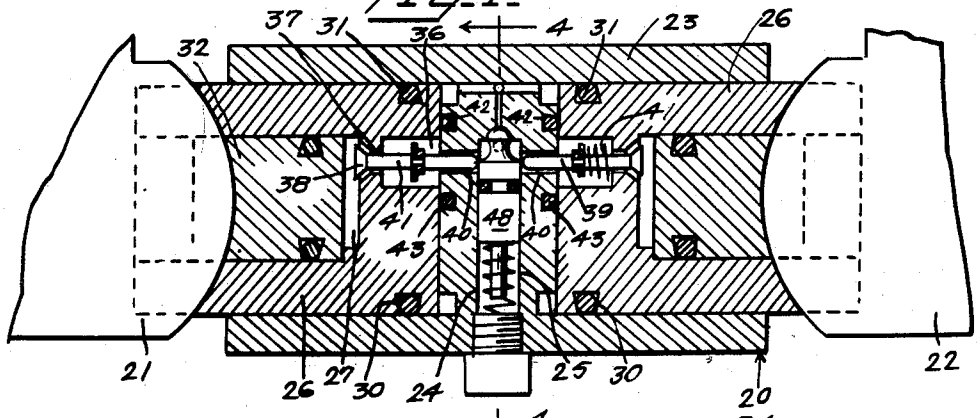
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HYDRAULIC SYSTEM

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FIG. 1.



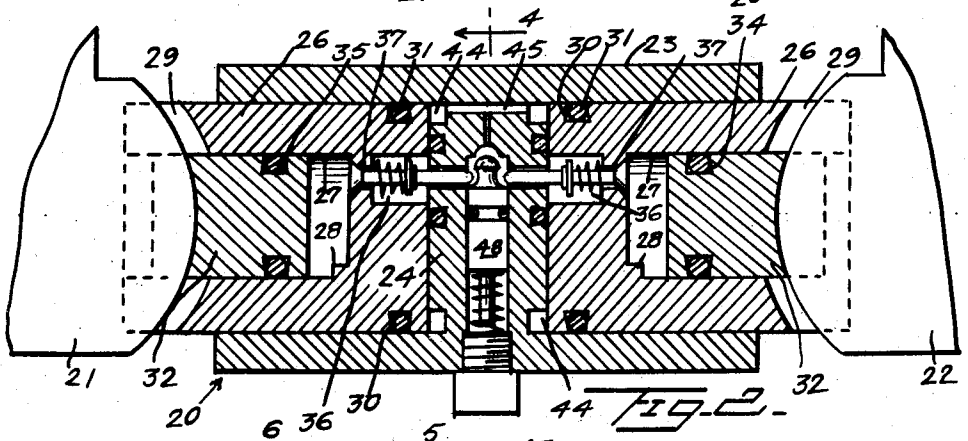


FIG. 2.

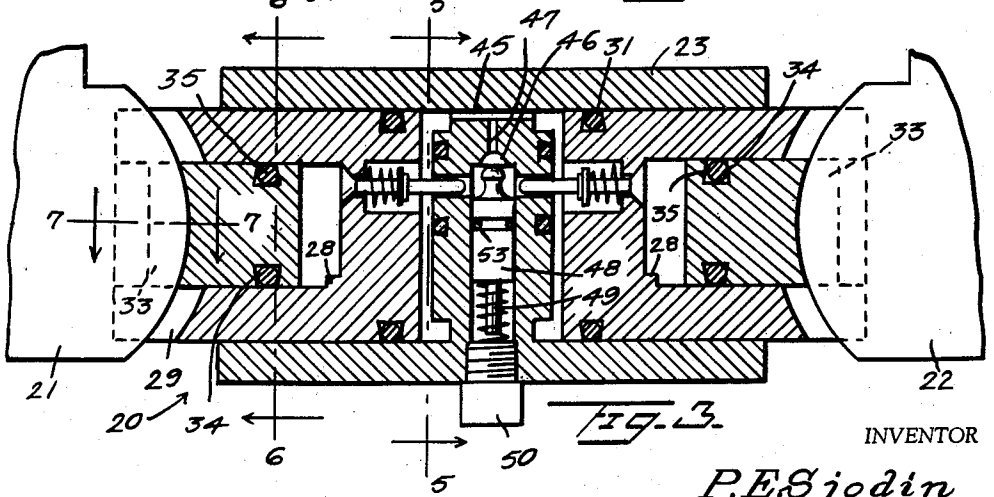


FIG. 3.

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HYDRAULIC SYSTEM

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Fig. 4

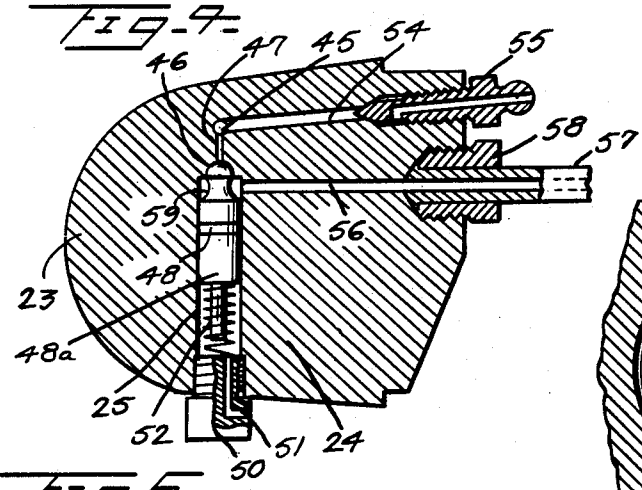


Fig. 5

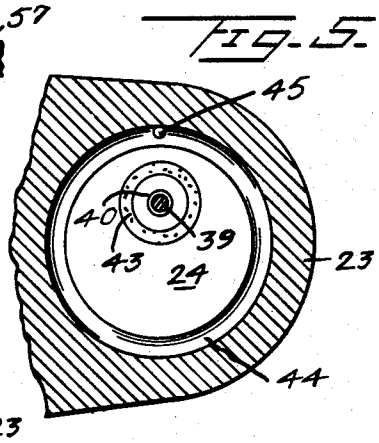


Fig. 6

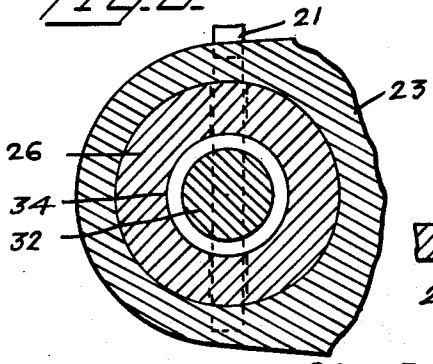


Fig. 7

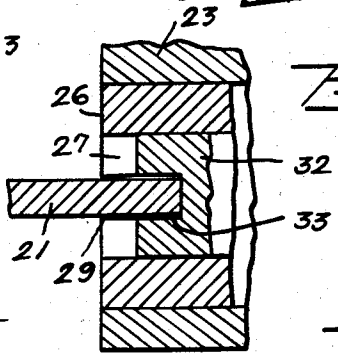


Fig. 8

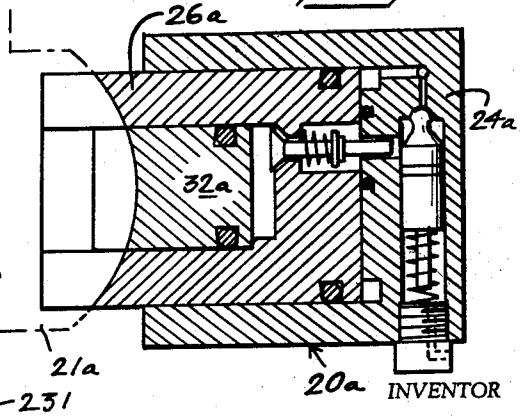


Fig. 10

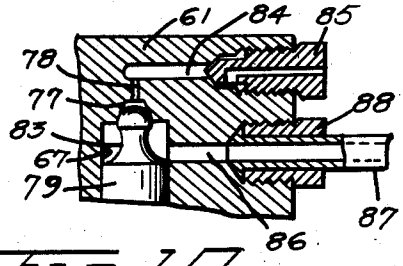
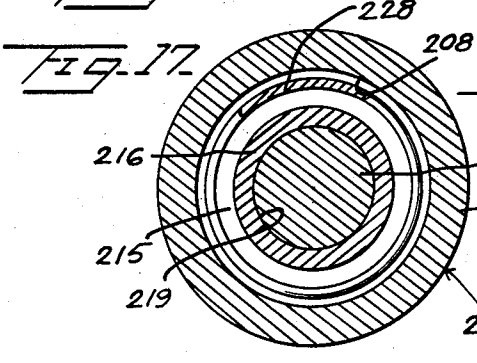


Fig. 17



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Fig. 9.

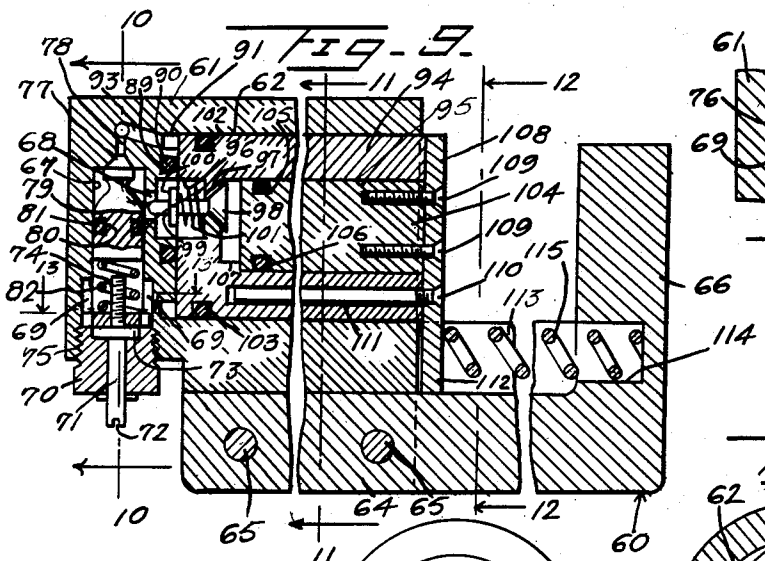


Fig. 13.

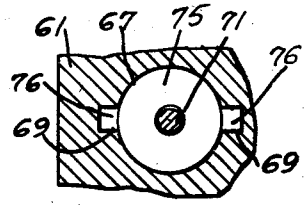


Fig. 12.

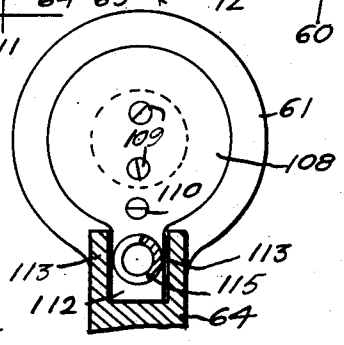


Fig. 11.

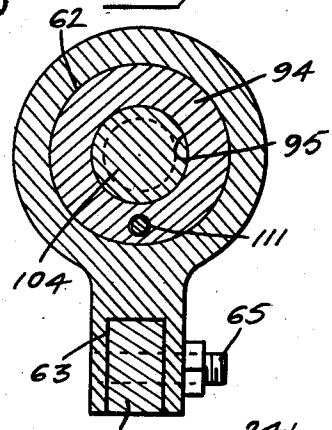
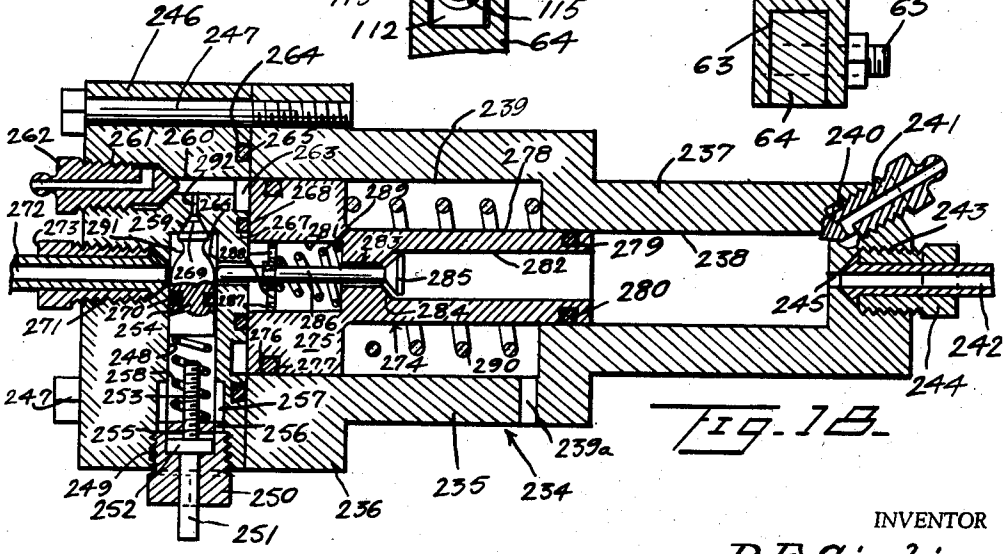


Fig. 10.



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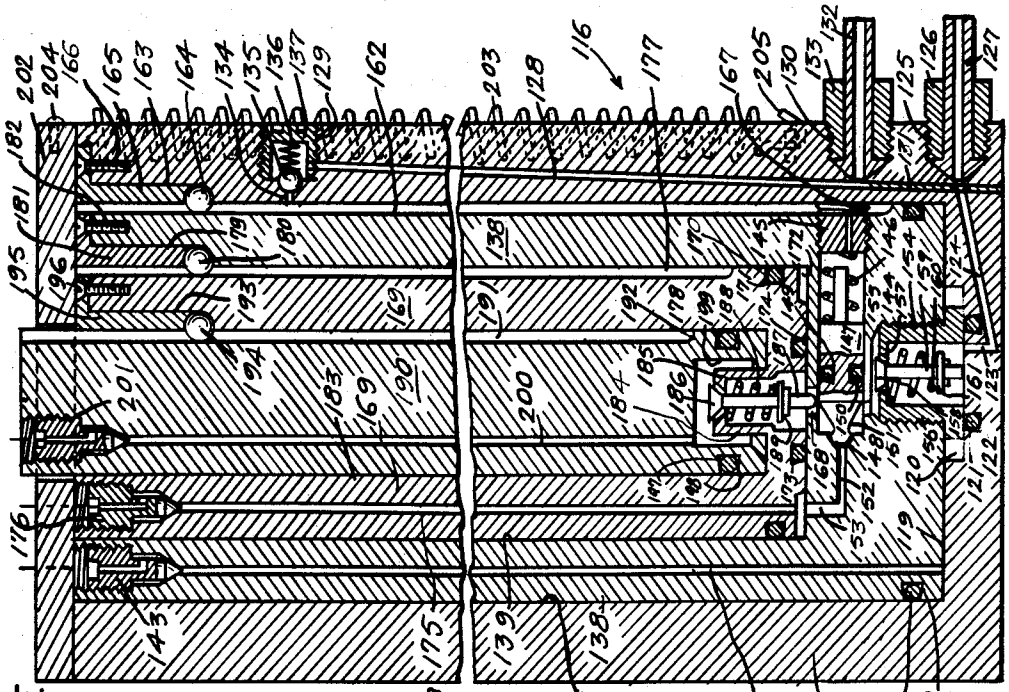
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HYDRAULIC SYSTEM

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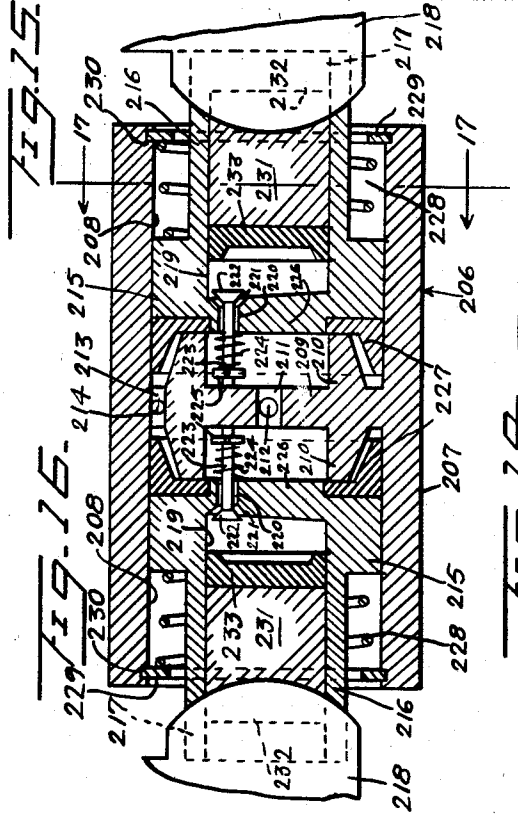


FIG. 1S

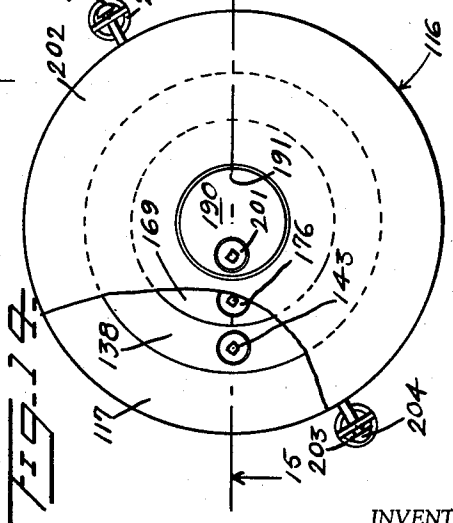


FIG. 1T

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United States Patent Office

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HYDRAULIC SYSTEM

Peter E. Sjodin, Houston, Tex.

Application November 19, 1957, Serial No. 697,357

5 Claims. (Cl. 60—97)

The present invention relates to hydraulic systems, and more particularly to hydraulic systems having pressure intensifying means associated therewith.

The primary object of the invention is to provide a hydraulic system in which the pressure responsive means moves rapidly to working position and then moves more slowly with increased power while performing the work operation.

Another object of the invention is to provide a hydraulic system of the class described above in which the pressure responsive device is automatically shifted from fast moving to slow moving operation.

A further object of the invention is to provide a hydraulic system of the class described above which is inexpensive to manufacture, simple to use, and which is completely effective in its action.

Other objects and advantages will become apparent in the following specification when considered in the light of the attached drawings, in which:

Figure 1 is a vertical cross-section taken through the preferred form of the invention illustrating one position thereof.

Figure 2 is a view similar to Figure 1, illustrating another position of the invention.

Figure 3 is a view similar to Figure 1, illustrating still another position of the invention.

Figure 4 is a transverse cross-section taken along the line 4—4 of Figure 1, looking in the direction of the arrows.

Figure 5 is a transverse cross-section taken along the line 5—5 of Figure 3, looking in the direction of the arrows.

Figure 6 is a transverse cross-section taken along the line 6—6 of Figure 3, looking in the direction of the arrows.

Figure 7 is an enlarged fragmentary horizontal cross-section taken along the line 7—7 of Figure 3, looking in the direction of the arrows.

Figure 8 is a vertical cross-section taken through a modified form of the invention.

Figure 9 is a vertical cross-section taken through another modified form of the invention.

Figure 10 is an enlarged fragmentary transverse cross-section taken along the line 10—10 of Figure 9, looking in the direction of the arrows.

Figure 11 is a transverse cross-section taken along the line 11—11 of Figure 9, looking in the direction of the arrows.

Figure 12 is a fragmentary transverse cross-section taken along the line 12—12 of Figure 9, looking in the direction of the arrows.

Figure 13 is an enlarged fragmentary horizontal cross-section taken along the line 13—13 of Figure 9, looking in the direction of the arrows.

Figure 14 is a top plan view of another modified form of the invention shown partially broken away for convenience of illustration.

Figure 15 is an enlarged fragmentary vertical cross-

section taken along the line 15—15 of Figure 14, looking in the direction of the arrows.

Figure 16 is a vertical cross-section taken through another modified form of the invention.

Figure 17 is a transverse cross-section taken along the line 17—17 of Figure 16, looking in the direction of the arrows.

Figure 18 is a vertical cross-section taken through another modified form of the invention.

Referring now to the drawings in detail wherein like reference characters indicate like parts through the several figures, and particularly to Figures 1 through 7, wherein the preferred embodiment of the invention is illustrated, the reference numeral 20 indicates generally a hydraulic pressure responsive device functioning as a wheel cylinder to press brake shoes 21 and 22 outwardly against a brake drum (not shown).

The pressure responsive device 20 includes an elongated tubular cylindrical body 23 having a central partition 24 positioned therein intermediate the opposite ends thereof. The partition 24 is formed integrally with the body 23 and has a transversely extending bore 25 extending therein.

A cylindrical piston 26 is slidably positioned in one end of the tubular body and an identical cylindrical piston 26 is slidably positioned in the opposite end of the body 23. The pistons 26 each have an axial bore 27 extending therein from the outer end thereof. A boss 28 is formed at the inner end of the bore 27 for reasons to be assigned.

The pistons 26 are each provided with a vertically extending slot 29 to engage over the free end of the brake shoes 21, 22. The pistons 26 are provided with an annular groove 30 adjacent the inner ends thereof in which is positioned a sealing ring 31 formed of resilient material.

A cylindrical piston 32 is positioned in the bore 27 for sliding movement therein and has the outer end thereof provided with a vertical slot 33 for engaging over the free ends of the brake shoes 21, 22. The piston 32 has an annular groove 34 formed therein adjacent the inner end thereof and having a resilient sealing ring 35 seated therein.

A bore 36 extends into the end of the piston 26 opposite the bore 27 at a position radially offset with respect to the center of the piston 26. A valve port 37 communicates the bore 27 with the bore 36, as can be best seen in Figure 1.

The piston 32 is limited in its inward movement in the bore 27 by the boss 28 to provide a space between the inner end of the bore 27 and the inner end of the piston 32.

A valve 38 is provided with an elongated stem 39 and is arranged to close the valve port 37 with the stem 39 extending through the bore 36 and into a bore 40 formed in the partition 24 in axial alignment with the bore 36. The bores 40 on each side of the partition 24 communicate with the bore 25 arranged centrally therein. Coil springs 41 are secured to the valve stems 39 to normally bias the valve 38 into closed position with respect to the valve ports 37.

A circular groove 42 is formed on each side of the partition 24 in surrounding relation to the bore 40 and has a sealing O ring 43 seated therein for sealing contact with the inner end of the piston 26 in the area immediately surrounding the bore 36.

Each side of the partition 24 is provided with an annular groove 44 adjacent the body 23, for reasons to be assigned. A bore 45 extends between the grooves 44 to provide communication therebetween. The inner end of the bore 25 is provided with a valve seat 46 and has a

bore 47 opening therethrough communicating with the bore 45.

A cylindrical valve plug 48 is slidably arranged in the bore 25 and has a shank 49 extending outwardly therefrom. A plug 50 is threaded into the outer end of the bore 25 and has a vent opening 51 extending therethrough.

A coil spring 52 engages against the valve plug 48 surrounding the shank 49 at one end and has its opposite end engaging against the plug 50 so as to normally urge the valve plug 48 into sealing engagement with the valve seat 46. The valve plug 48 has an annular groove 53 formed therein for holding a sealing O ring 48*a* in contact with the walls of the bore 25.

A bore 54 extends perpendicularly from the bore 45 and has its outer end closed by a conventional bleeder valve 55. A bore 56 extends transversely of the bore 25 adjacent the valve seat 46 and has a hydraulic line 57 coupled to the outer end thereof by a fitting 58.

The inner end portion of the valve plug 48 is provided with an annular groove 59 to permit the valve stems 39 to extend into the bore 25 when in their innermost position, as illustrated in Figure 2.

In the use and operation of the invention, as illustrated in Figures 1 through 7, hydraulic pressure from a master cylinder (not shown) is exerted through the conduit 57 and hydraulic fluid flows into the bore 56. The fluid in the bore 56 enters the bore 25 and flows outwardly through the bores 40 into the bores 36 and through the valve port 37 into the bores 27.

Hydraulic pressure in the bore 27 moves the piston 32 outwardly in the piston 26 to move the brake shoes 21 and 22 into initial contact with the brake drum (not shown). As the hydraulic pressures increase in the bore 25 due to the increased brake pedal pressure, as well as the cessation of movement of the piston 32, the valve plug 48 is moved rapidly downwardly off of the valve seat 46 aligning the annular groove 59 with the stems 39 of the valves 38 so that the springs 41 can quickly close the valves 38 trapping the hydraulic fluid in the bore 27 so as to lock the pistons 32 in their extended position.

After the valve plug 48 has moved away from the seat 46, hydraulic pressure will move through bore 47 which is of restricted size, and outwardly through bore 45 to the annular groove 44 into contact with the inner end of the pistons 26. The pistons 26 having a larger area than the pistons 32 will move the brake shoes 21 and 22 with greatly increased power, but due to the limited movement required will use only a small amount of hydraulic fluid.

On releasing the brake pedal, the shoes 21 and 22 are pulled inwardly by the springs (not shown) forcing the pistons 26 inwardly toward their retracted position. The spring 52 will move the valve plug 48 upwardly in the bore 25 seating in the valve seat 46, and simultaneously moving the groove 59 out of registry with the stems 39 so that as the pistons 26 move inwardly the stems 39 will unseat the valves 38 and release the hydraulic fluid trapped between the piston 32 and the piston 26.

In Figure 8 of the drawings, a modified form of the invention is illustrated, wherein a wheel cylinder 20*a* is provided for moving a brake shoe 21*a* outwardly into contact with a brake drum (not shown). The wheel cylinder 20*a* is identical to the wheel cylinder 20 except it is only half as long and contains only one large piston 26*a* at one end thereof with the partition 24*a* serving also as an end wall.

A small piston 32*a* is slidably arranged in the large piston 26*a* in the same manner as the small piston 32 is slidably arranged in the large piston 26.

The use and operation of the wheel cylinder 20*a* is identical to that of the wheel cylinder 20 with the exception that a single brake shoe 21*a* is actuated thereby rather than the two brake shoes 21, 22 of the preferred form of the invention.

Referring now to Figures 9 through 13, a modified form of the invention is illustrated comprising a clamp, indicated generally at 60. The clamp 60 includes a body 61 having a longitudinally extending bore 62 formed in one end thereof, and a longitudinally extending slot 63 formed in the lower edge thereof.

An elongated bar 64 is positioned in the slot 63 and detachably secured therein by bolts 65. The bar 64 extends substantially beyond the body 61 and has an upwardly offset jaw 66 formed integrally on the outer end thereof.

A bore 67 extends transversely into the body 61 perpendicularly to the bore 62 and slightly spaced from the inner end thereof. A relatively small bore 68 communicates the bore 67 with the bore 62 at a point adjacent to but spaced from the inner end of the bore 67. The outer end portion of the bore 67 is provided with a pair of oppositely disposed longitudinally extending slots 69, for reasons to be assigned.

A plug 70 is threaded into the outer end of the bore 67 and has a shaft 71 journalled therein with its outer end projecting beyond the plug 70.

The shaft 71 has a screw driver slot 72 in its outer end and is provided with a collar 73 intermediate its opposite ends and engaging against the plug 70. The shaft 71 has the end thereof opposite the screw driver slot 72 threaded at 74 from the collar 73 to the end.

A plate 75 is positioned in the bore 67 and threaded onto the threads 74 of the shaft 71, as can be seen in Figures 9 and 13. Ears 76 are integrally formed on the plate 75 engaging in the grooves 69 to restrain the plate 75 against rotation as the shaft 71 is rotated.

A valve seat 77 is formed in the inner end of the bore 67 and has a bore 78 extending axially therefrom. A valve plug 79 is slidably arranged in the bore 67 and is adapted to seat against the valve seat 77 to close the bore 78. The valve plug 79 has an annular groove 80 formed therein supporting an elastic sealing O ring 81 for contact with the sides of the bore 67.

A coil spring 82 is positioned between the plate 75 and the valve plug 79 and normally biases the valve plug 79 into engagement with the seat 77. The tension of the coil spring 82 can be adjusted by moving the plate 75 on the shaft 71 through the medium of the threads 74.

Referring now to Figure 10, it can be seen that the valve plug 79 is provided with an annular groove 83, for reasons to be assigned. A bore 84 communicates with the bore 78 and has the outer end thereof closed by means of a conventional bleeder valve 85. A bore 86 communicates with the bore 67 and has a hydraulic line 87 connected to the outer end thereof by a fitting 88.

A circular groove 89 is formed in the inner end of the bore 62 surrounding the bore 68 and has a sealing O ring 90 positioned therein. An annular groove 91 is formed in the inner end of the bore 62 along the peripheral edges thereof. A bore 93 communicates the bore 78 and the bore 84 with the annular groove 91.

A cylindrical piston 94 is slidably supported in the bore 62 and has an axial bore 95 extending longitudinally thereof.

A bore 96 is formed in the lower end of the piston 94 in alignment with the bore 68 in the body 61. A valve seat 97 is formed at the inner end of the bore 96 and its juncture with the bore 95.

A valve 98 is arranged concentrically of the valve seat 97 and has a stem 99 extending through the bore 96 and into the bore 68. A collar 100 is mounted on the stem 99 and a coil spring 101 is positioned between the valve seat 97 and the collar 100 to normally bias the valve 98 into engagement with the valve seat 97.

The piston 94 has an annular groove 102 formed adjacent the inner end thereof and an elastic sealing ring 103 is seated therein. A cylindrical piston 104 is slidably mounted in the bore 95 and has an annular groove 105 formed adjacent its inner end supporting an elastic

sealing ring 106. A boss 107 is integrally formed at the inner end of the bore 95 to maintain the piston 104 in spaced relation with respect thereto.

A jaw plate 108 has a diameter equal to the piston 94 and is secured to the outer end of the piston 104 by bolts 109. A guide pin 110 is secured to the jaw 108 and is slidably arranged in a bore 111 in the piston 94 spaced from and parallel to the bore 95. The jaw 108 has a depending tongue 112 extending toward the bar 64 and engaging between a pair of upstanding parallel spaced apart plates 113 integrally formed on the upper edge of the bar 64.

The jaw 66 is provided with a socket 114 oppositely of the tongue 112 and a coil spring 115 has one end thereof engaged in the socket 114 and the opposite end thereof engaging the tongue 112 to normally bias the tongue 112 and jaw 108 in a direction away from the jaw 66.

In the use and operation of the invention illustrated in Figures 9 through 13, hydraulic fluid under pressure flows through the conduit 87 into the bore 86 and from there into the bore 67. Fluid in the bore 67 flows outwardly through the bore 68, bore 96, past valve 98 into the bore 95.

When the hydraulic fluid enters the bore 95 it moves the piston 104 quickly outwardly of the bore 95 to bring the jaw 108 into contact with one side of a piece of work (not shown) engaged between the jaws 66 and 108. When the piston 104 contacts the work and its movement is retarded, the pressure of the hydraulic fluid within the body 61 is increased until it overcomes the pressure of the spring 82 forcing the valve plug 79 downwardly in the bore 67 so that the annular groove 83 aligns with the inner end of the stem 99 permitting the valve 98 to close against the seat 97. The closed valve 98 seals the bore 95 and locks the piston 104 in its extended position.

When the valve plug 79 moves downwardly in the bore 67, the bore 78 is opened and fluid flows therethrough and through the bore 93 to the annular groove 91 so that pressure is then brought to bear against the inner end of the piston 94. As the pressure increases in the hydraulic fluid it acts on the larger piston 94 to bring a more intense pressure against the jaw 108 than that exerted by the piston 104.

Upon releasing of the pressure on the hydraulic fluid in the system, the coil spring 115 will force the jaw 108 and piston 94 inwardly to return the fluid to a reservoir (not shown). The release of the pressure in the system permits the spring 82 to return the valve plug 79 to engagement with the seat 77 and moves the annular groove 83 out of alignment with the stem 99.

As the piston 94 moves to its innermost position, the stem 99 will contact the valve plug 79 and move the valve 98 off the seat 97 to release the fluid trapped in the bore 95 and permit the piston 104 to move inwardly therein.

The control of the tension of the spring 82 by means of the shaft 71 and plate 75 controls the force of the valve plug 79 against the seat 77 and the counter-acting pressures necessary in the hydraulic fluid to counter-act these pressures.

As can be readily seen, the modification illustrated in Figures 9 through 13, will rapidly move the jaw 108 into contact with the work to be clamped and then will automatically apply a full clamping force without requiring substantial additional hydraulic fluid displacement.

Referring now to Figures 14 and 15, another modification of the invention is illustrated and comprises a lift jack, generally indicated at 116.

The jack 116 includes an upright cylindrical body 117 having a bore 118 extending downwardly therethrough terminating at a point adjacent to but spaced inwardly from the lower end of the body 117. The inner end 119 of the bore 118 is centrally recessed at 120 and has a circular groove 121 extending downwardly therefrom. An elastic O ring seal 122 is seated in the groove 121, for reasons to be assigned.

A bore 123 extends downwardly from the recess 120 and intersects a bore 124 extending transversely of the body 117 toward one side edge thereof. A relatively large threaded bore 125 communicates with the outer end of bore 124 and has a fitting 126 threaded therein and supporting a conduit 127 in communication with the bore 124.

A generally upright bore 128 is formed in the body 117 adjacent the bore 118 and terminates in a transversely extending threaded bore 129 at the upper end thereof. A threaded bore 130 extends transversely through the side of the body 117 intersecting the bore 128 at its inner end. A plug 131 seals the lower end of the bore 128 below the bore 130, as is shown in Figure 15.

A conduit 132 is secured in communication with the bore 128 by means of a fitting 133 threadedly engaged in the threaded bore 130. A bore 134 extends axially of the threaded bore 129 and communicates with the bore 118. A valve ball 135 is arranged in sealing relation to the bore 134 and is normally biased to sealing position by a coil spring 136 supported by a threaded plug 137 engaged in the threaded bore 129.

A cylindrical piston 138 is mounted for vertical reciprocation in the bore 118 and has an axial bore 139 extending from its upper end to a point spaced from but adjacent to its lower end. An annular groove 140 is formed in the piston 138 adjacent the lower end thereof and has an elastic sealing ring 141 seated therein for engagement with the walls of the bore 118.

A vent bore 142 extends from the lower edge of the piston 138 to the upper end thereof and is closed at the upper end by a conventional bleeder valve 143. A transverse bore 144 is formed in the piston 138 below the inner end of the bore 139. A vented screw plug 145 is threaded into the outer end of the bore 144 and forms a stop for a coil spring 146 positioned in the bore 144.

A valve plug 147 is slidably arranged in the bore 144 and adapted to engage against a valve seat 148 formed in the inner end of the bore 144. The valve plug 147 has a groove 149 formed annularly thereabout and containing an elastic sealing ring 150 for engaging the walls of the bore 144. The valve plug 147 has an annular groove 151 formed adjacent one end thereof.

A bore 152 extends axially of the bore 144 terminating at the valve seat 148 at one end and a bore 153 at the other end. The bore 153 communicates the bore 152 with the bore 139.

A threaded bore 154 is formed in the lower end of the piston 138 and has an orifice 155 at its upper end communicating with the bore 144. A threaded hollow bushing 156 is seated in the threaded bore 154 and has a valve seat 157 formed in its inner end.

A valve 158 having a valve stem 159 depending therefrom cooperates with the valve seat 157 and is normally biased into engagement therewith by a coil spring 160 engaging the inner end of the hollow bushing 156 at one end and a collar 161 at the other end.

The stem 159 engages the bottom of the recess 120 when the piston 138 is in its lowermost position so that the valve 158 is held out of contact with the valve seat 157. The lower end of the threaded bushing 156 engages the seal 122, as can be seen in Figure 15.

The piston 138 has an elongated slot 162 extending vertically on its outer face from a point slightly above the annular groove 140 outwardly through the top of the piston 138. The bore 118 has a groove 163 extending inwardly from the outer end thereof and a ball 164 is seated in the groove 162 and the groove 163 and secured therein by an L-shaped member 165 mounted to the body 117 by a bolt 166.

The groove 162 terminates at 167 forming a stop shoulder to engage the ball 164 eliminating the outward movement of the piston 138 in the bore 118. The

bore 144 is communicated with the bore 139 in the piston 138 by a relatively short bore 168.

A cylindrical piston 169 is positioned in the bore 139 and adapted for vertical reciprocation therein. The piston 169 has an annular groove 170 formed adjacent the lower end thereof containing an elastic seal 171. The lower end of the piston 169 has an annular groove 172 on the peripheral edge thereof and a circular groove 173 positioned concentrically inwardly of the groove 172. An elastic sealing ring 174 is positioned in the groove 173 for engagement with the lower end of the bore 139.

A vent bore 175 extends upwardly from the annular groove 172 through the upper end of the piston 169 and has its upper end closed by a conventional bleeder valve 176. An elongated groove 177 extends upwardly along the outer face of the piston 169 from a point spaced above the lower end thereof outwardly through the upper end thereof. The lower end of the groove 177 terminates in a shoulder 178.

The bore 139 of the piston 138 has a groove 179 extending downwardly from the upper edge thereof and a ball 180 is seated in the grooves 177, 179 for engagement with the shoulder 178 to secure the piston 169 in the bore 139. An L-shaped member 181 is positioned in the groove 179 and secured to the piston 138 by means of a bolt 182 to retain the ball 180 in the groove 179.

The piston 169 has an axial bore 183 extending therethrough to a point adjacent to but spaced from the lower end of the piston 169. An upstanding hollow boss 184 is formed centrally of the piston 169 at the lower end of the bore 183 and has a valve seat 185 formed therein.

A valve 186 is associated with the valve seat 185 and has a stem 187 extending downwardly therefrom through the orifice 168. A coil spring 188 is positioned within the hollow boss 184 engaging at one end the valve seat 185 and at the other end a collar 189 secured on the stem 187.

An elongated piston 190 is arranged for reciprocation in the bore 183 and has an elongated slot 191 formed in the outer face thereof and terminating at its lower end in a shoulder 192. A groove 193 is formed in the bore 193 extending inwardly from the upper end thereof and a ball 194 is positioned in the groove 191 and the groove 193 where it is retained by an L-shaped member 195 secured to the piston 169 by a bolt 196.

The shoulder 192 engages the ball 194 to limit the outward movement of the piston 190 in the bore 183. The piston 190 has an annular groove 197 adjacent the lower end thereof and containing a sealing ring 198 for engagement with the bore 183.

A bore 199 extends upwardly from the lower end of the piston 190 to receive the hollow boss 184 therein. An elongated vent bore 200 extends from the bore 199 through the upper end of the piston 190 and is closed at its upper end by a conventional bleeder valve 201.

A circular plate 202 is secured to the upper end of the piston 190 by welding or the like and has a diameter equal to the body 117. A pair of coil springs 203 have their upper ends connected to pins 204 to the plate 202 and their lower ends mounted over pins 205 projecting outwardly from the body 117. The springs 203 are arranged parallel to the axis of the body 117 and are adapted to move the plate 202 downwardly upon the release of the hydraulic pressure in the jack 116.

In the use and operation of the invention, hydraulic fluid under pressure is received in the jack 116 from the conduit 127 and passes through the bores 124, 123 into the hollow bushing 156. The fluid then flows upwardly past the valve seat 157, through the bore 155, into the bore 144.

The fluid pressure causes the hydraulic fluid to flow through the orifice 168 into the hollow boss 184, past the valve seat 185, into the bore 199 of the piston 190.

The piston 190 then moves upwardly in the bore 183 until the work to be lifted is contacted, and if the load is too great for the piston 190, the pressures in the jack 116 increase due to the piston 190 stopping its movement with respect to the bore 183.

As the pressures increase, the valve plug 147 overcomes the resistance of the spring 146 and moves outwardly away from the valve seat 148 and simultaneously aligns the annular groove 151 with the valve stem 187 so that the valve 186 can close against the valve seat 185 sealing the bore 183 to prevent the piston 190 from moving downwardly therein.

Additional fluid pressure exerted on the hydraulic fluid will cause the hydraulic fluid to flow through the restricted passage 152, the bore 153, into the annular groove 172 so as to raise the piston 169 in the bore 139. The piston 190 is locked by the valve 186 to the piston 169 so that movement of the piston 169 will cause the piston 190 to move therewith with the increased force brought about by the increased cross-section of the piston 169 over the piston 190.

When the piston 169 has moved to fully extended position, locking the shoulder 178 to the ball 180, the fluid pressure in the bore 139 working on the piston 169 will move the piston 138, then locked to the piston 169, off its seat in the bore 118 and will allow valve stem 159 to leave its seat on the bottom of the bore 120. Spring 160 will then close the valve 158 and simultaneously with the lifting of the piston 138 and the closing of the valve 158, fluid pressure will flow by the seal 122, into the bores 118 and 120. Thereby, the piston 138 will continue to carry the load to the desired distance. Having the piston 138 go into operation only after the piston 169 has traveled to fully extended position covers that phase in my invention of multiple nested piston devices which is to produce a lifting or moving hydraulic device that will lift or move an object a greater distance than any hydraulic device of equal length, known to me.

Should the pressure of the hydraulic fluid in the bore 118 exceed the capacity of the jack 116, the ball valve 135 will be unseated and the fluid will flow through the bore 134 and bore 128 to the conduit 132, returning to the reservoir (not shown).

In lowering the jack 116 to the position illustrated in Figure 15, hydraulic pressure is removed from the hydraulic fluid within the jack 116 and pistons 190, 169 and 138 will lower as a unit until the piston 138 is completely housed within the bore 118 and the stem 159 contacts the bottom of the recess 120 to raise the valve 158 off of the valve seat 157 and release the fluid trapped in the bore 139.

When the valve 158 opens, the piston 169 moves downwardly until the stem 187 contacts the valve plug 147 which has been moved against the seat 148 by the spring 146. The valve stem 187 raises the valve 186 from the seat 185 and releases the fluid trapped in the bore 183 to permit the piston 190 to be completely retracted in the bore 183.

The springs 203 connected to the plate 202 bias the plate 202 downwardly with respect to the body 117 and return the pistons 138, 169 and 190 to their retracted position.

Referring now to Figures 16 and 17, another modified form of the invention is illustrated comprising a wheel cylinder indicated generally at 206. The wheel cylinder 206 includes a generally cylindrical body 207 having axial bores 208 extending inwardly from opposite ends thereof and terminating at a central transverse partition 209. The partition 209 has oppositely extending rings 210 projecting into the base of the bores 208.

An axial bore 211 extends through the partition 209 communicating the bores 208 on opposite sides thereof, and a fluid port 212 communicates with the bore 211 to supply hydraulic fluid under pressure to the bore 211.

A second bore 213 parallel to the bore 211 extends through the partition 209 communicating the bores 208

at the sides thereof. A port 214 communicates with the bore 213 at one end and has the opposite end thereof connected to the same source of fluid pressure (not shown) to which the port 212 is connected.

A piston 215 of cylindrical cross-section is arranged for reciprocation in each of the bores 208 and is provided with a reduced cross-section axial extension 216 having a slot 217 in the outer end thereof for engagement with the opposed ends of brake shoes 218. The pistons 215 have axial bores 219 extending therein from the outer end thereof.

An offset bore 220 extends through the pistons 215 at the bottom of the bores 219 and is provided with a valve seat 221 on the side thereof next to the bore 219. A valve 222 is arranged for cooperative engagement with the valve seat 221 and has a stem 223 extending through the bore 220 and arranged for engaging the partition 209.

A coil spring 224 is arranged in engagement with the inner end of the piston 215 at one end and has the opposite end engaging a collar 225 fixed to the stem 223. The spring 224 normally biases the valve 222 into engagement with the valve seat 221 and engagement of the stem 223 with the partition 209 raises the valve 222 out of engagement with the seat 221 when the pistons 215 are in their innermost position.

The pistons 215 each have a cylindrical boss 226 extending inwardly thereof and over which resilient sealing cups 227 are engaged.

A coil spring 228 is positioned in engagement with the outer end of the pistons 215 encompassing the reduced end portion 216 thereof and have their outer ends engaging a snap ring 229 seated in a groove 230 formed in the outer end of the bore 208.

A cylindrical piston 231 is arranged for reciprocation in the bores 219 and is provided with a slot 232 at its outer end for engagement with the brake shoes 218. A flexible sealing cup 233 is positioned in engagement with the inner end of the pistons 231 and in sealing engagement with the bores 219.

In the use and operation of the invention illustrated in Figure 16, fluid pressure enters the wheel cylinder 206 through the port 212, bore 211, into the bore 208, through the bore 220, past the valve 222 into the bore 219. As the hydraulic fluid, under pressure, enters the bore 219 the piston 231 is forced outwardly in the bore 219 until the brake shoes 218 are in engagement with the brake drum of the vehicle wheel (not shown).

As the brake drum stops the outward movement of the piston 231, the pressure of the hydraulic fluid will enter the bore 208 through the port 214 as well as the port 212, and will act on the pistons 215 to move them outwardly away from the partition 209. As soon as the pistons 215 move away from the partition 209, the stems 223 leave the partition 209 and the springs 224 close the valves 222 locking the fluid in the bore 219 and holding the pistons 231 in their extended position.

Further pressure applied to the hydraulic fluid will move the pistons 215 outwardly to apply a pressure to the brake shoes 218 far in excess of the pressure applied by the piston 231.

When the pressure is released on the hydraulic fluid, the springs 228 return the pistons 215 toward the partition 209, and as they reach their innermost position, the stems 223 engage the partitions 209 opening the valve 222 to release the trapped fluid from the bore 219 and permit the pistons 231 to be returned to their retracted position by pressure of the brake shoe springs (not shown) acting in the normal manner.

Referring now to Figure 18, another modified form of the invention is illustrated comprising a pressure multiplier illustrated generally at 234. The pressure multiplier 234 includes a cylindrical body 235 having a flange 236 formed at one end and a reduced cylindrical extension 237 integrally formed at the other end. A bore 238 extends axially through the extension 237 and a somewhat larger bore 239 vented at 239*a* communicates therewith and extends axially through the body 235.

A threaded bore 240 extends through the end of the extension 237 communicating with the bore 238 and is closed by a conventional bleeder valve 241. A conduit 242 is connected to a threaded bore 243 in the end of the extension 237 by means of a threaded fitting 244. An arm 245 connects the bore 238 to the bore 243.

A cylindrical block 246 has a diameter equal to the diameter of the flange 236 and is secured thereto by mounting bolts 247. The block 246 has a transverse bore 248 extending therethrough and is provided with a threaded outer end portion 249 in which is mounted a threaded bushing 250.

An adjusting stem 251 is journalled in the bushing 250 and has a collar 252 formed intermediate the opposite ends thereof and engaging the bushing 250 to secure the shaft 251 against outward movement therein. A threaded extension 253 extends inwardly from the shaft 251 and its inner end serves as a stop for a valve plug 254 arranged for reciprocation in the bore 248.

A plate 255 is threaded on the threaded extension 253 and has oppositely disposed ears 256 engaged in slots 257 in the side of the bore 248 to prevent the plate 255 from rotating with respect to the bore 248. A coil spring 258 is interposed between the plate 255 and the valve plug 254 to normally bias the valve plug 254 into engagement with a valve seat 259 formed at the inner end of the bore 248.

A longitudinally extending bore 260 communicates with the valve seat 259 and with a threaded bore 261 normally closed by a conventional bleeder valve 262. The block 246 is provided with an annular groove 263 having an outer diameter equal to the bore 239 and communicating therewith. The bore 260 communicates with the groove 263.

A second annular groove 264 is formed on the block 246 in surrounding relation to the groove 263 and has a resilient seal 265 positioned therein and engaging the flange 236 to seal the block 246 to the body 235.

A bore 266 extends between the bore 248 and the bore 239, and the block 246 is provided with an annular groove 267 concentrically surrounding the bore 266. A seal 268 is positioned in the groove 267, for reasons to be assigned.

The valve plug 254 has an annular groove 269 in which is seated a sealing O ring 270 for sealing engagement with the bore 248. A threaded bore 271 extends through the block 246 and communicates with the bore 248 and a conduit 272 is secured therein by means of a threaded fitting 273.

A piston member, indicated generally at 274, is provided with a piston portion 275 at one end thereof engaged in the bore 239 and having an annular groove 276 formed therein to receive a sealing gasket 277 engaging the walls of the bore 239 to seal the piston portion 275 thereto.

The piston member 274 has a second piston portion 278 having a diameter to permit sliding movement thereof in the bore 238. The piston portion 278 has an annular groove 279 adjacent its outer end in which is positioned a sealing ring 280 for sealing engagement with the bore 238.

The piston portion 275 has a bore 281 extending inwardly thereof and the piston portion 278 has a bore 282 extending inwardly thereof with the bores 281 and 282 being axially aligned and communicated by a bore 283 extending therebetween.

The end of the bore 283 adjacent the bore 282 is provided with a valve seat 284 closed by a valve 285. The valve 285 has a valve stem 286 extending through the bore 283, through the bore 281, and through the bore 266.

A guide collar 287 is fixed to the stem 286 and is provided with orifices 288. A coil spring 289 is positioned in the bore 281 engaging the inner end of the bore 281

at one end and the collar 287 at the other end to normally bias the valve 285 into contact with the valve seat 284.

A coil spring 290 engages the inner end of the bore 239 at one end and the piston portion 275 at the other end to normally bias the piston member 274 toward the block 246.

In the use and operation of the invention illustrated in Figure 18, hydraulic fluid under pressure is delivered to the pressure multiplying device 234, through conduit 272, into bore 248, through bore 266, into bore 281, through the orifices 288, bore 283, past the valve seat 284, into the bore 282, and the bore 238.

Hydraulic fluid continues to flow under pressure through the conduit 272 until the bore 238 is completely filled, and the fluid extends under pressure completely through the conduit 242 to the device (not shown) to be actuated thereby.

As the pressure increases in the pressure multiplying device 234, the valve plug 254 is forced downwardly against the tension of spring 258 aligning an annular groove 291 therein with the stem 286 so that the spring 289 can force the stem 286 in a direction to close the valve 285 against the valve seat 284 and lock the fluid in the bores 238, 282 and conduit 242 from returning to the bore 281.

After the valve plug 254 has moved downwardly in the bore 248, fluid flows through a greatly restricted bore 292 from the valve seat 259 to the bore 260 and outwardly to the annular groove 263 where the hydraulic pressure is brought to bear on the piston portion 275 moving the piston portion 275 outwardly in the bore 239 against the pressure of the spring 290 and pushes the piston portion 278 outwardly in the bore 238 so as to apply a pressure to the fluid trapped in the bores 282, 238 and the conduit 242 greatly in excess of the pressure in the conduit 272 acting on the piston portion 275.

On release of the pressure in the conduit 272, the valve plug 254 is pressed upwardly by the spring 258 so as to contact the seat 259 and seal the bore 292 and simultaneously move the annular groove 291 out of alignment with the stem 286.

The pressure of the spring 290 returns the piston member 274 to its starting point in the bore 239, and as it reaches its innermost position the stem 286 contacts the valve plug 254 and causes the valve 285 to unseat from the valve seat 284 to release the hydraulic fluid in the bore 282, bore 238, and conduit 242, returning all of the elements of the device to normal.

Having thus described the preferred embodiments of the invention, it should be understood that numerous other structural modifications and adaptations may be resorted to without departing from the scope of the appended claims.

What is claimed is:

1. A hydraulic device comprising a hollow cylinder, a hollow piston mounted for reciprocation in said cylinder, a second piston mounted for reciprocation in said first piston, means for connecting said cylinder to a source of fluid under pressure, seal means for separating said fluid under pressure from a large area of said hollow piston, a valved port extending through said hollow piston and communicating with the means connecting said cylinder to a source of fluid under pressure, and means actuated by fluid under pressure in said cylinder for initially maintaining said seal means in sealed condition and for initially maintaining said valved port in open condition to permit the fluid under pressure to move said second piston outwardly in said hollow piston and said last named means to move under fluid pressure in said cylinder to a position permitting the opening of said seal means and the closing of said valved port locking the fluid in said hollow piston and directing the fluid under pressure against the large area of the hollow piston to move said hollow piston outwardly in said cylinder.

2. A device as claimed in claim 1 wherein said valved port is closed by a reciprocating valve having a valve stem engageable with the means for maintaining said valved port in open condition, whereby said valved port is closed prior to movement of said hollow piston.

3. A device as claimed in claim 1 wherein the means for maintaining said valved port in open condition and maintaining said seal means in sealed condition includes a reciprocating valve plug movable under fluid pressure to close said valved port prior to movement of said hollow piston.

4. A hydraulic device comprising a cylinder, a plurality of concentrically arranged hollow pistons mounted for reciprocation in said cylinder, means connecting said cylinder to a source of hydraulic fluid under pressure, means for conducting said hydraulic fluid to move the innermost of said pistons with respect to the remainder of said pistons, sealing means for separating the remainder of said pistons from the fluid under pressure, means responsive to fluid under pressure for automatically and simultaneously locking the fluid under pressure behind said innermost piston in its extended position and directing the fluid pressure against a next larger piston, means for mechanically locking said next large piston in fully extended position whereby said fluid under pressure directed against the next larger piston will move the piston in which said next larger piston reciprocates, means for directing said hydraulic fluid against the piston in which said next larger piston reciprocates, and means for locking fluid under pressure behind said fully extended next larger piston whereby the fluid under pressure in the cylinder is directed solely against said piston in which said next larger piston reciprocates.

5. A device as claimed in claim 4 wherein said means responsive to fluid under pressure in said cylinder is provided with means for locking said fluid under pressure behind said innermost piston in extended position prior to a movement of said next larger piston.

References Cited in the file of this patent

UNITED STATES PATENTS

1,865,105	Houplain	June 28, 1932
2,227,245	Carroll	Dec. 31, 1940
2,282,556	Bowen	May 12, 1942
2,389,654	Van Der Werff	Nov. 27, 1945
2,597,404	Teske	May 20, 1952
2,638,750	Hettinger	May 19, 1953
2,649,691	Johnson	Aug. 25, 1953
2,737,777	Krusemark	Mar. 13, 1956

FOREIGN PATENTS

905,934	Germany	Mar. 8, 1954