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(54) Control system for load-handling vehicle.

(57) A control system for a lift truck with a telescopic lifting mast is operable to control fluid discharge from the lift cylinders (18, 19) so as to permit a higher lowering speed in the unladen condition than the maximum lowering speed possible in a laden condition. This speeds up load handling operations, especially for container-handling vehicles with tall masts where the time taken to retract the mast is a significant element in the load-handling operation. The control system provides additional discharge conduits (32, 33) and valves (21, 24) which are connected to the lift cylinders (18, 19) when lowering in an unloaded condition.

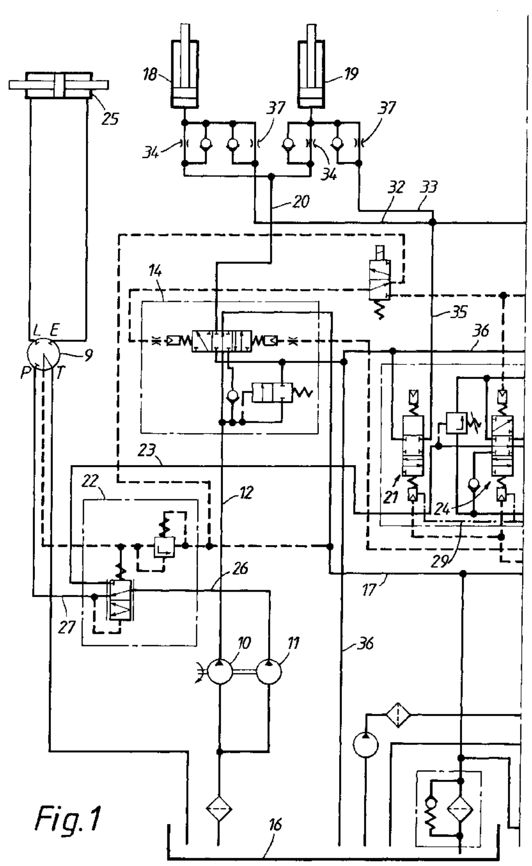

Fig.1

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The invention relates to a load handling vehicle of the kind comprising a lifting mast, and a lifting carriage having means for engaging a load moveable up and down the mast; and more particularly to a control system for such a vehicle.

The lifting mast in vehicles of this kind is commonly formed from two or more telescopic sections which are extended to increase the height to which the load can be lifted. In the case of vehicles which are designed to handle freight containers and similar standardised loads which can be stored in a stack, the required maximum lifting height has increased substantially over recent years and very tall extended masts are now needed to meet the demands of operators in this field. For example, empty freight containers are frequently stored in stacks of up to seven containers high, giving a required lifting height of more than 15 metres for the top container in the stack.

These very substantial lifting heights mean that the time taken to raise and lower the carriage during loading or unloading becomes a significant factor in the overall time required to complete a given load-handling operation-. The speed of raising the mast assembly is within the control of the manufacturer of the vehicle, but the lowering speed of the carriage is limited by safety legislation in most countries which restricts the lowering speed of the carriage in a loaded condition to a specific maximum value. In general, the speed limitation imposed by this legislation has been regarded by manufacturers as limiting the lowering speed of the carriage in both loaded and unloaded conditions.

In the prior art, various proposals have been made for providing a lift truck with a control system which permits more than one lowering speed. For example, it is known to control the rate of discharge from a lift cylinder as a function of the load carried by the lifting carriage so as to decrease the lowering speed of the carriage as the load is increased. In U.S. Patent No. 4930975, discharge from the lift cylinder during lowering is directed through a variable flow regulator which, in response to operation of the lift lever, provides less flow restriction and hence a greater lowering speed during most of the downward travel of the carriage, and a greater degree of restriction and hence slower speed at the beginning and end of its travel. The object of this arrangement is to compensate for unskilled operation of the vehicle by providing a "cushioning" effect during load pickup and setdown.

In U.S. Patent No. 4111283, a two-stage regulator valve is described for regulating the lowering speed. At normal pressure in the lift circuit the valve remains open, but should the pressure fall below a predetermined level due to slack in the lifting chains caused for example by inadvertent engagement of the lifting carriage with an obstruction, a subsequent dangerous free drop of the carriage is prevented by operation of the regulator valve to prevent further discharge of fluid from the lift cylinder.

None of these prior arrangements provide a control system for a load-handling vehicle in which the lowering speed of the unladen carriage can exceed the maximum lowering speed of the carriage when laden. Such an arrangement is within the ambit of current legislation and is proposed by the present invention. It can significantly reduce the time taken to complete a given loading or unloading operation.

According to the present invention, there is provided a control system for a load handling vehicle of the kind comprising a lifting mast and a carriage having means for engaging a load which is moveably up and down the mast, said control system comprising control means for controlling the rate of descent of said carriage; wherein the control means is operable to limit the rate of descent of the carriage to a pre-determined maximum value when a load is being carried thereby, and to permit lowering of the carriage at a higher rate when the carriage is in an unloaded condition.

This enables the use of lowering speeds whilst the carriage is unladen which are higher than those permitted by current legislation under load, thus saving on work cycle times.

Preferably the control means is operable to change the permitted rate of descent of the carriage from one value to another automatically in response to the presence of a load thereon. This is suitably achieved by load sensing means on the carriage. The higher rate of descent is thus selected automatically in the unloaded condition of the vehicle. Alternatively, the control means may be manually operable to change the permitted rate of descent of the load engaging means from one value to another. This arrangement enables the rate of descent to be selected by the driver of the vehicle depending on whether it is in an unloaded or loaded condition.

In one particular embodiment of the invention, the control means is operable selectively to vary the permitted rate of descent of the carriage in the unloaded condition. This enables the operator of the vehicle to select the rate of descent depending on local working conditions.

In order that the invention may be more fully understood, an embodiment thereof will now be described by way of example only with reference to Figure 1 of the accompanying schematic drawing which shows a hydraulic circuit for a container-handling vehicle fitted with a control system according to the invention.

The hydraulic circuit shown in the drawing is intended for controlling the operation of a container-handling vehicle fitted with a telescopic mast assembly of substantial height, e.g. more than 15m in the extended position. Various operating elements are illustrated including a cylinder 25 and associated steer pump 9 for operating the vehicle steering; lift cylinders 18 and 19 for raising and lowering the telescopic mast assembly (which in known manner entrains the lifting carriage along it); tilt cylinders 7 for tilting the mast assembly between its lifting and travelling positions; reach cylinders 6 and side-shift cylinder 5, with their associated control manifold 4; and hydraulic valve 3 for the power-assisted braking circuit. These components are all conventional and most of these will not be described in further detail.

The main components associated with the control system of the invention are hydraulic pumps 10 and 11, lift and lowering valve 14, lift cylinders 18 and 19, auxiliary lowering valve 21, auxiliary lift and lowering valve 24, and joystick controller 30. The circuit described is intended for a container-handling vehicle and the carriage in this case supports a gantry having hydraulically-operated twistlocks 28 operable to engage the corner fittings of a container. However, it will be appreciated that the control system of the invention can be applied to any load-handling vehicle, for example one in which the carriage comprises forks or other load-engaging means such as a "piggy-back" attachment for handling intermodal loads.

Valve 14, auxiliary lowering valve 21 and auxiliary lift and lowering valve 24 are all operated by servos controlled remotely by joystick controller 30 located in the driver's cab. In the embodiment shown the servos are operated hydraulically but they could be operated by other means, such as electrically. The position of these valves determines whether or not hydraulic fluid is fed to, held in, or expelled from lift cylinders 18 and 19. An electrical interlock 29 is connected between the servos which control valves 21 and 24 and the twistlocks 28.

Hydraulic pump 10 is dedicated to lift cylinders 18 and 19 and supplies fluid under pressure to valve 14 via line 12. In the position of this valve which is shown in the drawing, the cylinders are inactive and fluid from pump 10 is diverted back to fluid reservoir 16 via return line 17. Operation of joystick controller 30 to call for raising of the mast and carriage assembly causes valve 14 to move to the right in the drawing, directing fluid from line 12 into line 20 and operating lift cylinders 18 and 19. Movement of joystick controller 30 into the lift position also operates auxiliary lift and lowering valve 24 which is supplied with fluid (when available) by pump 11. The servos are designed such that initial movement of the joystick controller operates valve 24 to provide slow-speed lift under fine control. Further operation of the joystick causes valve 14 to operate as well, giving full lift flow to cylinders 18 and 19. In this condition, additional lift is supplied by pump 11 if fluid pressure is not being used for steering. Pump 11 supplies steering flow to hand steer pump 9 and thus to steer cylinder 25 via lines 26 and 27 but if some or all of this flow is not required, load sensing flow divider 22 sends fluid via line 23 to auxiliary lift and lowering valve 24 where it is directed via lines 31, 32 and 33 to cylinders 18 and 19 to supplement the flow supplied through line 20.

Lowering of lift cylinders 18 and 19 takes place in this embodiment under gravity (i.e. not under power) and is accomplished at two different rates, as follows.

In a loaded condition of the vehicle, the twistlocks 28 will be engaged with the corner fittings of the container being carried and the electrical interlock 29 will automatically disengage the servos controlling auxiliary lowering valve 21 and auxiliary lift and lowering valve 24 so as to prevent these valves from moving into a lowering position. In this condition, operation of the joystick control 30 to call for lowering of the load will cause only valve 14 to operate by moving to the left in the drawing, connecting line 20 to return line 36 and thereby returning fluid from cylinders 18 and 19 to reservoir 16. The rate of retraction of cylinders 18 and 19 will be determined by the size of the load and the restrictions 34 built into line 20, but under current legislation this will not exceed 0.6 m/sec with a fully-loaded container.

A higher lowering speed is achieved where no load is being carried by the vehicle. In this condition, the twist locks 28 are in the disengaged position and the electrical interlock 29 allows operation of both auxiliary lowering valve 21 and auxiliary lift and lowering valve 24. On operation of the joystick control to lower the carriage, lift valve 14 moves to the left as before, and auxiliary valves 21 and 24 are moved upwardly in the drawing into their lowering position. This connects lines 32 and 33, via lines 31 and 35, with return line 36 leading to reservoir 16. Since additional return lines are open, lift cylinders 18 and 19 void at a faster rate, and lowering of the mast and carriage assembly is achieved more rapidly. The lowering speed is determined by restrictions 37 in lines 32 and 33 but this will be significantly higher than the maximum lowering speed in the loaded condition, for example between 0.8 and 1.4 m/sec and preferably about 1.2 m/sec. At high rates of descent, it may be desirable to cushion the impact caused by stopping the carriage instantaneously. This can be achieved either hydraulically, with suitable valving, or electrically.

Restrictions 37 may not be required to control lowering in the unladen condition; instead the return flow may by-pass any check valve, and the carriage lowered as quickly as fluid can be displaced through the valves to the reservoir 16.

Instead of or in addition to an electrical interlock controlling the circuit automatically, a manual control can be provided to allow the operator to select the rate of descent as required by conditions, and as permitted by current legislation.

It will be appreciated that the control circuit described herein represents only one possible solution to the control system of the invention. For example, it is possible to both raise and lower the load under power; in this case the carriage and mast assembly would be driven downwards at a higher rater unladen than laden. It is also possible selectively to vary the rate at which the load is lowered; for example the rate of lower in both laden and unladen conditions could be controlled automatically by a micro processor under the command either of the driver or of factory programmed instructions contained on a data carrier such as a magnetic card. This would enable standard vehicles to be readily adapted for different purposes or for different markets in which different legislation might prevail.

Claims

1. A control system for a load handling vehicle of the kind comprising a lifting mast and a carriage having means for engaging a load moveable up and down the mast; said control system comprising control means (21, 24; 34, 37) for controlling the rate of descent of said carriage; characterised in that said control means is operable to limit the rate of descent of the carriage to a pre-determined maximum value when a load is being carried thereby, and to permit lowering of the carriage at a higher rate when the carriage is in an unloaded condition.

2. A control system as claimed in Claim 1, characterised in that said carriage comprises load sensing means (28,29) and said control means is operable automatically to change the permitted rate of descent of said carriage from one value to another in response to said load sensing means.

3. A control system as claimed in Claim 1, characterised in that the control means is manually operable to change the permitted rate of descent of the carriage from one value to another.

4. A control system as claimed in any of Claims 1 to 3, characterised in that the control means is operable selectively to vary the permitted rate of descent of the carriage in the unloaded condition.

5. A control system as claimed in any of Claims 1 to 4, characterised in that said lifting mast comprises a plurality of telescopic mast sections and one or more hydraulic jacks (18, 19) adapted to extend and retract the mast sections thereby to move the carriage up and down the mast; and said control means comprises flow restriction means (34, 37) operable to control the rate of descent of said carriage by controlling the rate at which hydraulic fluid is expelled from said jack or jacks.

6. A control system as claimed in Claim 5, characterised in that said control means comprises a first lift and lowering hydraulic valve means (14) and an auxiliary hydraulic valve means (21, 24); first conduit means (20) connecting said first hydraulic valve means to said jack or jacks; and auxiliary conduit means (31, 32, 33, 35) connecting said jack or jacks to said auxiliary hydraulic valve means; wherein said flow restriction means is located in said first conduit means and said control means is operable to prevent operation of said auxiliary hydraulic valve means to prevent return of fluid through said auxiliary conduit means when the carriage is in a loaded condition.

7. A control system as claimed in Claim 6, characterised in that said first and said auxiliary hydraulic valve means are servo-operated, and said control means is operable to block operation of the servo for the auxiliary valve means in response to operation of the load sensing means when the carriage is in a loaded condition.

8. A control system claimed in Claim 6, or Claim 7, wherein said auxiliary hydraulic valve means comprises a lift and lowering hydraulic valve (24) and a lowering valve (21).

9. A control system as claimed in Claim 7, characterised in that the vehicle is adapted for handling freight containers and other unitary loads such as swop bodies and semi-trailers, and said load engaging means are provided with a locking device (28) operable to engage a load; and the load sensing means (29) are operable to sense the presence of a load by sensing whether the locking device is in the locked or unlocked condition.

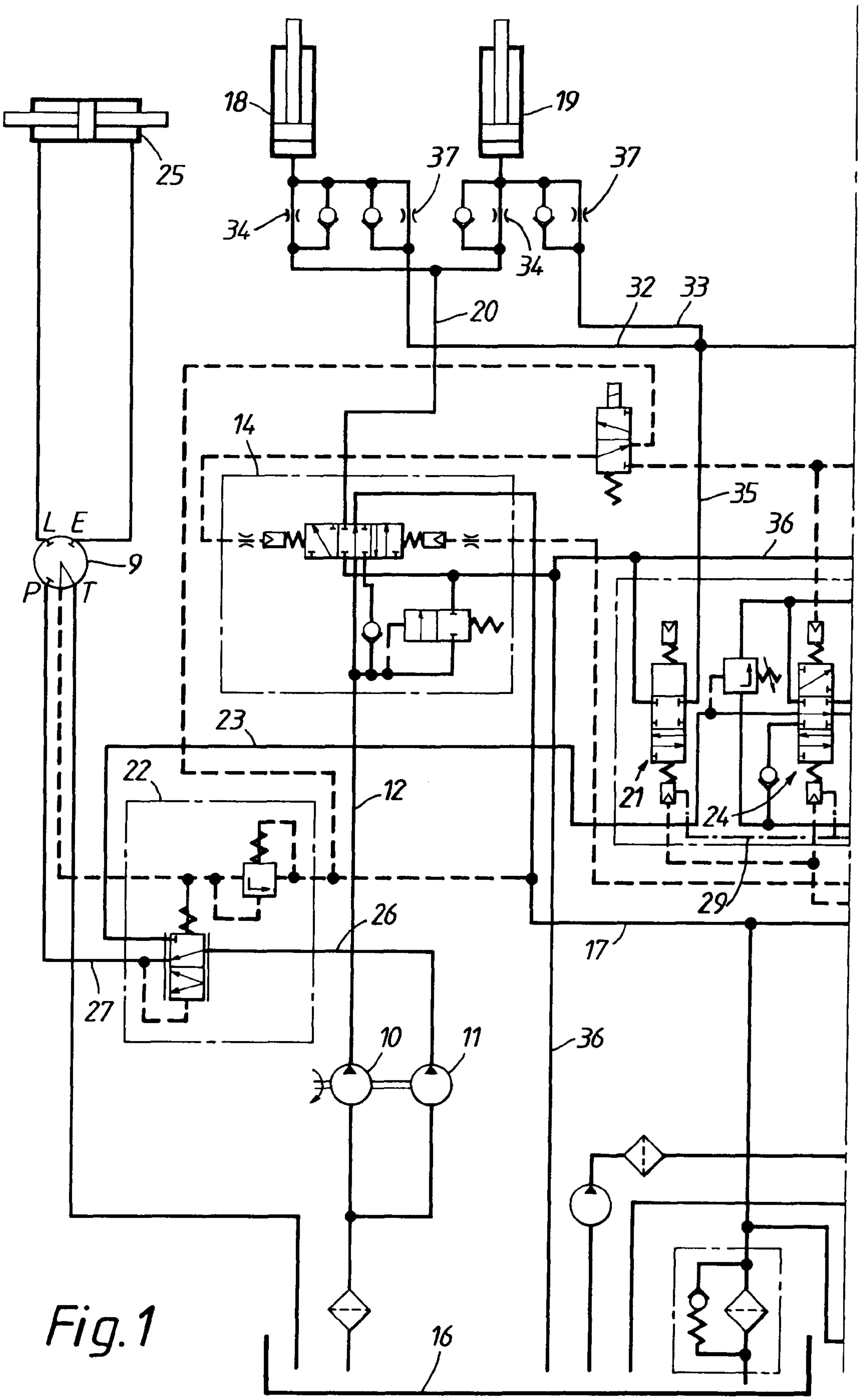
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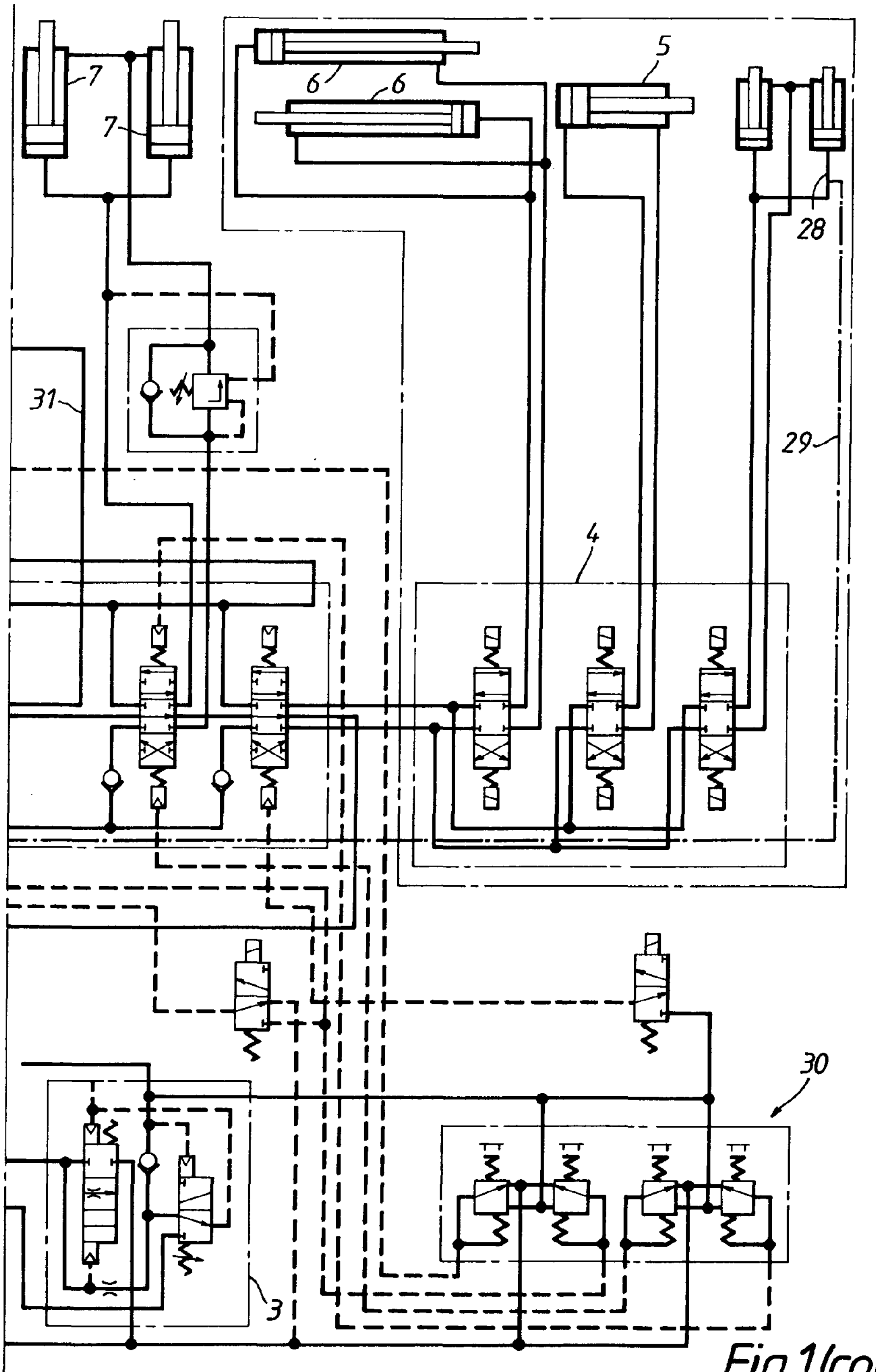
Fig.1



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