill this circuit with working fluid during the initial assembly thereof or for that matter if for any reason the master valve detent circuit is disassembled for service. Referring to FIG. 2, it will be seen that the rod end of the valve detent 60 is in communication with a conduit 106 connected to a threaded fitting 108 having a cap or plug 110. Pressurized air from any suitable source is communicated to the tank 56 by a conduit 100 having a pressure regulating valve 102 connected thereto. The pressure regulating valve 102 is adjusted so that the value of air pressure admitted to the tank 56 is sufficient to cause flow of the hydraulic fluid from the tank to the master detent circuit. With the plug 110 removed and the fluid of the tank biased with the pressurized air, the fluid is forced through the line 104 filling the reservoir 80, through the port 82, into the bore 84, through the line 92, and through the vent line 106. This bleeding action continues until all the air is purged from the master-detent circuit. Upon completion of the purging operation, the line 100 is disconnected from the source of pressure and the plug 110 is replaced.

After the machine shown in FIG. 1 has been assembled the tank 56 is filled with hydraulic fluid and the pump (not shown) is started. The control valve 58 and a similar valve (not shown) are actuated to direct pressure fluid from the pump discharge to the head end of the jacks 24 and 28 until the jacks are fully extended. The fluid level in the tank 56 would assume a position slightly below the level indicated in FIG. 2 and at this time the cap 95 is put in place sealing the tank 56. While the jacks are fully extended, the master-detent circuit is primed with fluid by removing the plug 110. After these steps have been completed, the control valves for the jacks 24 and 28 are actuated to effect retraction of the jacks returning the fluid from the head end of these jacks to the tank 56 and at the same time filling the rod ends of the jacks with fluid. The level of the fluid in the tank 56 will now be above that existing when the jacks were extending inasmuch as the volume of the rod end of the jacks is less than the volume of the head end. Thus due to the increase in the volume of fluid in the tank 56, after the jacks are retracted, the air in the tank is under a slight amount of compression. It is to be realized that the pressure of the air in the tank 56 will vary in accordance with the volume of fluid contained in the tank at any one time. By virtue of the line 104, the pressure in the tank and in the master-detent circuit is equalized.

The modification shown in FIG. 3 eliminates the need for the bleed plug 110 by extending the vent line 106 to communicate with the hydraulic fluid in the tank 56. In particular, this modification comprises a vent line 106a extending between the rod end of the valve detent 60 and the hydraulic fluid contained in the tank 56. A conventional ball-check valve 112, or any suitable equivalent, is connected in the line 106a to permit flow of hydraulic fluid from the tank 56 to the rod end cavity of the valve detent 60. In purging the master-detent circuit shown in FIG. 3, the line 104 is disconnected from the master valve 48 and pressurized air admitted to the tank 56 by

the line 100 forces the hydraulic fluid through line 104 displacing all of the air therefrom. Concurrently, the air forces the hydraulic fluid through the line 106a past the check valve 112, filling the rod end of the valve detent 60, through the line 92, the bore 84, and to the reservoir 80 through the port 82 until the fluid overflows the port connecting the line 104 to the reservoir. The line 100 is then disconnected from the source of pressurized air and the line 104 is connected to the master valve 48 since all of the air is now purged from the master-detent circuit.

In describing the operation of the novel hydraulic system it will be assumed that the bucket 20 is in the position 20b. Under such circumstances the load has been dumped and it is desired to return the bucket to its load position indicated by 20a. The operator shifts the spool 62 to the left establishing communication between the conduits 41 and 43 causing the jack 28 to extend. Such extension rotates the lever 32 in a counter-clockwise direction causing the bucket to rotate about the pivot 22 and translates the cam 94 to the position 94a which in turn moves the plunger 86 to the right increasing the pressure of the hydraulic fluid contained therein. By virtue of the line 92, the increase in pressure is communicated to the rod end cavity of the valve detent 60 forcing the piston 72 upwardly against the bias of the spring 71 disengaging the conical end 68 from the groove 66. The spool 62 then assumes a neutral position blocking communication between the conduits 41 and 43 which arrests further extension of the jack 28 and positions the bucket in its load position 20a.

It should be readily apparent that return of the bucket 20 to its dump position takes place when the spool 62 is shifted to the right establishing communication between the conduits 41 and 45 thus directing pressure fluid to the rod end of the jack 28 which retracts the jack and positions the bucket to the dump position 20b. When this occurs the cam 94 assumes the full-line position permitting the spring 88 to move the plunger 86 to the left.

Thus according to this invention a hydraulic system is provided which prevents the induction of air by maintaining an equal value of pressure in the master valve reservoir 80 and the valve detent 60.

We claim:

1. A hydraulic system of the type including a master valve operating to increase the pressure of hydraulic fluid to effect operation of a valve detent in communication therewith, the combination with said master valve and valve detent of a source of hydraulic fluid, means communicating said hydraulic fluid to said master valve and to said valve detent in order to establish the same value of

hydraulic pressure in such system, and selectively operable means for venting the system to the atmosphere to expel any air entrapped therein.

2. A hydraulic system comprising an air-tight hydraulic tank containing a quantity of oil, a master valve having a sealed reservoir in communication with the oil of said tank, a valve detent in communication with said master valve, a conduit venting said valve detent to the atmosphere, a removable plug in said conduit, and means communicating pressurized air to said tank to purge said master valve and valve detent of air when said plug is removed.

3. A hydraulic system comprising: a master valve including a sealed reservoir in communication with a bore having a piston reciprocally mounted therein, a valve detent operable in response to the reciprocation of said piston, an air-tight tank containing a quantity of hydraulic oil, conduits communicating the oil in said tank with said sealed reservoir of said master valve and said bore of said master valve with said valve detent, a vent line in communication with said conduits and including a removable plug, and means for communicating pressurized air to said tank, said air being effective to cause flow of oil from said tank through said master valve and said valve detent and through said vent line when said plug is removed in order to purge the system of air.

4. A hydraulic system comprising a master valve including a sealed reservoir; a valve detent in communication with said reservoir; a sealed tank containing a quantity of hydraulic oil; a first conduit communicating the oil of said tank to said reservoir; a second conduit establishing communication between said valve detent and the hydraulic oil in said tank; a check valve in said second conduit being operative to cause flow of oil from said tank to said valve detent; and means communicating pressurized air to said tank for purging the system of air; such purging taking place by disconnecting said first conduit from said reservoir in order to permit the pressurized air to force oil from said tank through the first conduit and simultaneously forcing oil from the tank through said check valve, the valve detent, and the reservoir, whereupon the oil is discharged from the reservoir.

#### References Cited by the Examiner

##### UNITED STATES PATENTS

|           |        |         |         |
|-----------|--------|---------|---------|
| 2,830,859 | 4/1958 | Parsons | 60—52 X |
| 2,970,655 | 2/1961 | Acton   | 60—52 X |

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