

Feb. 11, 1964

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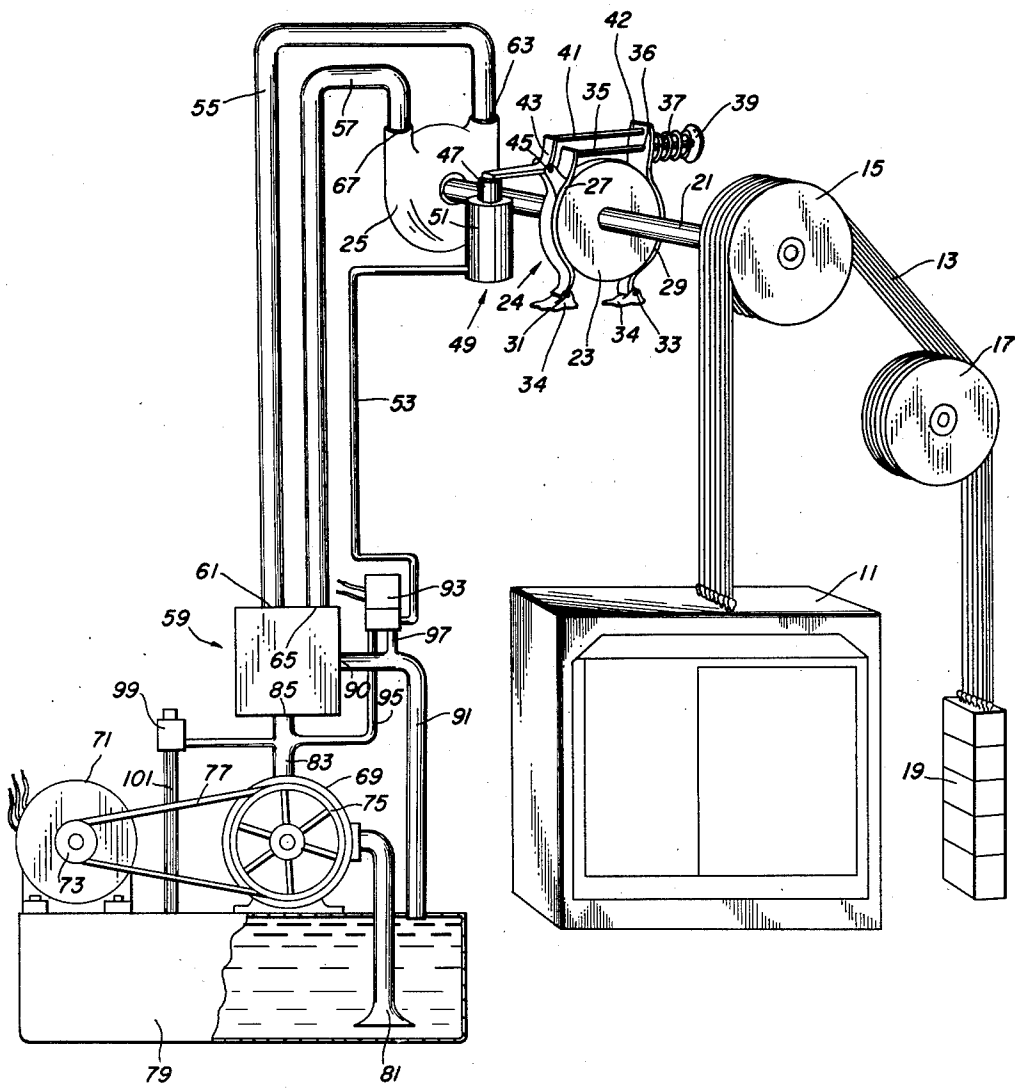
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HYDRAULIC DRIVE AND CONTROL FOR ELEVATORS

Filed Dec. 23, 1960

2 Sheets-Sheet 1

FIG. 1



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FIG. 2

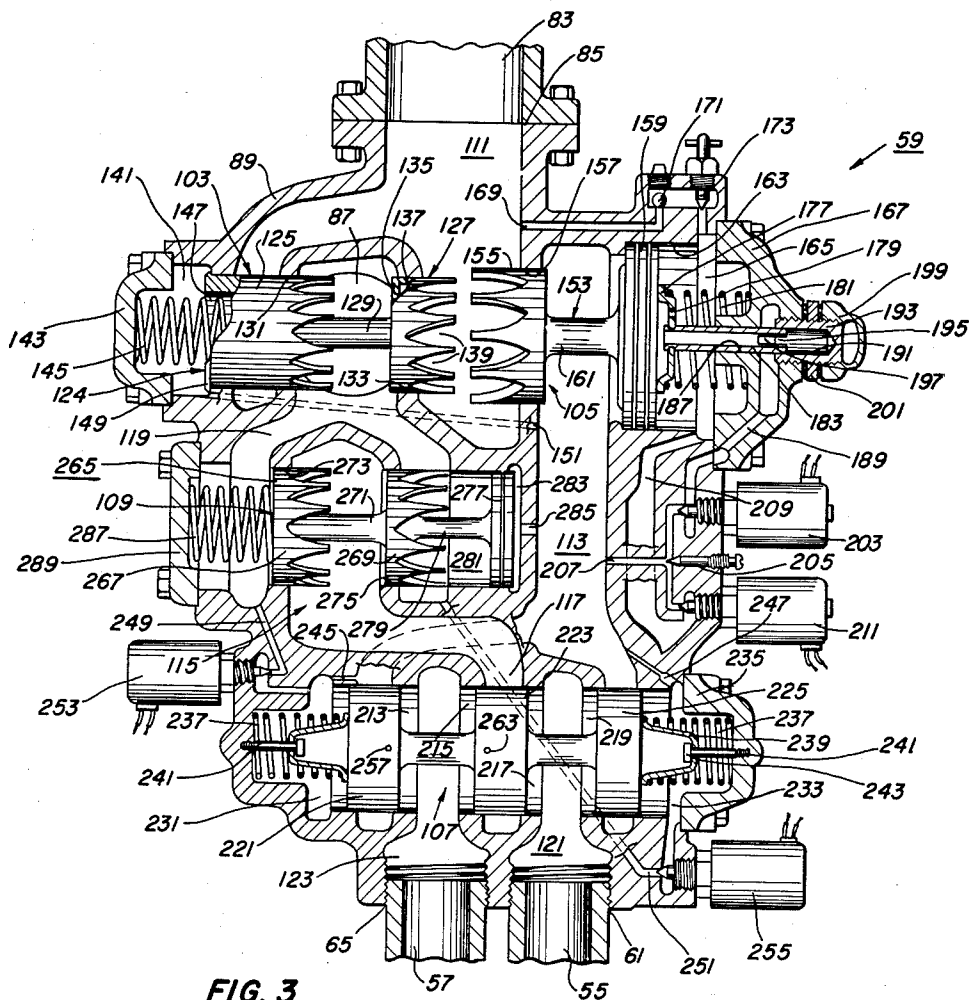
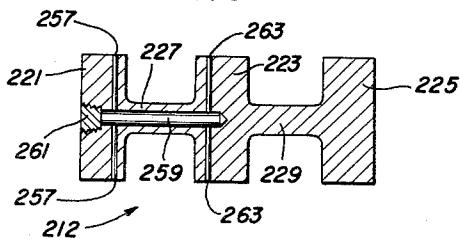


FIG. 3



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HYDRAULIC DRIVE AND CONTROL FOR ELEVATORS

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This invention relates to a hydraulic drive and control for elevators and the like, and in particular for elevators of the traction type, which employ a sheave over which are led cables that connect to the elevator for the lowering and raising thereof upon rotational drive of the sheave.

Heretofore, in elevators of the above mentioned traction type, it has been the usual practice to drive the sheaves by electric motors and to employ intricate and numerous electrical control components for controlling the voltage to raise and lower the elevator at various speeds and to stop the elevator.

The present invention is directed towards providing, in traction type elevators, means which eliminates the use of the intricate and numerous electrical components heretofore employed, by providing a unique hydraulic drive and control which offers means to control starts, stops and operating speeds in both directions regardless of the loads carried on the elevator. The present invention accomplishes these results in a manner that gives assurance against loss of control of the elevator by any means, as the hydraulic components employed are capable of holding the elevator against movement even without the use of a brake.

There have been other attempts at providing a hydraulic drive for traction type elevators, for example, the closed system type of hydraulic drive which uses a reversible and variable speed motor. There are other similar types which use either variable speed motors, or variable delivery pumps in a closed system. However, in the present invention the system is of an entirely new and unique concept in which an open hydraulic system, as opposed to a closed system, is employed that includes a constant displacement hydraulic motor, a constant displacement hydraulic pump, and means controlling the delivery of fluid from said pump to said motor in the desired amount and in the desired direction to move the elevator car at all speeds from zero to a maximum in either direction. By employing a constant displacement pump in the present invention, smooth operation of the elevator car is achieved in contrast to previous systems using variable delivery pumps which have a tendency to give noisy and rough operation due to the pulsations from the variable delivery pumps.

Thus, one of the objects of the present invention is to provide in a traction type elevator system, hydraulic means for driving the elevator at all speeds from standstill to maximum in both directions from a constant displacement hydraulic source.

A further object is to provide such an elevator system in which there is smoothness of operation.

A further object is to provide such hydraulic means in which acceleration and deceleration are controlled so positively that only a single signal is required to indicate to the equipment at what speed it should next operate.

A further object is to provide in such hydraulic means, a hydraulically released, spring operated brake which is so designed that it cannot release in the absence of hydraulic pressure capable of operating the elevator.

A further object is to provide a control valve providing means therein for regulating the flow therefrom, reversing the direction thereof, by-passing the surplus hydraulic fluid to a reservoir, and regulating the maximum pressures in the system.

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A further object is to provide means for insuring that a hydraulic motor cannot "run away" from its supply source.

A further object is to provide the use of a three-position speed setting valve in connection with a by-pass so that a definite portion of the hydraulic fluid may pass through the speed setting valve and the remainder be by-passed without substantial increase in the pressure of the fluid.

A further object is generally to improve the design and construction of hydraulic drives and controls for elevators.

Other objects and advantages of the present invention will become apparent from the ensuing description in the course of which reference is had to the accompanying drawings, in which:

FIG. 1 is a diagrammatic view of an elevator system provided with the hydraulic drive and control of the present invention, with parts shown in perspective and parts broken away for purposes of illustration.

FIG. 2 is a cross-sectional view of the valve portion of the present invention taken as on a vertical plane substantially through the middle of the valve, with portions of the valve being shown in elevation and portions being broken away for purposes of illustration, and with the valve being inverted relative to the position shown in FIG. 1 for purposes of clarity.

FIG. 3 is a cross-sectional view of the piston assembly of the reversing valve portion of the present invention taken as on a vertical plane substantially through the middle of the reversing valve.

Referring now to the drawings in which the various parts are indicated by numerals, and referring first more specifically to FIG. 1 wherein is shown an elevator car 11 normally traveling in vertical guides, not shown, and suspended by hoisting ropes or cables 13 passing over a traction sheave 15 and a deflector sheave 17 to counterweights 19 which also operate in guides, not shown. It will be understood that deflector sheave 17 is rotatably supported by suitable means, not shown. Traction sheave 15, in the usual manner, is provided with grooves equal in number to the number of hoisting cables 13 and these grooves are tapered so that the hoisting cables will wedge tightly enough to give frictional drive and to avoid slipping between traction sheave 15 and the cables. The above description of the elevator car, hoisting cable, traction sheave, deflector sheave, and counterweight arrangement is deemed to be sufficient since it forms no part of the present invention, but is the typical traction type of elevator arrangement with which the present invention is adapted to be employed. The present invention is directed towards the hydraulic drive and control hereinafter described which is connected to sheave 15 for the rotational drive thereof in opposite directions and various speeds from zero to a maximum in both directions to stop, start and operate the elevator car 11.

Sheave 15 is mounted on a shaft 21 to which it is fixedly connected, as by keying, for rotation therewith. Shaft 21 is rotatably supported in bearings, not shown, on a suitable base, not shown, and carries a brake wheel 23 also keyed thereto, which brake wheel forms part of a brake 24. Shaft 21 is also fixedly attached by suitable means to the rotating member, not shown, of a hydraulic motor 25 which is of the positive displacement type and of well-known construction. Brake wheel 23 is provided with a pair of friction shoes 27, 29 that are respectively pivotally mounted as at 31, 33 from a base 34, with only a fragmentary portion of the base being shown. A rod 35 is attached to friction shoe 27 adjacent the upper end of the friction shoe and extends through an aperture 36 in the upper end of friction shoe 29 and therebeyond for a portion and surrounding which portion is provided a

compression spring 37 extending between the back side of friction shoe 29 and a spring retainer 39. From the foregoing it will be understood that spring 37 normally urges shoes 27, 29 toward one another to engage frictionally brake wheel 23 to prevent rotation of sheave 15. A link 41 is connected at one end to an extension 42 of friction shoe 29 and is connected adjacent the opposite end to one arm of a lever 43 which in turn is pivotally mounted as at 45 from brake shoe 27. The other arm of lever 43 is engaged by the piston rod 47 of a suitable hydraulic jack 49, of usual construction, which also includes a cylinder 51 to which hydraulic fluid is brought through a conduit 53, which conduit is connected into the system in a manner later to be described. From the foregoing it will be understood that hydraulic fluid pressure brought to cylinder 51 by conduit 53, when desired, is effective to pivot lever 43 and force apart friction shoes 27, 29 through links 35, 41.

Although sheave 15, brake 24 and motor 25 have been shown spaced apart and coupled through shaft 21, it will be understood that these parts may be coupled together in one unitary assembly, without departing from the spirit and scope of the present invention. For example, if desired, motor 25 may be of the known type having the outer portion of the rotating part and formed with the sheave and brake thereon.

A pair of conduits 55, 57 are for the purpose of bringing and carrying away hydraulic fluid to and from hydraulic motor 25. Conduits 55, 57 respectively are interposed between a control valve, generally indicated as at 59, and hydraulic motor 25. Thus, one end of conduit 55 is connected as at 61 to valve 59 and connected at the opposite end thereof to motor 25 at connection 63; and one end of conduit 57 is connected as at 65 to valve 59 and is connected at the opposite end to motor 25 at connection 67. It will be understood that connection 63 serves as either the inlet or the outlet of motor 25, and connection 67 also serves as either the inlet or the outlet of the motor, depending upon which direction the hydraulic fluid is flowing through conduits 55, 57. For example, if the flow through conduit 55 is in a direction from valve 59 towards motor 25, then connection 63 is the inlet, and the discharge is through connection 67 and conduit 57 towards valve 59, in which case motor 25 will be driven clockwise, as viewed in FIG. 1, to raise the elevator car 11. If the fluid flow is in the opposite direction from that above described, motor 25 will be driven in the opposite direction to lower elevator car 11.

Fluid is pumped by a positive displacement pump 69, of usual construction, driven from a motor or other prime mover 71 as by pulleys 73, 75 in the usual manner by a continuous belt 77. Fluid is lifted from a vented reservoir 79 through suction pipe 81 and discharged from hydraulic pump 69 through conduit 83 connected to control valve 59 as at 85. The return flow leaves control valve 59 through a discharge conduit 91 which is connected adjacent one end to the control valve at connection 90 and leads to reservoir 79.

Pressure to operate brake release jack 49 is governed by a three-way electro-magnetic valve 93, of usual construction, which obtains pressure from pressure conduit 83 through line 95 and transmits it through conduit 53 to the jack when the three-way valve 93 is energized. When three-way valve 93 is not energized, it causes fluid to drain from conduit 53 back to reservoir 79 through conduit 97 leading from the three-way valve to discharge conduit 91.

Overpressure that might cause damage is prevented by a suitable pressure release valve 99, of known construction, which is interposed in a conduit 101 leading from the conduit 83 back to the reservoir 79 so that sufficient oil is by-passed to reduce the pressure to the set value.

Referring now more particularly to the control valve assembly 59, shown in detail in FIG. 2, in the control valve assembly are included four major valves and these

are: a by-pass control valve 103, a speed setting and non-return valve 105, a reversing valve 107, and a back pressure valve 109. Valve body 89 is provided in general with the following major chambers or passages: an inlet chamber 111 in communication with conduit 83 at connection 85 whereby the inlet chamber is adapted to receive hydraulic fluid from pump 69; an intermediate chamber 113 downstream of inlet chamber 111 with the flow therebetween being controlled by speed setting and non-return valve 105; a discharge passage 115 comprising a first discharge chamber 117 and a second discharge chamber 119 downstream of the first discharge chamber with chamber 119 communicating with discharge port 87, and with the flow between first discharge chamber 117 and second discharge chamber 119 being controlled by back pressure valve 109; a first passage 121 in communication with conduit 55 and which in effect forms an extension of conduit 55 in valve body 89; and a second passage 123 in communication with conduit 57 and which in effect forms an extension of conduit 57 in valve body 89. Reversing valve 107, which will be described in more detail later on in the description, controls the direction of the fluid flow to and from motor 25 through conduits 55 and 57. In general, reversing valve 107 is a three-position valve and has the following functions in the three positions: In the normal or central position the reversing valve stops the flow from and to conduits 55, 57, thereby holding the elevator at a given position; in another position the reversing valve opens communication between intermediate chamber 113 and conduit 55 to cause fluid flow through conduit 55 in a direction towards motor 25 and communicates conduit 57 with discharge passage 115 so that fluid can flow through conduit 57 away from the motor 25, thereby causing the motor to rotate in a direction to raise elevator car 11; and in still another position the reversing valve reverses the flow through conduits 55, 57 by communicating conduit 57 with intermediate chamber 113 and communicating conduit 55 with discharge passage 115, thereby causing the motor to rotate in a direction to lower the elevator car.

Referring now more specifically to the construction of the individual valves, their related parts and their association in the overall valve assembly 59, the by-pass control valve 103 comprises a piston assembly 124 preferably including two heads 125, 127 rigidly interconnected by a stem 129 and with the heads 125, 127 being respectively slidably fitted to cylindrical bores 131, 133 provided in body 89 between inlet chamber 111 and second discharge chamber 119. Inlet chamber 111 has two branches with one branch leading to bore 131 and the other branch leading to bore 133. Bore 131 is spaced directly across from bore 133 and the valve 103 arranged in such a manner that the flow through the bores 131, 133 is equal and in the opposite directions so that the rate of flow is balanced therethrough and the rate of fluid flow has substantially no effect on the valve. Head 127 is preferably constructed with a solid central portion 135 to which stem 129 is attached in the middle thereof, and the head includes a cylindrical side wall 137 which is provided with a plurality of V-shaped notches 139 along one edge thereof so that as the head is moved to the left, as viewed in FIG. 2, the notches provide gradually increasing passage area for the fluid. Head 125 is preferably constructed in substantially the same manner as head 127 and the heads move together so that as the piston assembly 124 moves to the left the notches in heads 125, 127 open increasingly the passage area for flow of fluid. A head chamber 141 is established at the left end, as viewed in FIG. 2, of valve assembly 124 and access is provided thereto through a closure cap 143 removably attached to the body 89 of the valve by suitable means and which forms one wall of the head chamber. A light compression spring 145 extends between closure cap 143 and the piston assembly 124 to urge the piston assembly towards the right, as

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viewed in FIG. 2, to the closed position shown. Head 125 is preferably recessed as at 147 to receive spring 145. A shoulder 149 provided on the outer end of head 125 is adapted to engage valve body 89 to limit rightward movement of the piston assembly 124 to stop the piston assembly in such a position that the by-pass valve 103 is completely closed off, as shown in the position in FIG. 2. A passage 151 communicates head chamber 141 with intermediate chamber 113, for a purpose later to be described. It will be noted that the effective areas on the remote ends of heads 125, 127 are of the same diameter, so that the pressures acting on the extreme ends of the valve assembly 124 are the only pressures that have an effect on the motion of the valve.

Speed setting and non-return valve 105 comprises a piston assembly 153 that includes a piston portion 155 preferably constructed similar to head 127 and slidably fitted in a cylindrical opening 157 which communicates between inlet chamber 111 and intermediate chamber 113. In FIG. 2 piston portion 155 is shown in the position in which the valve 105 is completely closed off and it will be understood that as the piston portion is moved to the right, flow will be permitted between the inlet chamber and the intermediate chamber. In addition, piston assembly 153 includes an enlarged piston portion 159 rigidly interconnected with piston portion 155 by a stem 161. Piston portion 159 is slidably fitted in a bore 163 in valve body 89 which is concentric with opening 157. Bore 163 is communicated adjacent one end with intermediate chamber 113 so that one side of piston portion 159 (the left side as viewed in FIG. 2) is exposed to the pressure of fluid in the intermediate chamber. On the other side of the piston portion 159 is a chamber 165, which chamber is defined by the end of the piston portion 159, the portion of bore 163 exposed by the piston portion, and a cover 167 removably attached to body 89 by suitable means, which cover closes off the end of bore 163. Chamber 165 communicates with inlet chamber 111 through a passage 169 in which is interposed, in series, a ball check valve 171 and an adjustable restricting needle valve 173. Ball check valve 171 permits flow through passage 169 towards chamber 165, but checks flow in the opposite direction. A washer 177 having an aperture 179 therethrough is held against the end of piston portion 159 by a compression spring 181, which spring extends between the washer and cover 167 to urge piston assembly 153 to the left, as viewed in FIG. 2, into a position in which the valve 105 is closed. A hollow stem 183 extends through the central bore of washer 177 and is fixed relative to the washer by the washer extending into the grooved end of stem 183. Stem 183 slidably extends through a bore 187 in cover 167 and passes through a passage 189 provided in the cover and thence the end of the stem slidably extends into the bore 191 of an adjusting screw 193 that is threadedly engaged in a threaded aperture in the cover. A slot 195 is provided in the end of hollow stem 183, which slot cooperates with adjusting screw 193 to provide a variable size opening 197 between the interior of stem 183 and passage 189. It will be understood that as stem 183 is moved to the right by movement of piston portion 159, opening 197 will be reduced in size until the passage is completely cut off between the interior of hollow stem 183 and passage 189. Also, it will be understood that adjustment of screw 193 to the left, as viewed in FIG. 2, will reduce opening 197 and make the cut-off point sooner, whereas adjustment of the screw to the right will increase opening 197 and make the cut-off point occur later in the travel of stem 183 to the right. A cover nut 199 is preferably provided over the end of screw 193, and washers 201 are preferably provided between the cover nut and cover 167. From stem 183, passage 189 leads through cover 167 and into body 89 where a normally closed solenoid valve 203 governs the flow therethrough, thence through a needle valve

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205, and through a passage 207 to intermediate chamber 113. When solenoid valve 203 is energized and opening 197 is open, discharge from chamber 165 is permitted through aperture 179, hollow stem 183, opening 197, passage 189, solenoid valve 203, needle valve 205, and passage 207. Another passage is provided for discharge from chamber 165 to intermediate chamber 113 through a passage 209 leading from bore 163 through valve body 89 to a solenoid valve 211 interposed in the passage 209, thence to needle valve 205 and passage 207 that it shares in common with the discharge from passage 89. Solenoid valve 211 is normally in a de-energized closed position and adapted to open when energized.

Reversing valve 107 includes a piston assembly 212, shown in detail in FIG. 3, acting in a cylindrical bore in body 89 and having five passages or chambers in order along its length, separated by cylindrical portions therebetween. Reading from left to right, as viewed in FIG. 2, the chambers or passages are in the following order: A first branch of intermediate chamber 113, second passage 123, first discharge chamber 117, first passage 121, and a second branch of intermediate chamber 113. Four ports are provided along the length of piston assembly 212 and they are, in order, reading from left to right as in FIG. 2: Port 212 between intermediate chamber 113 and second passage 123, port 215 between second passage 123 and first discharge chamber 117, port 217 between first passage 121 and first discharge chamber 117, and port 219 between intermediate chamber 113 and first passage 121. Piston assembly 212 is preferably spool-shaped and includes three enlarged spaced cylindrical piston portions 221, 223, and 225, in that order, reading from left to right in FIG. 3, rigidly interconnected by stem 227 extending between piston portions 221, 223, and stem 229 extending between piston portions 223 and 225. Chamber 231 and chamber 233 are respectively formed in body 89 at the opposite remote ends of piston assembly 212 so that the remote faces of piston portions 221 and 225 are exposed to the fluid pressure in the respective chambers. Chamber 233 is accessible by a cap 235 removably attached to body 89 by suitable means and forming one wall of the chamber 233. When piston assembly 212 is in the central position shown in FIG. 2, ports 213 and 219 are respectively blocked off by piston portions 221 and 225, and ports 215, 217 are blocked off by piston portion 223. Piston assembly 212 is urged to said central position by a pair of compression springs 237. Each of the inner ends of springs 237 are seated against a cupped washer 239 which is slidably mounted on a screw 241 extending through an aperture in the end of the cupped washer and stationarily fixed in threaded engagement in either the body 89 or cap 235. The inward movement of cupped washers 239 towards one another is limited by the respective engagement of the washers with the heads 243 of screws 241. The screws 241 are adjusted so that when piston assembly 212 is in said central position, springs 237 are barely able to reach it in this position. When piston assembly 212 is deflected by any means, one of the springs 237 will be compressed and will tend to return the piston assembly to the central position. Chambers 231, 233 are each in communication with intermediate chamber 113 through restricted drill ports 245, 247. Each of chambers 231, 233 may also be placed in communication with second discharge chamber 119 through passages 249 and 251 when solenoid valves 253 and 255 are energized. Solenoid valves 253, 255 respectively control the flow of fluid through passages 249, 251 and when de-energized close off the flow therethrough and when energized permit flow through the passages. Also, passages 249, 251 are respectively larger than drill ports 245, 247. When piston assembly 212 is in said central position restricted communication is provided between intermediate chamber 113 and first discharge chamber 117 through the

following means, shown in FIGURE 3: Radial drill ports 257 provided in piston portion 221 and communicating with a central bore 259 provided centrally of piston assembly 212, which bore is closed by a plug 261, and through drill ports 253 provided in piston portion 223 and communicating between central bore 259 and first discharge chamber 117.

Back pressure valve 109 includes a piston assembly 265 including piston portions 267, 269 rigidly interconnected by a stem 271. Piston portions 267, 269 are each respectively mounted in spaced apart bores 273, 275 to control the fluid flow between first discharge chamber 117 and the respective branches of second discharge chamber 119. Back pressure valve 109 is balanced in substantially the same manner as the by-pass control valve 103 so that when the piston assembly 265 is moved to the left by means to be hereinafter described the fluid flows in opposite directions through bores 273, 275 so that the valve is unaffected by changes in rate of fluid flow. Piston assembly 265 additionally includes a positioning piston 277 rigidly interconnected with piston portion 269 by means of a stem 279. Positioning piston 277 is slidably fitted in a bore 281 provided in body 89 and communicated adjacent one side of the positioning piston with second discharge chamber 119 and establishing on the other side of the positioning piston a chamber 283 which is in communication with intermediate chamber 113 through a passage 285. The opposite end of piston assembly 265 from positioning piston 277 is acted upon by a compression spring 287 which extends between the end of the piston assembly and a cover plate 289 removably attached to body 89. Spring 287 urges piston assembly 265 to the right as viewed in FIG. 2 to the closed position shown in this figure.

In the description of the operation of subject invention, let it be assumed that flow of fluid through conduit 55 towards motor 25 and return through conduit 57 will rotate motor 25 in such a direction as to raise elevator car 11, pump 69, if it is not already in operation, will be put into operation by energizing motor 71. Solenoid valves 211 and 253 will also be energized at this time through suitable well-known circuits, not shown in the drawings. If pump 69 has not previously been in operation, the fluid entering inlet chamber 111 will push assembly 124 to the left by acting on the end of head 127. This movement is possible since head chamber 141 is drained through passage 151 to intermediate chamber 113, which in turn has been drained to a low value through drill ports 257, central bore 259 and drill ports 263 to first discharge chamber 117, which in turn drains out through back pressure valve 109 to second discharge chamber 119 and thence to discharge conduit 91. Although back pressure valve 109 is shown in the closed position it will be understood that if there had previously existed a high pressure in intermediate chamber 113, this high pressure acting through passage 285 on piston 277 would have opened the back pressure valve 109 until the pressure lowered, at which time the back pressure valve would have closed. Draining of head chamber 141, as above described, allows by-pass control valve 103 to open fully and allow the hydraulic fluid to return directly to the reservoir 79 through discharge conduit 91. It will be understood, of course, that if pump 69 had been previously in operation, the hydraulic fluid would have already been returning directly to reservoir 79 through valve 103 and discharge conduit 91. A small pressure corresponding to the tension of spring 145 will be generated in inlet chamber 111. This pressure will also be applied to the effective area of piston portion 155, which would be unable to yield to this pressure because of the accumulation of pressure in chamber 165. However, the opening of solenoid valve 211 provides a drain for this pressure to intermediate

chamber 113, so that piston assembly 153 is enabled to move slowly to the right, as viewed in FIG. 2, and piston portion 155 opens the passage from inlet chamber 111 to intermediate chamber 113. Pressure in chamber 113 reaches chambers 231 and 233 through restricted passages 245 and 247. However, only chamber 231 will be able to build up pressure, as the operation of solenoid valve 255 drains away fluid from chamber 233 through passage 251 to second discharge chamber 119 faster than it can enter. The pressure rise will therefore operate on the left-hand end of piston portion 221 and cause piston assembly 212 to shift to the right, as viewed in FIG. 2, to a position in which piston portion 225 unblocks port 219 to permit fluid from intermediate chamber 113 through port 219 and conduit 55 towards motor 25, and at the same time piston portion 223 unblocks port 215 to permit return flow from conduit 57 through port 217 to first discharge chamber 117.

At this point the question must be examined as to whether the load in the elevator car 11 is less than or greater than the weight of counterweight 19. First, for the purpose of illustration, let us assume that it is greater, so that a net lifting effect will be required to move the elevator car 11 upward. In this case, piston assembly 153 will not be able to move until the pressure in inlet chamber 111 exceeds the pressure in intermediate chamber 113. This is because the area of enlarged piston portion 159 is greater than piston portion 155 and the right-hand side of piston portion 159 is acted upon by the pressure in chamber 165 which is substantially the same as that in intermediate chamber 113, which in turn is greater than the pressure in inlet chamber 111 that acts on the smaller effective area of piston portion 155. Since the pressure in intermediate chamber 113 is admitted to head chamber 141 through passage 151 to the left of head 125, it will assist spring 145 in moving valve assembly 124 to the right, restricting the by-pass flow, and causing pressure in inlet chamber 111 to rise as necessary. When the pressure in inlet chamber 111 exceeds the pressure in intermediate chamber 113, piston assembly 153 will shift, as previously explained, to the right, as viewed in FIG. 2, and admit fluid to move hydraulic motor 25 and elevator car 11 therethrough. This increased back pressure will also pass through valve 93, which must be energized by suitable means, not shown, when it is desired to move the elevator car 11, admitting pressure from conduit 83 to conduit 53 and lifting piston rod 47 so as to release friction shoes 27, 29 and allow shaft 21 to rotate as driven by motor 25. Valve 105 will continue to open until it reaches its fully open position, providing free passage of fluid from inlet chamber 111 to intermediate chamber 113 and therethrough to conduit 55. This pressure from intermediate chamber 113 acting in head chamber 141 to the right, as viewed in FIG. 2, in conjunction with the force of spring 145 will cause complete closure of valve 103 to the position shown. At this time elevator car 11 will move at full speed. It must be observed that the back pressure valve 109 is also caused to open fully. This is accomplished by pressure from intermediate chamber 113 entering chamber 283 and overcoming the relatively light bias of spring 287 to urge piston assembly 265 to its open position, so that valve 109 will allow fluid returning from conduit 57 to pass through port 215, first discharge chamber 117, open valve 109, second discharge chamber 119, and discharge conduit 91 to the reservoir 79. If the previously made assumption does not hold, and the weight of elevator car 11 with its load is less than the weight of counterweight 19, there will be a tendency for traction sheave 15 to turn, in the forward direction (i.e. clockwise in FIG. 1), faster than the fluid flow would compel. When the term "overhauling load" is used it will be understood to mean this condition hereinabove described. Back pressure valve 109 is provided to prevent uncon-

trolled motion in this case of an overhauling load by insuring that there will be a positive pressure in intermediate chamber 113 before the back pressure valve can open and discharge pressure from discharge passage 115. It may be seen that with such an overhauling load, the hydraulic motor 25 will generate pressure at its discharge higher than that at its inlet, and that as reversing valve 107 opens, this higher pressure will be communicated to first discharge chamber 117. However, it cannot find an outlet from this chamber 117 because of the valve 109 being in the closed position. Only when the pressure in intermediate chamber 113 rises to a sufficiently high value can it overcome the bias of spring 287 and open valve 107, and then it will open only to such a degree as will maintain this pressure in intermediate chamber 113. It may therefore be seen that the pump 69 will be obliged to generate this minimum pressure at all times, even though no pressure at all is required to cause the elevator car 11 to move in the desired direction.

When it is desired to cause the elevator car 11 to move in the lowering direction, valve 253 is energized instead of valve 255. This bleeds pressure out of chamber 231 while pressure is allowed to accumulate in chamber 233, and piston assembly 212 consequently moves to the left, as viewed in FIG. 2, to a position in which piston portion 221 unblocks port 213 and in which piston portion 223 unblocks port 217, thereby opening communication between intermediate chamber 113 and conduit 57 to permit fluid to flow towards motor 25 through conduit 57, and opening communication between conduit 55 and discharge passage 115 to permit fluid to flow from the motor through valve 59 and discharge conduit 91 to reservoir 79. Thus, motor 25 is caused to rotate in a counterclockwise direction, which in turn causes sheave 15 to rotate counterclockwise and lower elevator car 11.

To cause elevator car 11 to slow to a low speed, for the sake of making accurate stops when approaching landings, slow-speed solenoid valve 203 is energized in place of high-speed solenoid valve 211. When the solenoid valve 203 is first energized opening 197 will be closed off, since stem 183 has been pushed to the right, as viewed in FIG. 2, by the piston assembly 153 when the elevator car 11 is traveling at a fast speed. Thus, at this point there is no escape of fluid from chamber 165. Piston assembly 153 begins to move to the left, as viewed in FIG. 2, under fluid pressure entering through passage 169 past needle valve 173, and it serves to throttle the flow between inlet chamber 111 and intermediate chamber 113. This tends to increase the pressure differential therebetween and since the pressure from inlet chamber 111 is applied to the right-hand end, as viewed in FIG. 2, of piston assembly 124, while the pressure in intermediate chamber 113 is applied to the left-hand end, piston assembly 124 will move to the left and open the passageway of fluid from the inlet chamber to the discharge chamber 115 to prevent this difference exceeding a fixed amount corresponding to the tension of spring 145. As piston assembly 153 moves to the left, opening 197 will begin to open and piston assembly 153 will come to rest when the size of opening 197 is just adequate to discharge the fluid entering through passage 169. This condition defines a definite partly open position for valve 105 which may be adjusted by moving screw 193, as required. Therefore, when valve 105 is open only to a definite limited degree, the greater part of the fixed discharge from pump 69 entering inlet chamber 111 will be by-passed through valve 103 to the reservoir 79, and only that passing through a fixed reduced opening through valve 105 is sent to the hydraulic motor 25. Since this is at a fixed pressure differential, as previously described, the amount of this reduced flow is also fixed, and establishes the slow or leveling speed of the elevator car 11. The transition

between the high rate and the low rate depends on the rate of the closing of valve 105, which is established by the setting of needle valve 173. Therefore, the transition in speed from full speed to the reduced or leveling speed may be made smoothly under control of this adjustment needle valve 173.

When a stop of elevator car 11 is desired, any of the solenoid valves 93, 203, 211, 253, and 255, which are energized, are de-energized at this time. It is preferable, however, that solenoid valve 93, controlling the brake 24, be governed by a time-delay action so that other functions of the system described will bring the elevator car 11 to a halt before brake 24 is applied. Release of solenoid valves 203 and 211 removes all means of draining fluid from chamber 165, so that fluid admitted under pressure from inlet chamber 111 entering through passage 169 can accumulate in chamber 165 and force piston assembly 153 to the left, as viewed in FIG. 2, gradually to a closed position of valve 105. As valve 105 closes, pressure in intermediate chamber 113 will fall while that in inlet chamber 111 will continue to rise, acting on valve 193 to open the by-pass more fully. At the same time, release of the valves 253 or 255 will remove the drain from either end of piston assembly 212 and allow this piston assembly to move to said central position shown in FIG. 2 at which it blocks all ports, i.e. 213, 215, 217 and 219. Loss of pressure through passage 285 to chamber 283 will likewise remove the pressure that has been holding valve 109 in the open position and this latter valve will also close to block exit of the fluid. These actions reduce the fluid flow in conduits 55 and 57 substantially to zero, bringing hydraulic motor 25 to a halt and holding the elevator car 11 regardless of any brake application. When solenoid valve 93 is released, conduit 53 will be put into communication with discharge conduit 91 to allow jack 49 to retract and release shoes 27, 29 so that they may securely hold brake wheel 23 under the pressure of spring 37.

From the foregoing it will be understood that unique and novel means have been provided to give complete control of quantity and direction of flow to a hydraulic motor used to move a traction type elevator at all speeds from zero to maximum in either direction, deriving the energy from a constantly operated constant volume source of hydraulic fluid pressure. Actually, of course, the source of fluid pressure may be shut down during periods of inactivity, but it is not contemplated that it will be started for each individual motion of elevator car 11. This control has been accomplished by means that are relatively simple and reliable which eliminate the use of intricate and numerous electrical components heretofore employed. It will be further understood that in a hydraulic system a control valve assembly is provided for regulating flow therefrom, reversing the direction thereof, by-passing the surplus hydraulic fluid to a reservoir, and regulating the maximum pressures in the system. In addition, it will be understood that a unique means is provided for insuring that a hydraulic motor cannot "run away" from its supply source. Also, a unique means is provided by the use of a three-position speed setting valve in connection with the by-pass so that a definite portion of the hydraulic fluid may pass through the speed setting valve and the remainder be by-passed without substantial increase in the pressure of the fluid.

Although the invention has been described and illustrated with respect to a preferred embodiment thereof, it is to be understood that it is not to be so limited since changes and modifications may be made therein which are within the full intended scope of this invention as herein-after claimed.

I claim:

1. In a hydraulic elevator system of the type having an elevator car and having means including rotatable means adapted to be driven in opposite directions for respectively raising and lowering said elevator car, a hydraulic motor adapted to be selectively driven in one of two directions

in response to the flow of hydraulic fluid therethrough and having a pair of connections for receiving and discharging said fluid, means coupling said hydraulic motor to said rotatable means to selectively raise and lower said elevator car, and a constant displacement hydraulic pump for supplying said fluid to said motor, the combination therewith of means for controlling the delivery of said fluid to said pump, comprising means establishing an inlet chamber, conduit means communicating said pump and said inlet chamber to supply said hydraulic fluid under pressure to said inlet chamber, means establishing an intermediate chamber, speed setting valve means disposed between said inlet chamber and said intermediate chamber for selectively controlling the flow of said fluid from said inlet chamber to said intermediate chamber, a first conduit means connected to said hydraulic motor at one of said connections thereof, a second conduit means connected to said hydraulic motor at the other of said connections thereof, means establishing a discharge passage, reversing valve means selectively movable between a first position and a second position, when in said first position said reversing valve means communicating said first conduit means with said intermediate chamber and said second conduit means with said discharge passage for driving said hydraulic motor in a first direction to raise said elevator car, when in said second position said reversing valve means communicating said second conduit means with said intermediate chamber and said first conduit means with said discharge passage for driving said hydraulic motor in an opposite direction to lower said elevator car.

2. The structure according to claim 1 including back pressure valve means in said discharge passage for restricting the discharge of fluid responsive to an overhauling condition of said hydraulic motor, so that said elevator will be prevented from running away from said pump.

3. The structure according to claim 1 including back pressure valve means in said discharge passage responsive to pressure in said intermediate chamber so that the discharge of fluid is controlled to maintain the fluid pressure in said intermediate chamber no lower than a given minimum amount.

4. In a hydraulic elevator system of the type having an elevator car suspended from cables leading over a sheave adapted to be driven in opposite directions for respectively raising and lowering said elevator car, a hydraulic motor adapted to be selectively driven in one of two directions in response to the flow of hydraulic fluid therethrough and having connections for receiving and discharging said fluid, means coupling said hydraulic motor to said sheave to selectively raise and lower said elevator car, and a constant displacement hydraulic pump for supplying said fluid to said motor, the combination therewith of a valve for controlling the flow to and from said hydraulic motor to control the raising and lowering of said elevator car, said valve comprising means establishing an inlet chamber, conduit means communicating said pump and said inlet chamber to supply said hydraulic fluid under pressure to said inlet chamber, means establishing an intermediate chamber, speed setting valve means disposed between said inlet chamber and said intermediate chamber for selectively controlling the flow from said inlet chamber to said intermediate chamber, said speed setting valve means including means responsive to the operation thereof to establish a partially opened condition having a definite opening size, by-pass valve means communicating with said inlet chamber and said intermediate chamber and responsive to pressure difference between said inlet chamber and said intermediate chamber for bypassing fluid from said inlet chamber to maintain the pressure difference between said inlet chamber and said intermediate chamber substantially constant when said speed setting valve means is in said partially opened condition whereby the flow through said speed setting valve when in said partially opened condition is substantially constant,

a first conduit means connected to said hydraulic motor at one of said connections thereof, a second conduit means connected to said hydraulic motor at the other of said connections thereof, means establishing a discharge passage, reversing valve means selectively movable between a first position and a second position, when in said first position said reversing valve means communicating said first conduit means with said intermediate chamber and said second conduit means with said discharge passage for driving said hydraulic motor in a first direction to raise said elevator car, when in said second position said reversing valve means communicating said second conduit means with said intermediate chamber and said first conduit means with said discharge passage for driving said hydraulic motor in an opposite direction to lower said elevator car.

5. The structure according to claim 4 in which said speed setting valve includes a piston portion, and in which said means for opening said speed setting valve to a partially open condition comprises an enlarged positioning piston coupled to said piston portion, means establishing a first chamber exposed to said positioning piston on one side thereof and said positioning piston being exposed adjacent the opposite side thereof to said intermediate chamber, means establishing restricted flow of fluid from said inlet chamber to said first chamber, passage means for establishing flow of fluid from said first chamber to said intermediate chamber, said passage means including means establishing an opening variable in size in accordance with the position of said piston portion and said positioning piston so that when the flow of fluid out of said first chamber is equal to the flow of fluid therinto said positioning piston holds said piston portion at said partial opening of said speed setting valve.

6. In a hydraulic elevator system of the type having an elevator car suspended from cables leading over a sheave adapted to be driven in opposite directions for respectively raising and lowering said elevator car, a hydraulic motor adapted to be selectively driven in one of two directions in response to the flow of hydraulic fluid therethrough and having connections for receiving and discharging fluid, means coupling said hydraulic motor to said sheave to selectively raise and lower said elevator car, and a constant displacement hydraulic pump for supplying said fluid to said motor, the combination therewith of a valve for controlling the flow to and from said hydraulic motor to control the raising and lowering of said elevator car, said valve comprising means establishing an inlet chamber, conduit means communicating said pump and said inlet chamber to supply said hydraulic fluid under pressure to said inlet chamber, means establishing an intermediate chamber, speed setting valve means disposed between said inlet chamber and said intermediate chamber for selectively controlling the flow from said inlet chamber to said intermediate chamber, said speed setting valve means including means responsive to the operation thereof to establish a partially opened condition having a definite opening size, by-pass valve means communicating with said inlet chamber and said intermediate chamber and responsive to pressure difference between said inlet chamber and said intermediate chamber for bypassing fluid from said inlet chamber to maintain the pressure difference between said inlet chamber and said intermediate chamber substantially constant when said speed setting valve means is in said partially opened condition whereby the flow through said speed setting valve when in said partially opened condition is substantially constant, and means controlling the delivery of fluid from said intermediate chamber to said motor for controlling the drive thereof.

7. The structure according to claim 6 including brake means coupled to said sheave, said brake means being normally effective to hold said sheave in a stopped position, and said brake means being operable to release said sheave in response to hydraulic pressure from said pump sufficient to run said elevator car.

8. The structure according to claim 6 in which said speed setting valve includes a piston portion, and in which said means for opening said speed setting valve to a partially open condition comprises an enlarged positioning piston coupled to said piston portion, means establishing a first chamber exposed to said positioning piston on one side thereof and said positioning piston being exposed adjacent the opposite side thereof to said intermediate chamber, means establishing restricted flow of fluid from said inlet chamber to said first chamber, passage means for establishing flow of fluid from said first chamber to said intermediate chamber, said passage means including means establishing an opening variable in size in accordance with the position of said piston portion and said positioning piston so that when the flow of fluid out of said first chamber is equal to the flow of fluid therinto said positioning piston holds said piston portion at said partial opening of said speed setting valve.

9. In a hydraulic elevator system having a constant volume source of hydraulic fluid pressure and a constant displacement hydraulic motor adapted to be selectively driven in one of two directions in response to the flow of hydraulic fluid therethrough for driving an elevator car and having conduit means including first and second conduits for selectively conducting hydraulic fluid to and from said constant volume source and conducting said fluid to and from said hydraulic motor, the combination therewith of means establishing first passage means in communication with said source of hydraulic fluid pressure, means establishing a discharge passage, speed setting valve means disposed in said first passage means, by-pass valve means disposed in said first passage means upstream of said speed setting valve means to by-pass portions of fluid from said speed setting valve and operating in conjunction with said speed setting valve to control the fluid flow through said speed setting valve, reversing valve means interposed in said first passage means downstream of said speed setting valve, said discharge passage leading from said reversing valve means, means operably coupled to said reversing valve means for the positioning thereof in a selected one of first, second and third positions, when in said first position said reversing valve communicating said first passage means with said first conduit for driving said hydraulic motor in a first of said two directions and communicating said second conduit with said discharge passage for discharging the fluid from said hydraulic motor, when in said second position said reversing valve communicating said first passage means with said second conduit for driving said hydraulic motor in the opposite of said two directions and communicating said first conduit with said discharge passage for discharging the fluid from said hydraulic motor, and when in said third position said reversing valve blocking off all flow through said first passage and said discharge passage to stop said hydraulic motor, and back pressure valve means in said discharge passage for restricting the discharge of fluid responsive to an overhauling condition of said hydraulic motor so that said hydraulic motor will be prevented from running away from said constant volume source.

10. In a hydraulic elevator system having a constant volume source of hydraulic fluid pressure and a constant

displacement hydraulic motor adapted to be selectively driven in one of two directions in response to the flow of hydraulic fluid therethrough for driving an elevator car and having conduit means including first and second conduits for selectively conducting hydraulic fluid to and from said constant volume source and conducting said fluid to and from said hydraulic motor, the combination therewith of means establishing first passage means in communication with said source of hydraulic fluid pressure, means establishing a discharge passage, speed setting valve means disposed in said first passage means, by-pass valve means disposed in said first passage means upstream of said speed setting valve means to by-pass portions of fluid from said speed setting valve and operating in conjunction with said speed setting valve to control the fluid flow through said speed setting valve, reversing valve means interposed in said first passage means downstream of said speed setting valve, said discharge passage leading from said reversing valve means, means operably coupled to said reversing valve means for the positioning thereof in a selected one of first, second and third positions, when in said first position said reversing valve communicating said first passage means with said first conduit for driving said hydraulic motor in a first of said two directions and communicating said second conduit with said discharge passage for discharging the fluid from said hydraulic motor, when in said second position said reversing valve communicating said first passage means with said second conduit for driving said hydraulic motor in the opposite of said two directions and communicating said first conduit with said discharge passage for discharging the fluid from said hydraulic motor, and when in said third position said reversing valve blocking off all flow through said first passage and said discharge passage to stop said hydraulic motor.

11. The structure according to claim 10 in which said reversing valve means includes a piston assembly having opposite end faces, and in which said means for positioning said reversing valve means comprises means establishing a pair of chambers respectively exposed to opposite end faces of said piston assembly, means for respectively introducing restricted flow of fluid under pressure to each of said pair of chambers, a pair of resilient means respectively positioned in respective chambers and acting on opposite faces of said piston assembly to urge said piston assembly inwardly towards said third position, means respectively limiting inward movement of said resilient means so that when said piston assembly is in said third position said resilient means barely touches the faces of said piston assembly, and means for selectively draining one of said pair of chambers so that the fluid pressure in the other of said chambers is effective to move said piston assembly against the one of said resilient means in the drained chamber and into a selected one of said first or second positions.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,120,880

February 11, 1964

Lawrence F. Jaseph

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 12, for "89" read -- 189 --; line 25, for "Port 212" read -- Port 213 --; column 7, line 5, for "253" read -- 263 --; column 8, line 14, after "fluid" insert -- flow --; line 43, for "therethrough" read -- therewith --.

Signed and sealed this 23rd day of June 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents