BRAKING MEANS FOR A HYDRAULIC DRIVE CYLINDER

Filed May 29, 1961

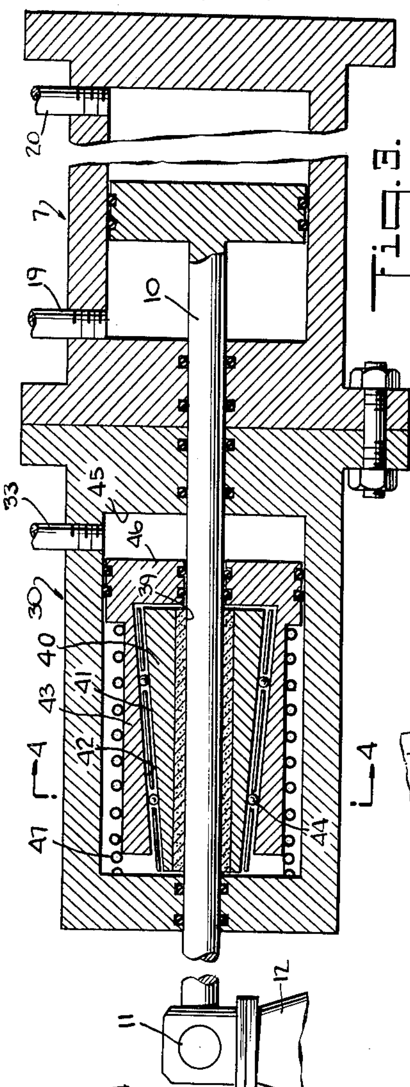

Fig. 3

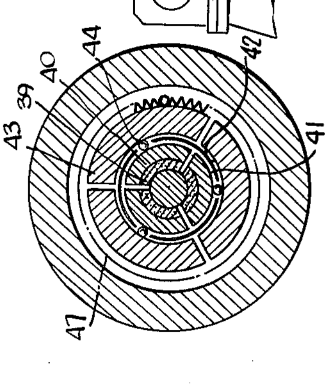

Fig. 4

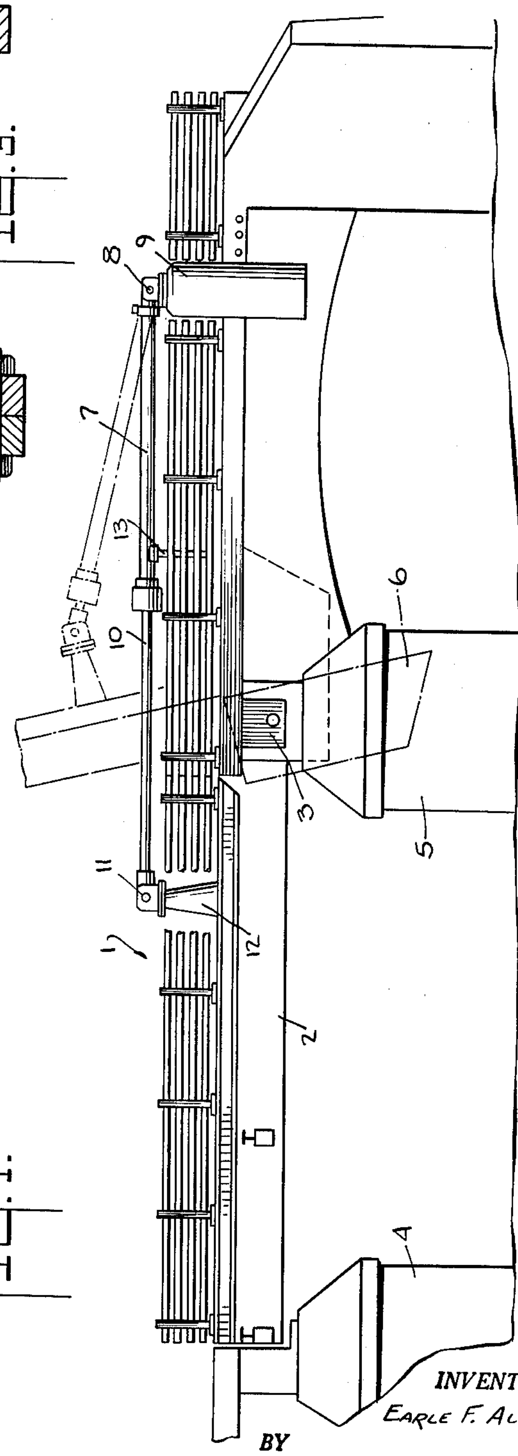

Fig. 1

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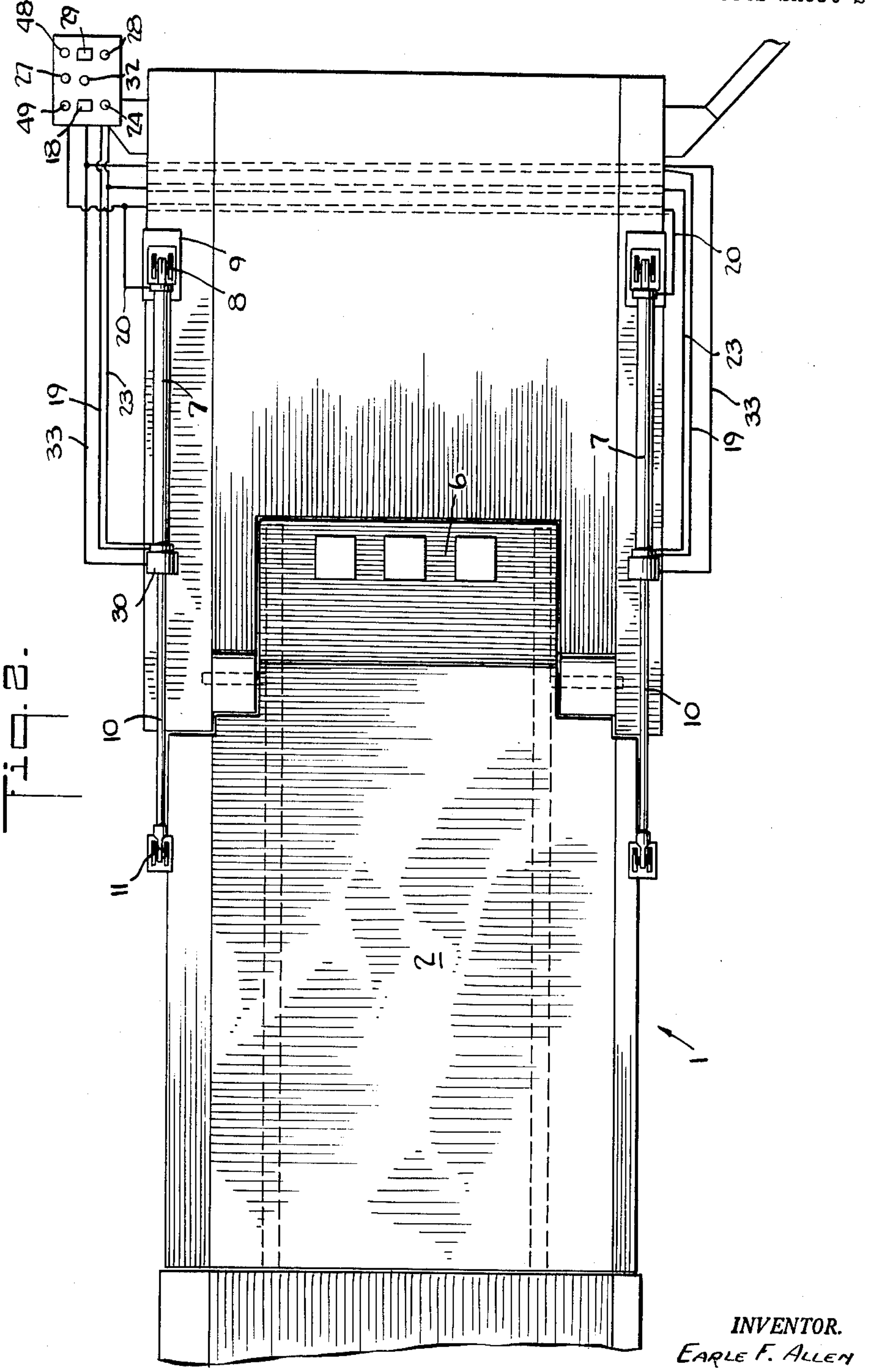

Fig. 2.

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BRAKING MEANS FOR A HYDRAULIC DRIVE CYLINDER

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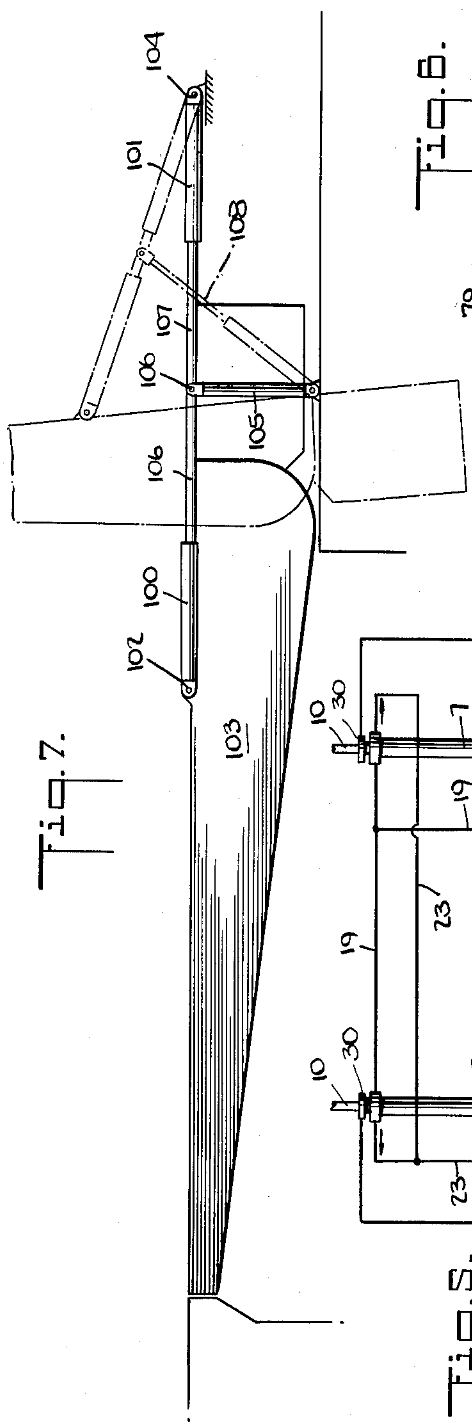

Fig. 7.

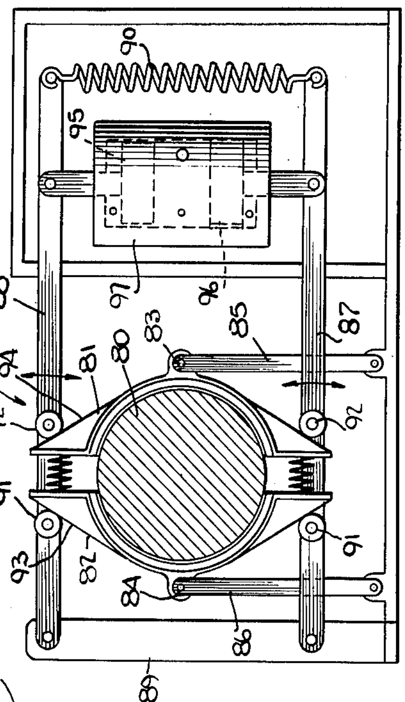

Fig. 8.

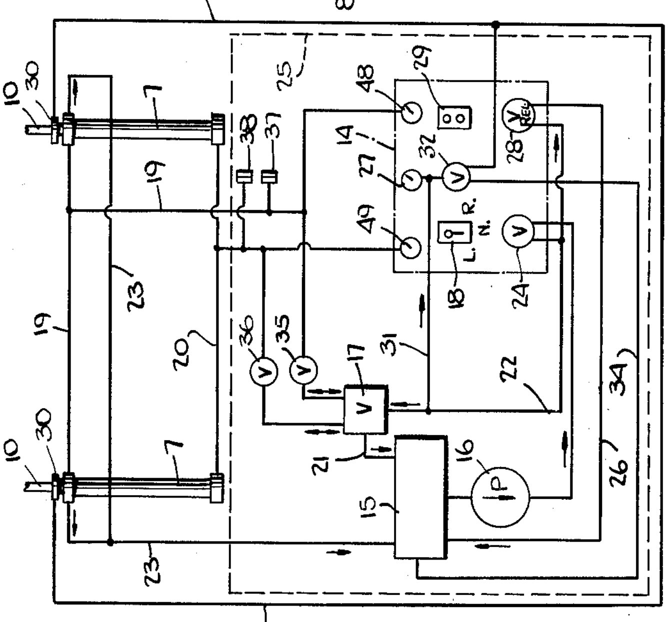

Fig. 5.

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BRAKING MEANS FOR A HYDRAULIC DRIVE CYLINDER

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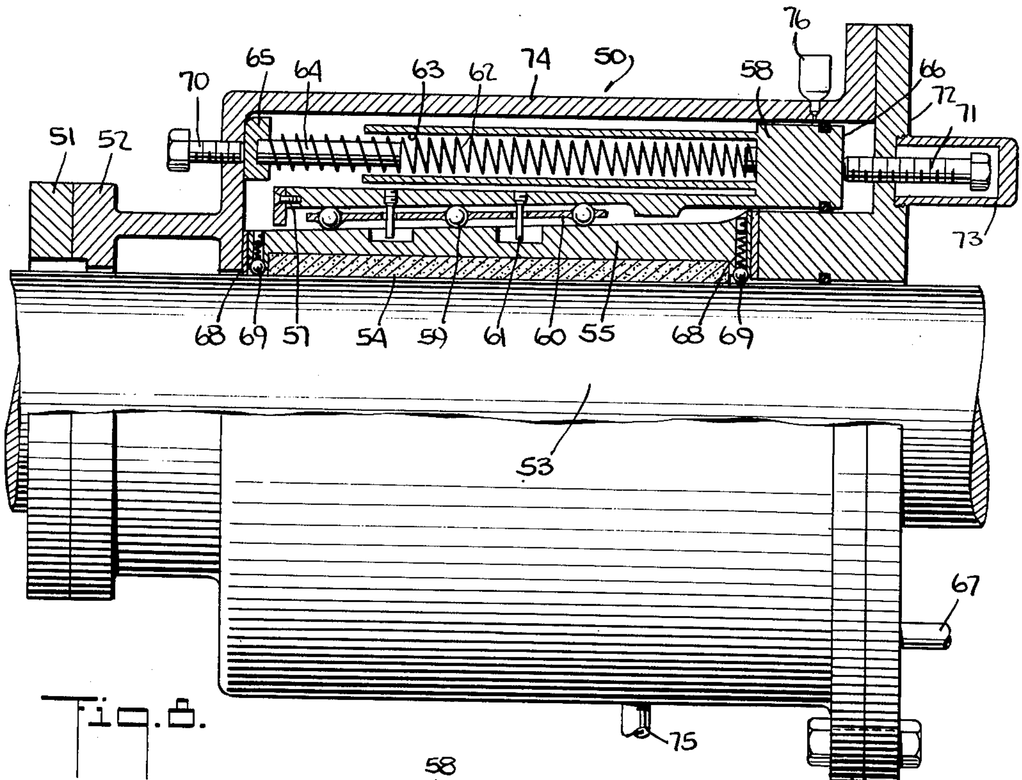

Fig. 8.

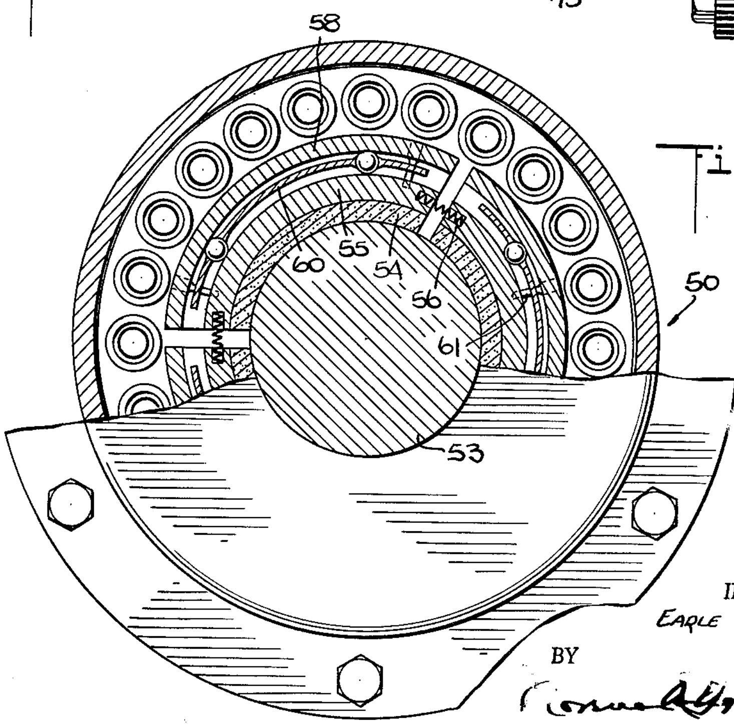

Fig. 9.

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BRAKING MEANS FOR A HYDRAULIC DRIVE CYLINDER

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7 Claims. (Cl. 188—170)

The present invention relates to an improved hydraulic drive and more particularly to an improved hydraulic drive and control system adapted for use with lift bridges and other structures or loads.

The improved hydraulic drive and control system of the present invention has been found to be particularly useful with lift bridges such as the bascule type and the following description is of a preferred embodiment of the use of the invention on such a bridge. It is clear that the invention is applicable in other uses where similar problems are faced in moving other structures or loads.

There are numerous short bridges on roads or tracks which extend over other waterways, roads, tracks or passageways wherein it would be desirable to have the bridge open to provide clearance. In many of these installations, however, the use of a movable span though desirable has been impracticable due to the relatively large investment required for such an installation. One result of this, for example, has been that the ever increasing network of highways has been responsible for the cutting off of access by water to many otherwise suitable boating areas. This has tended to create a shortage of commercial and recreational boating facilities adjacent to rivers, streams and coastal areas. There is thus an urgent need for a highway bridge which may be opened when necessary and which at the same time is relatively inexpensive, which has an operating mechanism which is simple, safe and rugged, and which is of the utmost reliability so that it may be operated by personnel inexperienced in such procedures so that the bridge does not require a regular attendant.

Previous bridges of relatively small size which have been designed to open in some cases have had only an impractical and time consuming fully manual control system or have had electro-mechanical systems with numerous sensitive and critical parts which have been subject to failure from time to time and which have been operated only with difficulty.

Accordingly, an object of the present invention is to provide an improved hydraulic drive and control system.

Another object of the present invention is to provide a rugged, relatively simple, safe and easily operated hydraulic drive and control system for a lift bridge or other structure or load.

Another object of the present invention is to provide a hydraulic drive system which requires only minimum maintainence.

Another object of the present invention is to provide an improved fail-safe brake for a hydraulic drive system.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

FIG. 1 is a side elevational view of a lift bridge with the hydraulic drive of the present invention;

FIG. 2 is a top plan view of the lift bridge of FIG. 1;

FIG. 3 is an enlarged detailed sectional view of a hydraulic drive cylinder and brake;

FIG. 4 is a sectional view of the brake of FIG. 3 taken along line 4—4 of FIG. 3;

FIG. 5 is a schematic diagram of a preferred embodiment of the hydraulic drive and braking system;

FIG. 6 is a side elevational view of another embodi- of a brake for a hydraulic cylinder;

FIG. 7 is a side elevational view of an alternate embodiment of the hydraulic lifting system;

FIG. 8 is a side elevational partially in section of another embodiment of a brake for a hydraulic cylinder; and

FIG. 9 is a sectional view of the brake of FIG. 8.

FIG. 1 illustrates at **1** a bascule type of lift bridge having a span **2** pivotally mounted at **3** so that it may be swung upwardly to clear the opening between the spaced abutments **4** and **5**. In order to facilitate the swinging movement of the span **2** and to minimize the power required to raise the span **2** to its lifted position, a counterweight **6** is provided to balance the weight of the span **2**.

As illustrated in FIGS. 1 and 2, the drive means for opening and closing the span **2** is a pair of hydraulic cylinders **7**. Each cylinder **7** has one end pivotally connected at **8** to a mounting post **9** and has the outer end of its piston rod **10** pivotally attached at **11** to another post member **12** on the span **2**. In order to swing the span **2** to its raised position, the piston rods **10** are forced inwardly of the hydraulic cylinders **7** so that the span **2** is raised to the position indicated by dash-dot lines in FIG. 1. When the span **2** is in its raised position, the cylinders **7** are subjected to their maximum load resulting from wind forces on the span **2**. At this point, however, as illustrated in FIG. 1, the piston rods **10** have been moved within the hydraulic cylinders **7** so that the hydraulic cylinders **7** and their piston rods **10** are in their strongest conformation and best able to resist the wind load on the raised span **2**. A suitable fixed support **13** is provided adjacent the outer end of each hydraulic cylinder **7** to support it when the span **2** has been lowered to its closed position.

FIG. 5 illustrates a preferred embodiment of the control system for raising and lowering the span **2**. With the exception of the hydraulic cylinders **7** and the hydraulic lines connected thereto, the elements illustrated in FIG. 5 are conveniently positioned in a suitable enclosed control cabinet **25** which may be completely closed and locked when the system is not in use. A central control panel **14** is provided in cabinet **25** to mount the various switches and valves which operate the hydraulic lift system. A reservoir **15** for the hydraulic fluid provides for a suitably large reserve so that the system may be operated for long periods without the addition of fluid. An electrically operated pump **16** has its inlet connected to the reservoir **15** and its outlet coupled through a main control valve **17** to each of the hydraulic cylinders **7**. In the preferred embodiment, the control valve **17** is an electrically operated valve with its control solenoid coupled to valve control switch **18** which is conveniently positioned on the control panel **14**. The valve **17** has a "neutral" position and "raise" and "lower" positions which are controlled by the appropriate manipulation of the control handle **18**. When the control handle **18** is in its "neutral" position, conduits **19** and **20** which are coupled to the outer and inner ends respectively of the hydraulic cylinders **7** are both disconnected from pump **16**. When the control handle **18** is moved to its "raise" position, the line **19** is connected to the pump **16** through line **22** causing the pistons **10** to be forced inwardly of the hydraulic cylinders **7** and the inner end of each hydraulic cylinder **7** is coupled by line **20**, valve **17** and line **21** to the reservoir **15**. When it is desired to lower the span **2**, the control handle **18** is moved to reverse these connections so that lines **20** are coupled to the pump 16 through conduit 22 by valve 17 and the outer end of each of the hydraulic cylinders 7 is coupled to the reservoir 15 through conduit 19, valve 17 and conduit 21.

Conduits 23 are preferably provided between the packing glands of the hydraulic cylinders 7 and the reservoir 15 to drain any hydraulic fluid back to the reservoir 15 which has leaked into the glands during the operation of the hydraulic cylinders 7. The rate of movement of the span 2 is conveniently controlled in the preferred embodiment by placing a flow control valve 24 in the high pressure pump line 22. The valve 24 is conveniently positioned on the control panel 14. A pressure relief valve 28 is also conveniently positioned on the control panel 14 and the valve 28 connects between the pump high pressure outlet line 22 and the reservoir 15 through line 26 to prevent the system pressure from rising above a predetermined value. A motor control switch 29 for the electrically driven pump motor 16 is also mounted on the control panel 14. Pressure gages for the system are also mounted on the control panel 14. Thus, a pressure gage 27 is provided to register the pressure in the high pressure pump line 22 and gages 48 and 49 are connected in the pressure lines 19 and 20 for indicating the span raising and lowering pressures respectively.

A hydraulically operated brake 30 is mounted on each of the hydraulic cylinders 7 so that the piston rods 10 may be tightly locked at any position when it is desired to hold the span 2 against movement. These brakes 30 which will be described more fully below are each coupled to the high pressure line 22 through conduit 31, control valve 32 and connecting lines 33. Valve 32 is moved to its open position to connect each of the brakes 30 to the high pressure fluid to move the brakes to their open position. The brakes 30 are applied to the piston rods 10 through internal spring pressure in each brake 30 by moving the valve 32 to its closed position which cuts off the high pressure hydraulic fluid source from the connecting lines 33 and couples these lines to the hydraulic reservoir 15 through a brake release line 34.

In order to raise the bridge span 2, the electric motor for the pump 16 is first eneregized by switch 29. The brakes 30 are next released by opening the valve 32 and the control valve 18 is then moved to its "raise" position. In order to lower the bridge, the valve 18 is moved to its "lower" position with the brakes in their off position.

As will be more fully described below, the brakes 30 are of the fail-safe type and are applied by mechanical spring forces independent of the hydraulic system. This permits the span 2 to be held at any position including its fully raised position even though the hydraulic pressure fails due to a failure in the system or due to the intentional shutting down of the pump 16. It also results in the automatic application of the brakes 30 whenever the hydraulic pressure fails.

In the preferred embodiment, an alternate emergency system is provided to permit the span 2 to be raised or lowered by any independent hydraulic system such as that which might be provided on a portable compressor. This emergency system includes valves 35 and 36 to isolate the raising and lowering conduits 19 and 20 respectively Quick disconnects 37 and 38 are included in the lines 19 and 20 respectively to permit the application of the outside hydraulic pressure as necessary to move the bridge either upwardly or downwardly after the valves 35 and 36 have been closed.

One embodiment of the combined hydraulic piston and brake arrangement of the present invention is illustrated in detail in FIGS. 3 and 4. The brake 30 is mounted directly on the outer end flange of the hydraulic cylinder 7 and is concentrically spaced about the piston rod 10. The braking force is applied to the rod 10 by cylindrical brake lining 39 which is mounted on the cylindrical brake shoe 40. Both the linings 39 and shoes 40 are preferably divided into longitudinal sections as seen in FIG. 4.

The braking force is applied to the shoe 40 by relative motion between the tapered outer surface 41 of shoe 40 and the complementary inner tapered surface 42 of piston 43 through the intermediation of the ball bearings 44. Piston 43 is slidably mounted on piston rod 10. Where there is no hydraulic fluid under pressure in the cavity 45 adjacent to the end 46 of piston 43, the helical spring 47 forces the piston 43 to the right (FIG. 3) thereby providing a squeezing force on the brake shoes 40 through the intermediation of the ball bearings 44. Thus, the brake 30 tightly grips the rod 10 to lock it in position whenever the hydraulic pressure behind the piston 43 is intentionally or inadvertently released. Since the fluid for the brake control line 33 is provided from the same source as is the hydraulic fluid which operates the main hydraulic cylinders 7 through lines 19 and 20, the brake 30 also provides for safe and controlled operation of the hydraulic drive system since the brake 30 cannot be released until sufficient pressure has been generated in the over-all hydraulic system to move piston 43 against the force of the spring 47.

FIGS. 8 and 9 illustrate in detail a preferred embodiment of the hydraulic brake of the present invention which is particularly adapted for fail-safe operation and also for providing integral adjustment means and indicating means within a simple compact structure.

This brake 50 is also adapted to be attached to an end flange 51 of a hydraulic drive cylinder by means of a mounting flange 52. The brake 50 is of concentric design so that its members surround an extending portion of the hydraulic cylinder piston rod 53. The preferred braking surface comprises cylindrical linings 54 which are divided into sections comprising three sections in the preferred embodiment each covering about 120 degrees. The brake linings 54 are mounted on a cylindrical brake shoe 55 which also is preferably formed in three sections which are resiliently held apart by the spacing springs 56. The outer surface of the combined brake shoe sections has a tapered form as illustrated so that radially inwardly directed braking pressure is applied to the brake linings 54 through the intermediation of a complementary tapered braking surface 57 formed on the brake piston 58. A relatively great squeezing or braking force is generated by movement of the brake piston 58 axially of the piston rod 53 by the inclined plane or wedging action which results between the concentrically tapered brake shoe 55 and surface 57 of the piston 58. A frictionless transfer of these forces is provided by ball bearings 59 positioned between the brake shoe 55 and the piston 58. A suitable spaced 60 is provided to hold the bearings 59 in place and radial guide pins 61 are provided to position both the piston 58, the spacer 60 and the brake shoe 55.

The brake piston 58 is moved to the right (FIG. 8) by spaced braking springs 62 which have one end positioned in suitable apertures 63 in the piston 58 and which have their opposite ends retained on mounting pins 64 spaced around an annular spring adjustment plate 65. In the absence of hydraulic pressure on the face 66 of the piston 58, the springs 62 force the piston 58 to the rightly thereby applying a compressive force to the brake shoe 55 through the intermediation of the inwardly tapered surface of the piston 58, the ball bearings 59 and the outer tapered surface of the brake shoe 55. In the preferred embodiment, the relatively large number of springs 62 provide for an even application of the braking force and insure continued operation of the brake even though one or more individual springs 62 may fail.

The brake is released by the application of hydraulic pressure to the face 66 of the piston 58 through one or more hydraulic inlets 67. This moves piston 58 to the left (FIG. 8) thereby releasing the compressive force on the brake shoe 55 and permitting it to be lifted from the rod 53 by the resilient brake release members which include springs 68 and ball bearings 69.

The spring pressure applied to the piston 58 in the braking action is adjustably set by a series of adjustable screws 70 which engage the adjustment plate 65 at spaced intervals to cause it to compress the springs 62 in the necessary amount. A series of limit screws 71 are equally spaced around the opposite end 72 of the brake 50 in position to engage face 66 of the piston 58 to provide a limit stop for the piston movment.

These limit screws 71 which are normally covered by removal caps 73 may also be used as a manual release in the event the hydraulic pressure fails. When thus used, the screws 71 are turned inwardly to move the braking piston 58 to the left so that it releases brake shoe 55 in the same way that the hydraulic force does when it moves the piston 58 in this direction.

The combination of the hydraulic piston with the tapered wedging action and its related mechanical advantage permits an enormous braking force to be applied to the rod 53 so that a braking force such as 5 tons or more may be applied to a rod 6 inches in diameter even through the rod is lubricated. Thus, in the preferred embodiment, the braking cylinder 74 is partially filled with oil so that the rod 53 is lubricated to resist corrosion. The lubricating oil does not completely fill the space around the rod 53 so that it does not interfere with movement of the piston 58. In order to assure that the lubricating oil does not interfere with brake operation, a relief outlet 75 coupled to a low value pressure relieve valve is provided on the spring side of the piston 58 to vent excess lubricating oil when necessary.

A pressure operated switch or other device to show that the brake is off may be mounted on the brake 50 as illustrated at 76 so that movement of the piston 58 to its brake release position exposes the indicator 76 to the hydraulic pressure behind piston 58.

FIG. 6 illustrates at 79 another embodiment of the brake for hydraulic cylinders. In the above described brakes as illustrated in FIGS. 3 and 8, the hydraulic release system and the braking springs are included in an integral construction with the braking shoes and in a common housing. The embodiment of FIG. 6 illustrates a brake having a separate hydraulic motor or cylinder for opening the brake and a separate braking spring. The main piston rod 80 adapted to operate the bridge or a similar device is shown in lateral section with a pair of brake shoes 81 and 82 partially encircling the rod 80. These shoes 81 and 82 are pivotally attached at 83 and 84 to mounting links 85 and 86. The shoes 81 and 82 are closed to grip the rod 80 by a pair of spaced brake rods 87 and 88, each of which is pivotally mounted at one end on a bracket 89. A stretched spring 90 resiliently connects and urges the free ends of the rods 87 and 88 together to apply the brake by causing cam rollers 91 and 92 to move on the brake shoe camming surfaces 93 and 94 so that shoes 81 and 82 are forced toward one another and against the rod 80.

The brake is released by admitting hydraulic fluid under pressure between the two hydraulic pistons 95 and 96 in cylinder 97 causing the pistons to separate and the brake rods 87 and 88 to be moved apart against the force of the spring 90. The same hydraulic pressure which is being used to operate the main hydraulic drive system to move the rod 80 may be used to release the brake 79 during operation. This pressure may be separately cut off from cylinder 97 when it is desired to operate the brake 79 and should the main hydraulic pressure fail, the brake 79 is automatically applied by the spring 90.

FIG. 7 illustrates another embodiment of the hydraulic control for a lift bridge or similar structure. The previously described system has hydraulic cylinders attached at spaced locations for moving the bridge span. The embodiment of FIG. 7 illustrates several hydraulic cylinders interconnected to provide for a smooth powerful control where greater loads are handled.

In this embodiment, two hydraulic cylinders 100 and 101 are pivotally connected together in a line between a suitable pivot point 102 on a movable span 103 and a pivotal attachment on a fixed anchor 104. A third hydraulic cylinder 105 is pivotally attached at 106 to the pivotal coupling between the hydraulic cylinders 100 and 101. In this arrangement, hydraulic cylinder 105 is connected to provide a toggle arrangement so that a greatly multiplied mechanical force resulting from the toggle action is obtained as the piston rods 106 and 107 are drawn inwardly and the piston rod 108 of the hydraulic cylinder 105 is extended. This greatly multiplied force is particularly useful in this coupling as it is applied in the structure of FIG. 7 at the start of the lifting movement of span 103 where the greatest lifting force is required. This permits the bridge counterweight to be eliminated or reduced in size and weight. This arrangement may be operated by a control system as described above to permit this hydraulic drive system to be effectively applied to lift bridge spans or to other similar structures. One or the other of the hydraulic cylinders 100 or 101 may be replaced by a solid linkage where the lifting power of three hydraulic cylinders is not required.

It will be seen that the present invention provides an improved hydraulic control system for lift bridges or other structures or loads. The hydraulic system combines dependability with relative simplicity by minimizing the number of moving parts and other parts and by incorporating fail-safe features such as the automatic hydraulic locking brakes as related parts of the hydraulic control system. In addition, the present hydraulic drive and control system is particularly well suited for occasional use by unskilled operators due to its fail-safe features and the small number of controls required for operation. The lubricated hydraulic piston rods and the confinement of the electrical elements and other controls to a single remotely positioned and completely enclosed control compartment provides a weather proof system. The system is also operable by alternate operating means after a failure of the hydraulic system or the electrical system.

As various changes may be made in the form, construction and arrangement of the parts herein without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim:

1. A fail-safe brake for a hydraulic drive cylinder having a movable drive piston and an elongated piston rod coupled thereto within said cylinder and contacting the hydraulic fluid comprising the combination of a generally cylindrical elongated brake shoe having a generally cylindrical inner braking surface surrounding said piston rod and having a flared outer surface, an elongated generally cylindrical braking piston surrounding said brake shoe and having a flared inner surface complementary to the outer flared surface of the brake shoe, a spring means engaging said braking piston urging said flared surfaces into engagement and said braking surface against said piston rod, and an enclosed cavity adjacent a portion of the braking piston for applying hydraulic pressure against said braking piston to disengage said flared surface.

2. A fail-safe brake for a hydraulic drive cylinder having a movable drive piston and an elongated piston rod coupled thereto within said cylinder and contacting the hydraulic fluid comprising the combination of a generally cylindrical elongated brake shoe having a cylindrical braking surface surrounding said piston rod and having a flared outer surface, an elongated generally cylindrical braking piston surrounding said brake shoe and having a flared inner surface complementary to the outer flared surface of the brake shoe, a plurality of

springs and engaging said braking piston and arranged generally parallel to said drive piston and equi-distantly spaced from one another urging said flared surfaces into engagement and said braking surface against said piston rod, and hydraulic means coupled to said braking piston for applying hydraulic pressure against said braking piston to disengage said flared surface against the force of said springs.

3. A fail-safe brake for a hydraulic drive cylinder having a movable drive piston therein and an elongated piston rod coupled to said piston within said cylinder and wetted by the hydraulic fluid comprising the combination of a generally cylindrical elongated brake shoe having a cylindrical braking surface surrounding said piston rod and having a flared outer surface, said brake shoe constrained against movement longitudinally of said piston rod, an elongated generally cylindrical braking piston surrounding said brake shoe and having its inner surface flared complementary to the outer flared surface of the brake shoe, bearing means intermediate said brake shoe and said braking piston, said braking piston being loosely mounted on said brake shoe for movement longitudinally of said piston rod, adjustable stop means for limiting the movement of the braking piston, a plurality of springs engaging said braking piston and urging its flared surface toward the flared surface of said brake shoe forcing the brake shoe against the wetted surface of said piston rod, a separate means for adjusting the force applied by said springs, and hydraulic means in communication with said drive cylinder and acting on said braking piston to move its flared surface away from the flared surface of said brake shoe to release the brake shoe from the piston rod when hydraulic pressure is applied to the drive piston.

4. A fail-safe brake for a hydraulic drive cylinder having a movable drive piston therein and an elongated piston rod coupled to said piston within said cylinder and wetted by the hydraulic fluid comprising the combination of a generally cylindrical elongated brake shoe having a cylindrical braking surface surrounding said piston rod and having a flared outer surface, said brake shoe constrained against movement longitudinally of said piston rod, an elongated generally cylindrical braking piston surrounding said brake shoe and having its inner surface flared complementary to the outer flared surface of the brake shoe, said braking piston being loosely mounted on said brake shoe for movement longitudinally of said piston rod, a spring means engaging said braking piston and urging its flared surface toward the flared surface of said brake shoe forcing the brake shoe against the wetted surface of said piston rod, and hydraulic means in communication with said drive cylinder and acting on said braking piston to move its flared surface away from the flared surface of said brake shoe to release the brake shoe from the piston rod when hydraulic pressure is applied to the drive piston.

5. The brake as claimed in claim 4 which further comprises means for preventing rotation of said braking piston about said brake shoe.

6. The brake as claimed in claim 4 in which said bearing means comprises a plurality of bearing members, and a spacing member loosely retaining each of said bearing members in position relative to the brake shoe.

7. A fail-safe brake for a hydraulic drive cylinder having a movable drive piston therein and an elongated piston rod coupled to said piston within said cylinder and wetted by the hydraulic fluid comprising the combination of a generally cylindrical elongated brake shoe mounted on said cylinder and having a cylindrical braking surface surrounding said piston rod and having a flared outer surface, said brake shoe constrained against movement longitudinally of said piston rod, an elongated generally cylindrical brake piston movably mounted surrounding said brake shoe and having its inner surface flared complementary to the outer flared surface of the brake shoe, ball bearing means intermediate said brake shoe and said braking piston, said braking piston being loosely mounted on said brake shoe for movement longitudinally of said piston rod, adjustable stop means for limiting the movement of the braking piston towards said brake shoe and positioned for selectively moving said braking piston away from said brake shoe, a plurality of springs engaging said braking piston and urging its flared surface toward the flared surface of said brake shoe forcing the brake shoe toward said stop means and against the wetted surface of said piston rod, a separate means for adjusting the force applied by said springs, and hydraulic means in communication with said drive cylinder and acting on said braking piston to move its flared surface away from the flared surface of said brake shoe to release the brake shoe from the piston rod when hydraulic pressure is applied to the drive piston.

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