HYDRAULICALLY OPERATED MACHINES

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The present invention relates to hydraulic machines. More particularly, the present invention relates to hydraulic machines such as hydraulically operated power shovels or cranes wherein a plurality of different hydraulic means is provided for respectively carrying out different operations some of which must be carried out simultaneously with others. For example, in a crane the load is lifted and the crane is turned simultaneously, and in a power shovel the shovel is fed forwardly and is raised simultaneously.

With machines of this type where the power required for the simultaneous operations is different the pressure in the hydraulic conduit is determined by the operation requiring the lowest power and thus the pressure in the hydraulic conduit is not sufficient for the operation requiring the greater amount of power.

These difficulties may be overcome by such expedients as providing independent pumps respectively connected to the several hydraulic devices for respectively carrying out the plurality of operations or the machine may be so constructed that the power requirements for the different operations are the same, but both of these expedients are unsatisfactory. Where independent pumps are provided for all of the hydraulic devices, respectively, the machine is extremely expensive and where the machine is constructed so that the same power requirements are required for the different hydraulic devices the flexibility of the machine is greatly sacrificed. Furthermore, it is necessary for the machine to have different power supplied as when certain operations are accelerated or decelerated.

One of the objects of the present invention is to overcome the above drawbacks by providing a flexible simply constructed machine capable of performing more than two hydraulic operations while at the same time having only two pumps and also capable of performing pairs of operations simultaneously.

Another object of the present invention is to provide a machine of the above type which has its own tracks, for example, and which is self-propellable by hydraulic motors respectively connected operatively with the tracks, these motors being respectively driven selectively by the same two pumps which drive the hydraulic devices.

An additional object of the present invention is to provide a hydraulic machine of the above type wherein the same manual controls are used for controlling the operation of hydraulic devices which carry out predetermined operations of the machine and for controlling the operation of the motors used in propelling the machine.

With the above objects in view the present invention includes in a hydraulic machine of the above type a pair of pump means for feeding a shovel through a desired stroke or in the case of a crane for changing the inclination of the boom thereof so as to change the reach of the crane. A pair of valves 4b and 7a cooperates with the conduit means leading to the hydraulic means 9, and the conduit means in addition communicates 12e with a hydraulic means 14a for driving a track of the hydraulic machine in order to propel the same. The conduits 12a lead through a device 13 which provides communication of the conduit means with the motor 14a even though the cab of the machine turns with respect to the tracks thereof, the portion 13 of the conduit means having its axis coinciding with the turning axis of the cab and the parts carried by.
The latter. The valve 7a has a pair of positions in which the pump means 1a is selectively placed in communication with the hydraulic means 9 or the hydraulic motor 14a and the valve 4b has a pair of positions which control the direction of flow of hydraulic fluid through the hydraulic means 9 or the motor 14a depending upon which of these devices is connected with the pump 1a by the valve 7a. With the valve 7a in the position illustrated in Fig. 1 the hydraulic means 9 will be operated in one direction when the valve 4b is raised and in an opposite direction when the valve 4b is lowered, as is evident from Fig. 1. When the valve 7a is raised to its upper operating position, as viewed in Fig. 1, the hydraulic means 9 will not operate and instead fluid will flow in one direction through the motor 14a when the valve 4b is raised and in an opposite direction through the motor 14a when the valve 4b is lowered.

At the opposite side of the structure the conduit 3b forms part of a conduit means leading to a hydraulic means 8 for turning the cab of a crane or power shovel, for example, and the structure carried thereby with respect to tracks which support the cab, and this conduit means corresponds in all respects to the conduit means which cooperates with the hydraulic means 6 and in addition cooperates with a valve 4c corresponding in all respects to the valve 4a so that when the valve 4c is raised the hydraulic fluid will flow in one direction through the hydraulic means 8 while when the valve 4c is lowered the hydraulic fluid will flow in an opposite direction through the hydraulic means 8, as is evident from Fig. 1.

The conduit means at the right side of the structure of Fig. 1 extends beyond the valve 4c and the hydraulic means 8 to an additional hydraulic means 11 as well as through the conduit 12b and the device 13 to the hydraulic motor 14b and the hydraulic brakes 29b, the hydraulic brakes 29a communicating with the device 13 also, the device 13 being described in detail below and being shown in detail in Fig. 2. The hydraulic means 11 is used in the case of a power shovel for changing the length of the boom thereof while such a hydraulic means would not be required in a crane. The hydraulic motor 14b drives the other of the tracks of the machine so that with the structure of the invention, the two tracks used for propelling the machine are independently driven by different motors, respectively, and these motors are in turn independently driven by the pumps 1a and 1b so that it is possible with the invention to drive each of the tracks independently and thus to operate the machine in the best possible manner while it is a matter of preference if different power requirements are required for the two tracks, respectively. The two valves 4d and 7b are interposed in and form part of the conduit means leading to the hydraulic devices 11 and 14b and these two valves correspond respectively to the valves 4b and 7a and operate in the same way. Thus, the valve 7b may be operated to selectively place the pump 1b in communication either with the hydraulic means 11 or the motor 14b and the valve 4d can be shifted between a pair of positions for controlling the direction of flow of the hydraulic fluid through the devices 11 or 14b depending on which of these is placed in communication with the pump 1b by the valve 7b. In the position of the valve 7b shown in Fig. 1 the hydraulic means 11 is placed in communication with the pump 1b and will be operated in one direction if the valve 4d is raised and in an opposite direction if the valve 4d is lowered.

The valve 7b may be raised to place the motor 14b in communication with the pump 1b, and then the valve 4d may be raised to control the motor 14b in one direction and lowered to operate the motor 14b in an opposite direction.

It is evident that with the above-described structure, either one of the two hydraulic means on one side of the structure illustrated in Fig. 1 may be operated simultaneously with either one of the two hydraulic means on the other side of the structure, and in addition the pumps may be selectively placed respectively in communication with the valves 7a and 7b for propelling the vehicle, and at all times the power requirements are easily taken care of by the pumps even though there are only two pumps and even though the power requirements may be different from each other and may vary during the performance of certain operations.

The structure includes manually operable controls for actuating the several valves, and the valves 7a and 7b are actuated simultaneously so as to be lowered together or raised together. As is diagrammatically shown in Fig. 1, the rods of the valves 7a and 7b carry pins at their top ends which respectively extend into slots of a pair of bell cranks 19b and 19c which are supported for turning movement about stationary axes and which are interconnected by a connecting rod 19a having a pin extending into a slot of a manually operable lever 18 which is turnable about its stationary axis, the expression "stationary axis" meaning a stationary axis with respect to a cab in the case of a crane or a power shovel, for example. When the lever 18 is turned in a clockwise direction, as viewed in Fig. 1, the bell cranks 19b and 19c will also be turned in a counterclockwise direction so as to simultaneously raise both of the valves 7a and 7b to a position when the valve 4c is raised to a position when the valve 7b is lowered.

The pair of valves 4a and 4b, on the one hand, and 4c and 4d, on the other hand, are actuated by additional manual controls, a pair of controls being provided for this purpose and being identical with each other. One of the manual controls includes a lever 10 connected to a plate 10a which in turn is connected to a plurality of rods 15a—15d extending downwardly from and pivotally connected to the plate 10a, these rods extending slidably through a block down to a position below the block, as is evident from Fig. 1. A universal joint supports the plate 10a so that the lever 10 may be actuated and is turnable in a pair of perpendicular planes. The rods 15a and 15b are located in these planes while the rods 15c and 15d are located in the other of these planes. The rods 15a and 15b are pivotally connected at their bottom ends to a rod 17a which is in turn connected with the valve 4b, this rod 17a being pivotally supported intermediate its ends by a rod 16 extending downwardly from the block. A second rod 17b is pivotally supported intermediate its ends by the rod 16 and is connected to the valve 4a, and the rods 15c and 15d are pivotally connected to the block, this rod 17b being pivotally supported intermediate its ends by the rod 16 extending downwardly from the block. The rod 17a is supported by the plate 10a which includes the axes of the rods 15a and 15b the rod 17a will be tilted in one direction or the other so as to raise or lower the valve 4b, while when the lever 10 is tilted in the plane which includes the rods 15c and 15d the rod 17b will be tilted so as to raise or lower the valve 4a. The structure for actuating the valves 4c and 4d is identical with that which actuates the valves 4a and 4b.

It will be noted that with this construction the levers 10 are used to actuate not only the valves 4a—4d but in addition the actuation of the valves 4b and 4d by the levers 10 controls the operation not only of the hydraulic devices 9 and 11 when the valves 7a and 7b are in the position shown in Fig. 1 but also the operation of the motors 14a and 14b when the valves 7a and 7b are raised upwardly to their other operating positions. Thus, additional sets of controls are not required to operate the vehicle during the time that other levers 10 which are used to operate devices 9 and 11 are used to control the vehicle while it is propelling itself.

As was pointed out above in the case of a crane or power shovel, the cab and the structure carried thereby turns with respect to the track structure, and thus it is necessary to provide a device 13 which will provide the,
communication between the track motors 14a and 14b and the brakes 29a and 29b, on the one hand, and the pumps 1a and 1b on the other hand, during turning of the cab. The details of this device 13 are illustrated in Fig. 2. As may be seen from Fig. 2, the device 13 includes an elongated substantially cylindrical member 20 which turns with the cab and which has its axis coinciding with the turning axis of the cab, the member 20 being fixed in any suitable way to the cab and having its top end closed. The member 20 is provided with a plurality of axially extending bores 26a which are angularly distributed about the axis of the member 20, and correspond in number to the number of conduits leading to the device 13. These conduits 12a and 12b shown in Fig. 1 are connected with the openings 20b shown in Fig. 2, and these openings 20b respectively communicate with the bores 26a, there being four such bores displaced by 90° with respect to each other in the construction shown in Fig. 2. The member 20 is in addition formed with a plurality of lateral bores 20c located at different elevations and respectively communicating with the several bores 20a. The member 20 is surrounded by a plurality of rings 21 which are formed at their inner peripheries with annular grooves 21a directed toward the outer surface of the member 20 and the several bores 20c are respectively located at the elevations of the grooves 21a. The conduits which lead to the motors 14a and 14b respectively communicate with the rings 21, and in this way the fluid under pressure which is delivered to the several bores 20a through the openings 20b will be delivered from these bores through the openings 20c and the rings 21 to the motors 14a and 14b. It will be noted that there are four rings 21 in Fig. 2. The rings 21 form part of an assembly which is fixed to the track assembly of the machine and which does not turn with the cab, and with the member 20 turns with the cab the openings 20c thereof will at all times communicate respectively with the grooves 21a which in turn communicate through the openings of the rings 21 with the motors 14a and 14b.

Non-return valves are located at the lower portions of the bores 20a, respectively, and these valves communicate with a plurality of radial passages 25 formed in the member 20 and communicating at their inner ends with an elongated axial bore 22 of the member 20, these passages 25 actually communicating with an annular groove 26 which in turn communicates with the axial bore of the member 20. An elongated rod 31 is axially slidably within the bore 22 and at its bottom end this rod 31 forms a slide valve 23 which is shiftable between the lower solid and upper dotted line positions indicated in Fig. 2.

The member 20 is formed with an annular groove communicating with the axial bore 22 as well as with radial passages 27 which respectively lead to an annular groove 28 at the inner periphery of a ring provided with a pair of openings communicating with the groove 28 and connected to a pair of lines which respectively lead to the brake cylinders 29a and 29b. Just above this ring is a second ring provided with an annular groove, and this latter groove communicates with radial passages 29 leading from the bore 22 to the annular groove of the next to the lowest ring of Fig. 2, and this latter ring has openings communicating with its inner annular groove and communicates also with the brake cylinders 29a and 29b. A discharge conduit 18' communicates with the inner bore 22 of the member 20.

When the rod 31 is placed by the operator in the position where the slide valve 23 is in its lower solid line position shown in Fig. 2, the fluid under pressure which flows through the non-return valve 24 from the bores 26 will flow to the passages 27 and from the latter through the groove 28 and the ring of which this groove forms a part to the brake cylinders 29a and 29b so that the brakes are engaged with the rod 31 in the position shown in Fig. 2 in solid lines. However, when this rod 31 is raised so as to place the slide valve 23 in its upper dotted line position shown in Fig. 2, then the brake cylinders 29a and 29b are placed in communication with the passages 29, and these passages communicate with a by-pass 30 leading to the bore 22 so that the oil under pressure within the brake cylinders flows therefrom through the passages 29 and 30 and along the axial bore 22 of the member 20 to the conduit 18' which leads back to the reservoirs 2a and 2b, and thus the raising of the rod 31 releases the brakes. When the rod 31 has been placed in the desired location where operations are to be carried out, by operation of the motors 14a and 14b, the rod 31 is moved down to the position locating the slide valve 23 in the solid line position thereof shown in Fig. 2 so as to lock the brakes and hold the machine in its location, and then the valves 7a and 7b are actuated so that the devices 9 and 11 may be operated for carrying out the operations at the place where the machine is located. When it is desired to propel the machine to another location the valves 7a and 7b are raised from the positions thereof shown in Fig. 1 and the rod 31 is raised so as to release the brakes and then the motors 14a and 14b are capable of being operated by actuation of the valves 4b and 4d respectively.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of hydraulic machines differing from the types described above.

While the invention has been illustrated and described as embodied in hydraulic machines such as cranes and power shovels, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and as desired to be secured by Letters Patent is:

1. In a hydraulic circuit required to perform three operations two of which are not performed simultaneously, in combination, a pair of pump means; three hydraulic means for respectively performing three different operations; first conduit means providing communication between one of said pump means and a pair of said hydraulic means; second conduit means providing communication between the other of said pump means and the third of said hydraulic means; second conduit means providing communication between the other of said pump means and the third of said hydraulic means; first valve means cooperating with and forming part of said first conduit means for selectively placing said one pump means in communication with either of said pair of hydraulic means and for controlling the operation of either of said pair of hydraulic means by said one pump means; and second valve means located in and forming part of said second conduit means for controlling the operation of said third hydraulic means by said other pump means, whereby said third hydraulic means may be simultaneously with either of said pair of hydraulic means, and said pair of hydraulic means cannot be operated simultaneously.

2. In a hydraulic circuit required to perform at least three different operations which of which are not performed simultaneously, in combination, a pair of pump means; three hydraulic means for respectively performing three different operations; a pair of hydraulic motors; first conduit means providing communication between one of said pump means, a pair of said hydraulic means,
and one of said hydraulic motors; second conduit means providing communication between the other of said pump means, the third of said three hydraulic means, and the other of said hydraulic motors; first valve means cooperating with and forming part of said first conduit means for placing said one pump means selectively in communication with either of said pair of hydraulic means or in communication with said one hydraulic motor and for controlling the operation of either of said pair of hydraulic means and said one motor; and second valve means cooperating with and forming part of said second conduit means for placing the other of said pump means selectively in communication with said third hydraulic means or said other motor, whereby when said motors are not operating said third hydraulic means may be operated simultaneously with either of said pair of hydraulic means and when said three hydraulic means are not operating said motors may be independently operated by said pump means, respectively, said pair of hydraulic means being incapable of simultaneous operation.

3. In a hydraulic circuit required to perform at least three different operations two of which are not performed simultaneously, in combination, a pair of pump means; three hydraulic means for respectively performing three different operations; a pair of hydraulic motors; first conduit means providing communication between one of said pump means, a pair of said hydraulic means, and one of said hydraulic motors; second conduit means providing communication between the other of said pump means, the third of said three hydraulic means, and the other of said hydraulic motors; first valve means cooperating with and forming part of said first conduit means for placing said one pump means selectively in communication with either of said pair of hydraulic means or in communication with said one hydraulic motor and for controlling the operation of either of said pair of hydraulic means and said one motor; second valve means cooperating with and forming part of said second conduit means for placing the other of said pump means selectively in communication with said third hydraulic means or said other motor, whereby when said motors are not operating said third hydraulic means may be operated simultaneously with either of said pair of hydraulic means and when said three hydraulic means are not operating said motors may be independently operated by said pump means, respectively, said pair of hydraulic means being incapable of simultaneous operation.

4. In a hydraulic circuit capable of performing four different operations two pairs of which are not performed simultaneously, in combination, a pair of pump means; four hydraulic means for respectively performing four different operations; first conduit means providing communication between one of said pump means and one pair of said hydraulic means; second conduit means providing communication between the other of said pump means and the remaining pair of hydraulic means; first valve means cooperating with and forming part of said first conduit means for selectively placing said one pump means in communication with either of said one pair of hydraulic means and for controlling the operation of either of said remaining pair of hydraulic means, whereby either one of the hydraulic means of each pair of hydraulic means may be operated simultaneously with either one of the other pair of hydraulic means.

5. In a hydraulic circuit capable of performing four different operations two pairs of which are not performed simultaneously, in combination, a pair of pump means; four hydraulic means for respectively performing four different operations; a pair of hydraulic motors; first conduit means providing communication between one of said pump means, one pair of said four hydraulic means, and one of said motors; second conduit means providing communication between the other of said pump means, the remaining pair of hydraulic means, and the other of said motors; first valve means cooperating with and forming part of said first conduit means for selectively placing said one pump means in communication with either of said one pair of hydraulic means or in communication with said one motor; and second valve means cooperating with and forming part of said second conduit means for selectively in communication with either of said remaining pair of hydraulic means or with the other of said motors, whereby either of said pairs of hydraulic means may be operated with one of its hydraulic means operating simultaneously with either of the other pair of hydraulic means whereby said four hydraulic means are not operating the pair of motors may be respectively operated by said pair of pump means.

6. In a power shovel, in combination, a pair of pump means; first hydraulic means for closing and opening a shovel; second hydraulic means for feeding the shovel through a desired stroke; third hydraulic means for turning the power shovel; fourth hydraulic means for changing the length of the boom of the shovel; first conduit means providing communication between one of said pump means and said first and second hydraulic means; second conduit means providing communication between the other of said pump means and said third and fourth hydraulic means; first valve means cooperating with and forming part of said first conduit means for placing said one pump means selectively in communication with said first or second hydraulic means and for controlling the operation of said first and second hydraulic means; and second valve means cooperating with and forming part of said second conduit means for placing the other of said pump means selectively in communication with said third or fourth hydraulic means and for controlling the operation of said third and fourth hydraulic means, whereby said first or second hydraulic means may be selectively cooperatively connected to said first or second valve means so that all of the operations may be carried out simultaneously in any desired combination except that the closing and opening of the shovel is not carried out simultaneously with feeding of the shovel and turning of the power shovel is not carried out simultaneously with changing of the boom length.

7. In a power shovel as recited in claim 6 and wherein the power shovel is self-propellable, a pair of hydraulic motors adapted to drive a pair of tracks of the machine, respectively, said first and second conduit means respectively having extensions which place said pair of pump means respectively in communication with said pair of motors and said first and second valve means being operable to place said pair of pump means selectively in communication with one of the first and second hydraulic means and one of the second and third hydraulic means or with said pair of motors so that said pump means may be used to propel said motors, respectively, independently of each other for propelling the machine.

8. In a crane, in combination, a pair of pump means; first hydraulic means for operating a jack of the crane; second hydraulic means for changing the reach of a boom of the crane; third hydraulic means for turning the crane; first conduit means providing communication between one of said pump means and said first and sec-
ond hydraulic means; second conduit means providing communication between the other of said pump means and said third hydraulic means; first valve means cooperating with and forming part of said first conduit means for placing said one pump means selectively in communication with said first or said second hydraulic means and for controlling the operation of said first and second hydraulic means; and second valve means cooperating with the forming part of said second conduit means for controlling the operation of said third hydraulic means, whereby the turning of the crane may be carried out simultaneously with the operation of the jack thereof or a change in the reach of the boom thereof.

9. In a crane as recited in claim 8, a pair of hydraulic motors adapted to respectively drive a pair of tracks of the crane for propelling the same, said pair of hydraulic motors communicating respectively through said first and second conduit means with said pair of pump means and said first and second valve means placing said pair of pump means selectively in communication with said pair of motors or in communication with said first or second hydraulic means or with said third hydraulic means, so that when the plurality of hydraulic means are not operating said pair of pump means may be used for independently driving said motors in order to propel the crane.

10. In a hydraulic machine, in combination, pump means; first hydraulic means for performing a first operation; first conduit means placing said pump means in communication with said first hydraulic means; first valve means cooperating with and forming part of said first conduit means and having a pair of different positions respectively providing different directions of flow of hydraulic fluid through said first hydraulic means so as to control the direction of operation thereof; second and third hydraulic means for respectively performing second and third operations; second conduit means communicating with said first conduit means and leading therefrom to said second and third hydraulic means so that said pump means may communicate through said first and second conduit means with said second and third hydraulic means; and second and third valve means cooperating with and forming part of said second conduit means, said second valve means having a pair of different positions respectively placing either of said second and third hydraulic means selectively in communication with said first conduit means through said second conduit means; and said third valve means having a pair of positions providing, respectively, different directions of flow of hydraulic fluid through said second conduit means and through said second hydraulic means when said second valve means is in a position placing said second hydraulic means in communication with said first conduit means and through said third hydraulic means when said second valve means is in a position placing said third hydraulic means in communication with said first conduit means.

11. In a hydraulic machine, in combination, a pair of pump means; a pair of hydraulic means for respectively performing different operations; a pair of hydraulic motors for driving tracks for propelling the machine, respectively; a pair of hydraulic brakes for respectively braking the tracks; first conduit means providing communication between one of said pump means, one of said hydraulic means, one of said motors, and one of said brakes; second conduit means providing communication between the other of said pump means, the other of said hydraulic means, the other of said motors, and the other of said brakes; first valve means cooperating with the forming part of said first conduit means for selectively placing said one pump means in communication with said one hydraulic means or said one motor and said one brake; second valve means cooperating with and forming part of said second conduit means for placing said other pump means selectively in communication with said other hydraulic means or said other motor and brake; and third valve means cooperating with portions of said first and second conduit means leading to said brakes for controlling the operation of the latter when said first and second valve means place said pair of pump means in communication with said motors and brakes.

12. In a machine as recited in claim 11, said pair of pump means and said pair of hydraulic means, on the one hand, and said pair of motors and said pair of brakes, on the other hand, being turnable with respect to each other and said first and second conduit means providing communication between said pair of pump means and said motors and brakes during turning of said pair of pump means and said pair of hydraulic means, on the one hand, and said pair of motors and brakes, on the other hand, with respect to each other.

References Cited in the file of this patent

UNITED STATES PATENTS

2,322,739 Vanderzee December 22, 1943
2,475,963 Howell July 12, 1949
2,707,867 Ruhl May 10, 1955