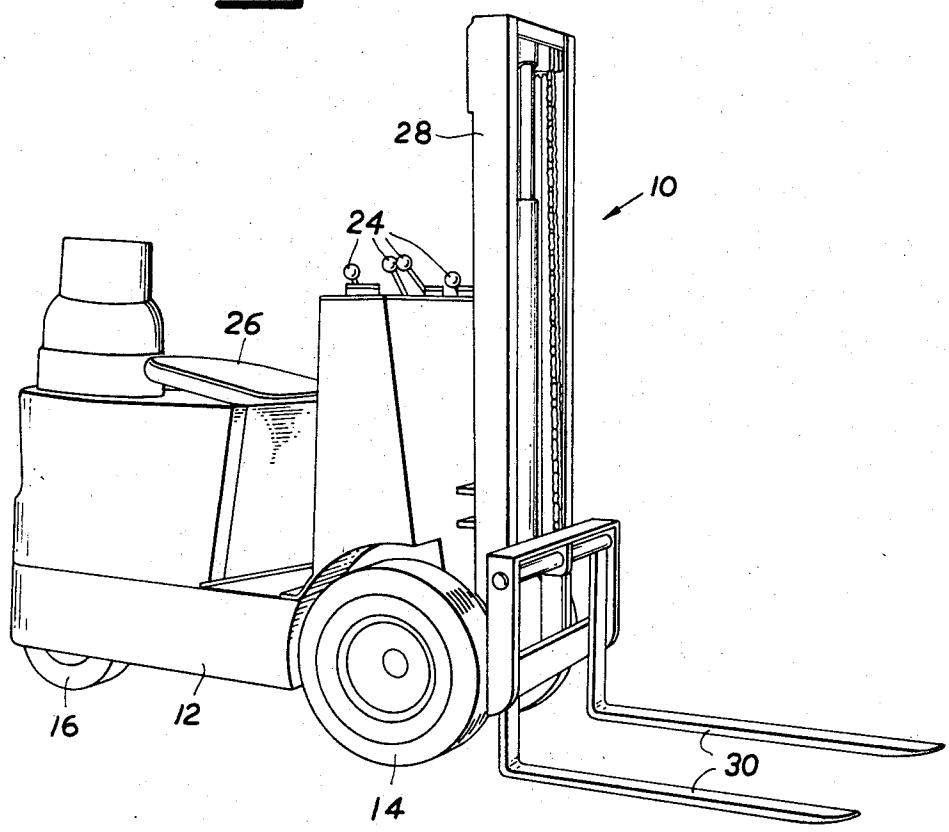
Sept. 17, 1968 L. C. SCHAFER 3,401,764

HYDRAULIC CONTROL FOR FORK LIFT TRUCKS

Filed Dec. 20, 1965 3 Sheets-Sheet 1

Fig. 1



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HYDRAULIC CONTROL FOR FORK LIFT TRUCKS

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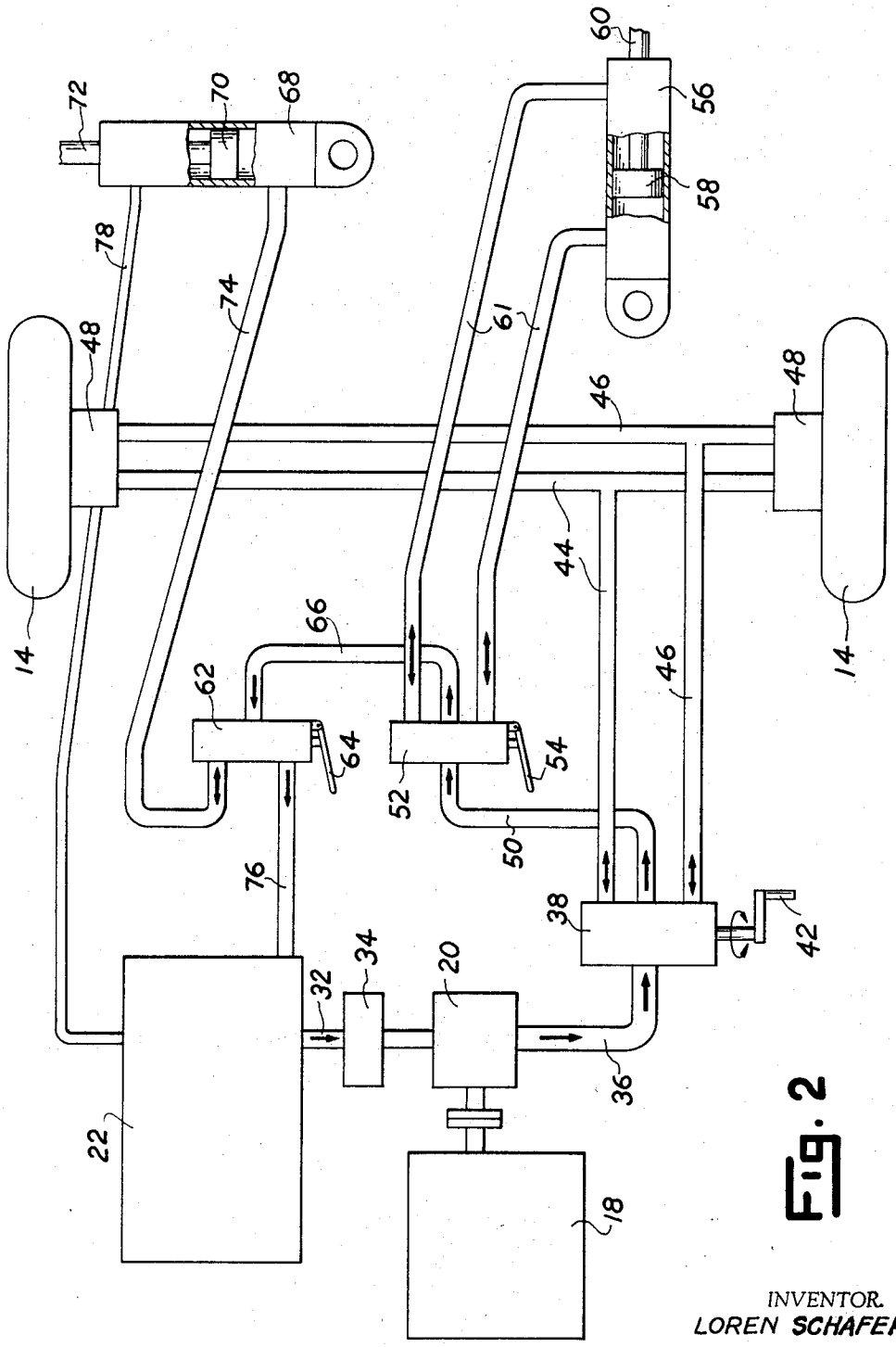

Fig. 2

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Fig. 3

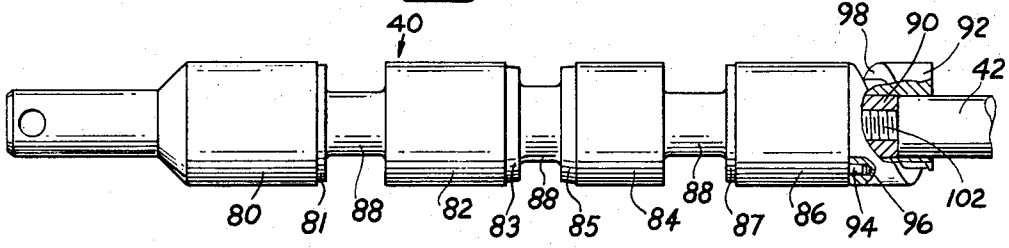
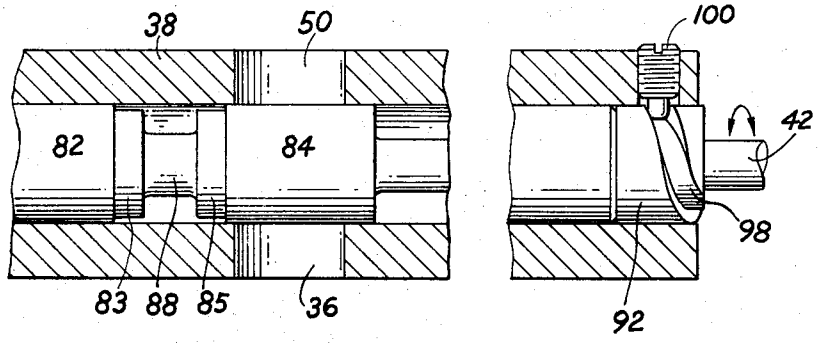


Fig. 4



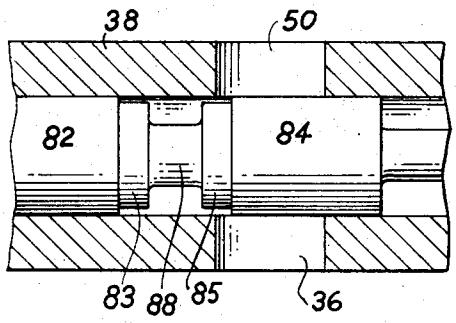
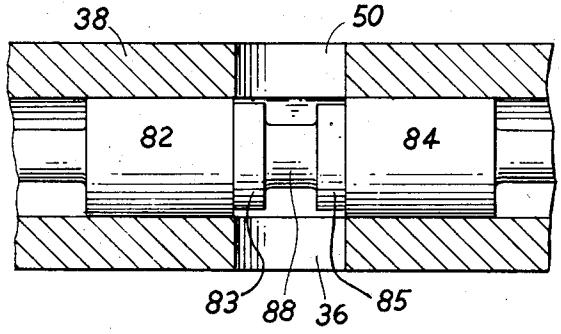


Fig. 5

Fig. 6



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HYDRAULIC CONTROL FOR FORK LIFT TRUCKS

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3 Claims. (Cl. 180—66)

ABSTRACT OF THE DISCLOSURE

A hydraulic control for fork lift trucks having hydraulic wheel drive motors arranged in parallel circuits and each in series with a valve having a spool shiftable endwise relative to circuit-controlling ports, wherein a land of said spool has a narrow circumferential part at one end having slight clearance in the valve housing and said spool has means for rotating it and a helical cam track engaging a part of said housing to advance said spool endwise by rotation thereof.

This invention relates to a hydraulic control for fork lift trucks.

The primary object of this invention is to provide a hydraulic control for a fork lift truck operation to govern the wheel drive of the truck, the fork-elevating means of the truck, and the mast tilting means of the truck.

A further object is to provide a control of this character having a novel means for metering the flow of liquid through control valves and for regulating, not only the functioning speed of hydraulic components, but also regulating such functioning at two different rates relative to a unit of movement of a controlling element at different portions of the stroke thereof.

A further object is to provide a hydraulic control of this character having a spool type valve with a novel rotary action spool to accommodate long spool travel and accurate control of flow of oil through small increments of change of position of the spool.

Other objects will be apparent from the following specification.

In the drawings:

FIG. 1 is a perspective view of a fork lift truck utilizing my new hydraulic control;

FIG. 2 is a schematic illustration of the hydraulic control;

FIG. 3 is a side elevational view of a novel spool element utilized in a valve of my new hydraulic control;

FIG. 4 is a schematic view illustrating one operative position of a valve utilizing my new valve spool;

FIG. 5 is a schematic view illustrating a second adjustment position of the valve using my new spool;

FIG. 6 is a schematic view illustrating a third operating position of a valve utilizing my new valve spool.

Referring to the drawings, and particularly to FIG. 1, the numeral **10** designates a fork lift truck having a chassis **12** which is preferably provided with counterbalance weights and is supported upon front driving wheels **14** and one or more rear steering wheels **16**. The chassis mounts a prime mover **18** or a drive motor, such as a gasoline engine or an electric motor. A hydraulic pump **20** is driven by prime mover **18** and a liquid reservoir **22** and other components of a hydraulic system are also mounted on the chassis. Suitable control members **24** for the hydraulic system and steering means are located within convenient reach of an operator from the seat **26**. The chassis **12** mounts a tiltable mast **28** on which fork lift arms **30** are vertically adjustable between elevated and lowered positions. Mast **28** may be of any construction of the character well understood in the art.

The hydraulic control is illustrated schematically in FIG. 2. A line or conduit **32** connects with the reservoir

22 and the pump **20** and preferably has a filter **34** interposed therein. A pump outlet line **36** extends to a first control valve **38** which preferably is of a spool type and which preferably includes a spool **40**, as illustrated in FIG. 3, which will be described hereafter. Valve **38** is adjusted or controlled by suitable manually operated member, such as a crank **42**. A pair of lines **44** and **46** are connected to control valve **38** and extend to reversible hydraulic wheel motors **48** serving to drive the wheels **14**. The wheel motors are preferably of a high torque low speed type and are preferably connected in parallel so as to provide differential action to accommodate short radius turning of the truck.

A line **50** connects the first control valve **38** with a second control valve **52** which is preferably a double action spool type valve controlled by actuator handle **54**. A double acting power member, consisting of a cylinder **56** mounted on the chassis and a piston reciprocable in the cylinder and connected by a ram **60** with the tilting mast, has connection with the valve **52** through the conduits **61**. Thus manipulation of the control handle **54** of the valve **52** will regulate actuation of mast-tilting member **56, 58** in selected direction, or serves to hold the mast in selected position by shutting off liquid flow from valve **52** through lines **61**.

A single action valve **62**, preferably of the spool type and having a valve actuating control handle **64**, is connected at **66** to the outlet port of the valve **52**. Connection **66** is herein shown diagrammatically as a conduit, but it will be understood that this is illustrative only inasmuch as the valves **52** and **62** may be a part of a single valve assembly or unit having two independently operable spools. A single action power member, consisting of a cylinder **68** and a piston **70**, is mounted on the chassis, and the piston **70** actuates a ram **72** mounted upon the mast and connected with the fork lift arms **30**. A line **74** provides a connection between the valve **62** and the cylinder **68** of the power member. The arrangement is such that in one valve setting the line **74** delivers liquid under pressure to the fork lifting cylinder **68** to elevate the fork arms, and in another valve setting line **74** returns liquid from the cylinder **68** to the valve **62** for flow therethrough to a return line **76** connected to the reservoir **22** to permit the ram to be lowered by the weight of the fork arms **30** and the load carried thereby. A relief line **78** may connect the upper end of the cylinder **68** to the reservoir **22**. The relief line **78** provides for gravitational flow of liquid which may leak past piston **70** into the upper end of the fork lift hoisting cylinder **68**.

The spool **40** of the valve **38** is preferably of a construction as illustrated in FIG. 3 and is provided with a plurality of spaced coaxial cylindrical portions or lands of any selected number, such as the lands **80, 82, 84** and **86**, which form parts of an integral or unitary structure being interconnected by reduced neck parts **88**. Each of the cylindrical spool parts or lands **80, 82, 84, 86**, or selected ones thereof are provided with slightly reduced coaxial circular portions at least at one end thereof, as illustrated at **81, 83, 85** and **87**, adjacent one of the reduced neck parts **88** of the spool.

The arrangement and functioning of the valve **38** is illustrated in FIGS. 4, 5 and 6, in which a schematic illustration of a part of the valve body and spool, an inlet connected with conduit **36** and an outlet connected with conduit **50**, are shown. The inlet and outlet both preferably have a longitudinal dimension equal to the longitudinal spacing between the ends of adjacent spools, such as ends **82** and **84**; that is, a spacing equal to the axial dimensions of the reduced land parts **83** and **85** plus the axial dimension of the intervening reduced neck part **88** of the spool. The lands **82** and **84** will each have an axial dimen-

sion adequate to completely span and close the inlet **36** and the outlet **50**.

FIG. 4 illustrates a position of the spool **40** in the valve **38** in which the land **84** completely spans and closes both the inlet **36** and the outlet **50**, so that no flow occurs through the valve between the inlet **36** and outlet **50**.

FIG. 5 illustrates a position in which land **84** has been displaced slightly from closed position so that a reduced part **85** thereof is partly in register with inlet **36** and the outlet **50**. Inasmuch as the cross-sectional dimension or area of the part **85** is only slightly less than the cross-sectional dimension or area of the land **84**, only a slight or restricted path of flow is provided between inlet **36** and outlet **50** in the FIG. 5 position. This is particularly important in the drive control valve **38** which controls the operation of the wheel motors **48**, for which purpose the lands **80** and **86** with reduced parts **81** and **87** serve the function of regulating the rate of flow to the lines **44** and **46** from the valve **38**. Thus it will be apparent that the arrangement makes possible a very slow rate of operation of the wheel motors when one of the lands **80** and **86** is displaced only slightly from closing position. In practical terms it will be seen that this arrangement makes it possible to drive a fork truck at normal operating speed to a point adjacent to the point of use, and then to greatly reduce the speed and "inch" the truck to its final operating position.

Full speed or full open position of the valve is shown in FIG. 6, at which time unrestricted flow occurs through the valve **38** to the line **50**. It will be understood that in this position the valve lands **80** and **86** will fully close the lines **44** and **46** so as to hold the vehicle in a brake-operating position.

It will be observed that the control valve **38** permits flow in a number of different paths. Thus flow through the valve **38** can occur from conduit **36** only to the conduit **50**, or flow can occur through valve **38** from conduit **36** to line **44**, motor **48**, line **46**, back through valve **38** to the line **50**, or flow can occur from line **36** through valve **38** to line **46**, through wheel motors **48**, back through conduit **44**, and valve **38** to the conduit **50**. In all of these positions it will be observed that flow from conduit **36** ultimately passes to conduit **50**, and that in the various adjustments of the valve to control the drive wheels, various divisions and changes of path may occur before the ultimate delivery of fluid to the conduit **50**.

In order to facilitate close control of the setting of the spool and the valve **38**, it will preferably be actuated by a rotary cam of the construction illustrated in FIG. 3. Thus, one end of the spool will preferably have a reduced end part **90**, on which is mounted a cylindrical cam **92** held in selected position by any suitable means, such as a pin **94** projecting from the end of the land **86** spaced from the reduced spool end part **90** and fitting into a socket **96** formed in the inner end of the cylindrical cam **92**. If desired, a plurality of circumferentially spaced pockets may be provided to selectively receive pin **94**. Cam **92** is characterized by a helical cam groove **98** into which may project a pin **100** carried by the valve casing, as illustrated in FIG. 4. The reduced spool end part **90** will preferably have a screw-threaded central or axial bore to receive a reduced screw-threaded part **102** mounted on the end of the crank **42**. It will be apparent that the lead of the cam groove **98** will determine the rate of axial movement of the spool upon rotation of the cam to any predetermined angle. Thus if close control or accuracy of control is desired, lead of the cam groove will be short, or, if rapid movement of the valve spool through a long stroke is desired, a long lead of the cam groove will provide that result. The latter may be advantageous in some instances and can be provided without loss of sensitivity of control for "inching" the drive wheels when necessary by reason of the flow-restricting function provided by the slightly reduced portions **81**, **83**, **85** and **87** of the valve spool lands **80**, **82**, **84** and **86**, respectively.

It will be observed that the vlaves **38**, **52** and **62** are arranged in series. This is important in order to accommodate simultaneous functioning of the wheel motors **48**, the mast-tilting unit **56**, **58**, and the fork lift unit **68**, **70**. The valve **52** is of a double-acting character and accommodates the following flow paths respectively: Flow from conduit **50** direct to conduit **66**; flow from conduit **50** to a selected one of the conduits **61**, and return flow from the other of said conduits through the valve **52** to the conduit **66**.

The valve **62** is preferably of the single action type and normally will accommodate flow from conduit **66** to the line **76** connected to the reservoir **22**. However, flow may occur through the valve from line **66** to conduit **74** to operate the fork lift power member **68**, **70**. The valve **62** will also provide return flow from conduit **74** to the discharge line **76** in one setting so as to permit lowering of the forks by the weight thereof.

Each of the valves **38**, **52** and **62** may be of conventional construction well understood in the art and, therefore, only schematic illustration thereof has been provided herein.

While the preferred embodiment of the invention has been illustrated and described, it will be understood that changes in the construction and arrangement may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. In a vehicle having a drive wheel, a hydraulic motor for rotating said drive wheel, and a hydraulic control system including a reservoir, a pump, conduits defining a hydraulic circuit connecting said reservoir, pump and motor, and a spool-type valve in said circuit for controlling liquid flow to said motor, the improvement comprising a shiftable valve spool shiftable endwise in a valve housing bore and having a land adapted in one position to span and close a port communicating with said motor, said land having a narrow circumferential portion at one end thereof having a slight clearance in said bore to restrict flow therepast to said port when it registers with a portion of said port and the land spans the remainder of said port and thereby provide slow speed operation of said wheel drive motor.

2. The construction defined in claim **1**, wherein said spool includes a cam portion having a helical cam track, a member on said valve housing and engaged by said cam track, and means for rotating said spool to advance it endwise relative to said port.

3. The construction defined in claim **1**, wherein a pair of drive wheels are provided with individual motors, and said circuit includes conduits connecting said motors in parallel circuit arrangement to each other and in series circuit arrangement to said valve to accommodate differential actuation of said wheel motors.

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