(No Model.)

2 Sheets—Sheet 1.

W. F. COLE.

VALVE GEAR.

No. 525,693.

Patented Sept. 11, 1894.

Figure 1.

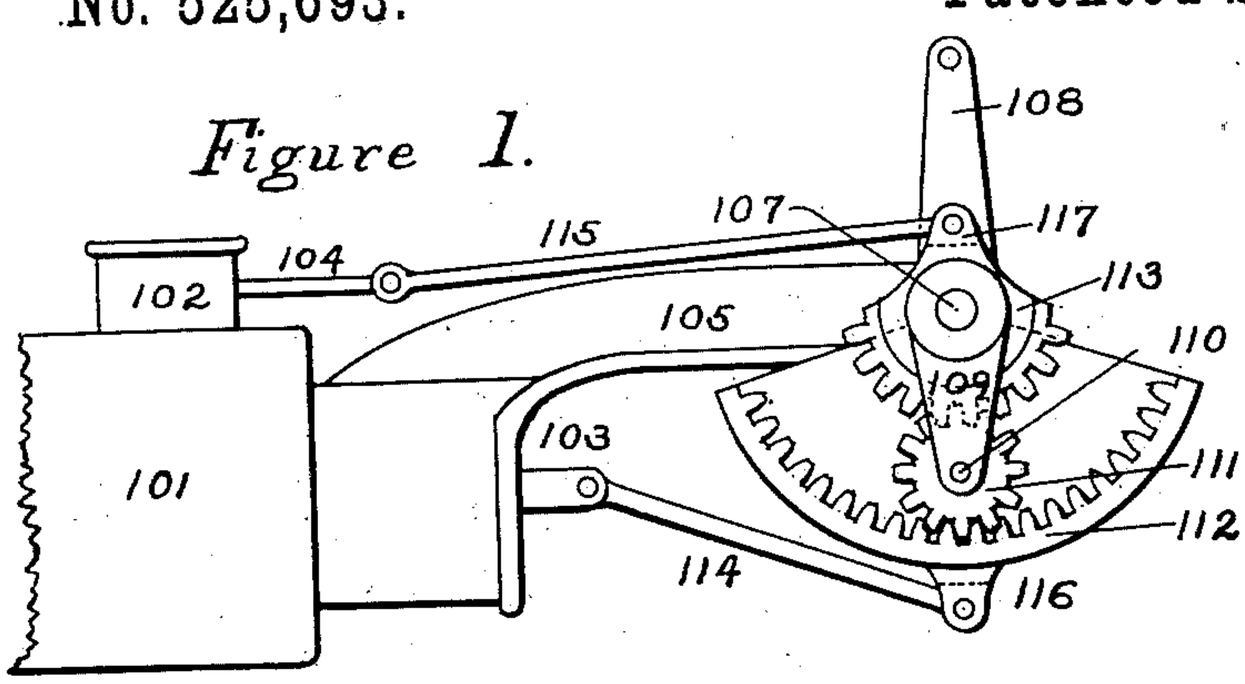


Fig. 4.

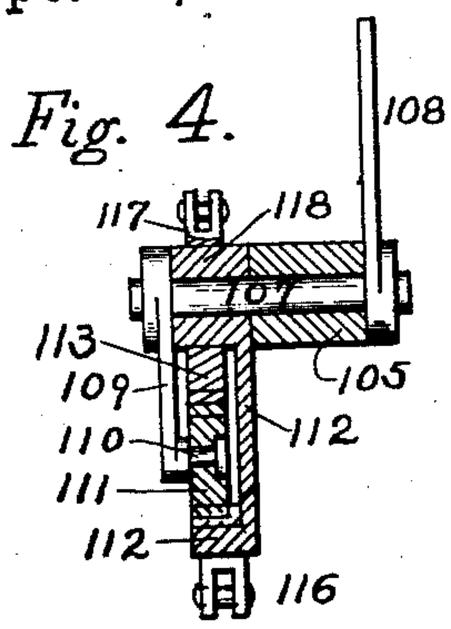


Figure 2.

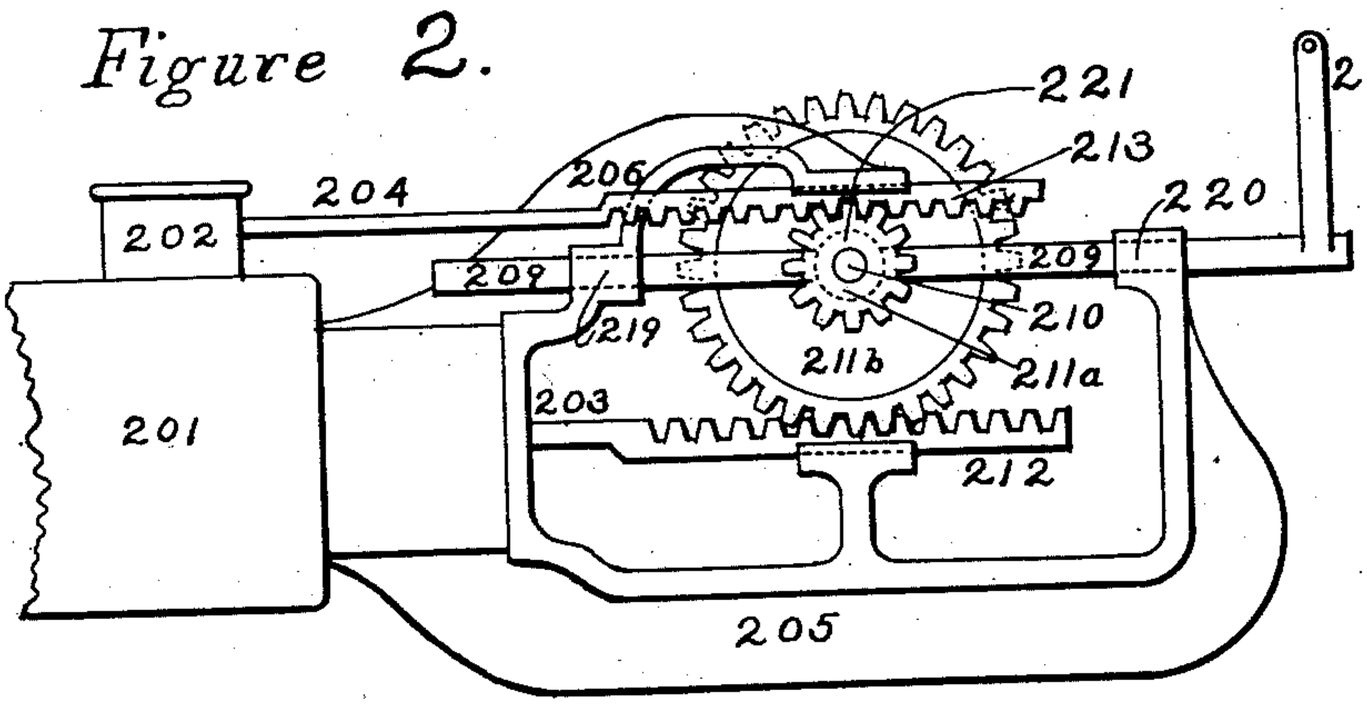


Fig. 5.

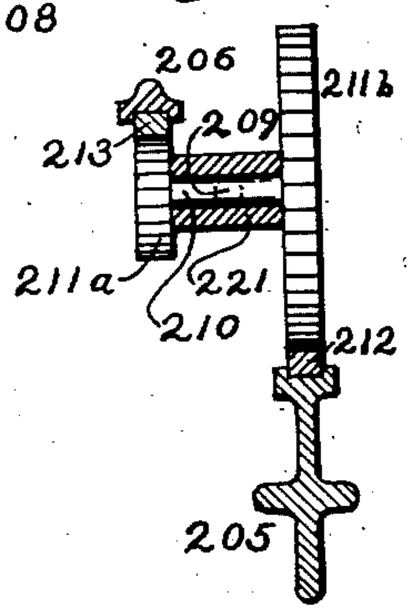


Figure 3.

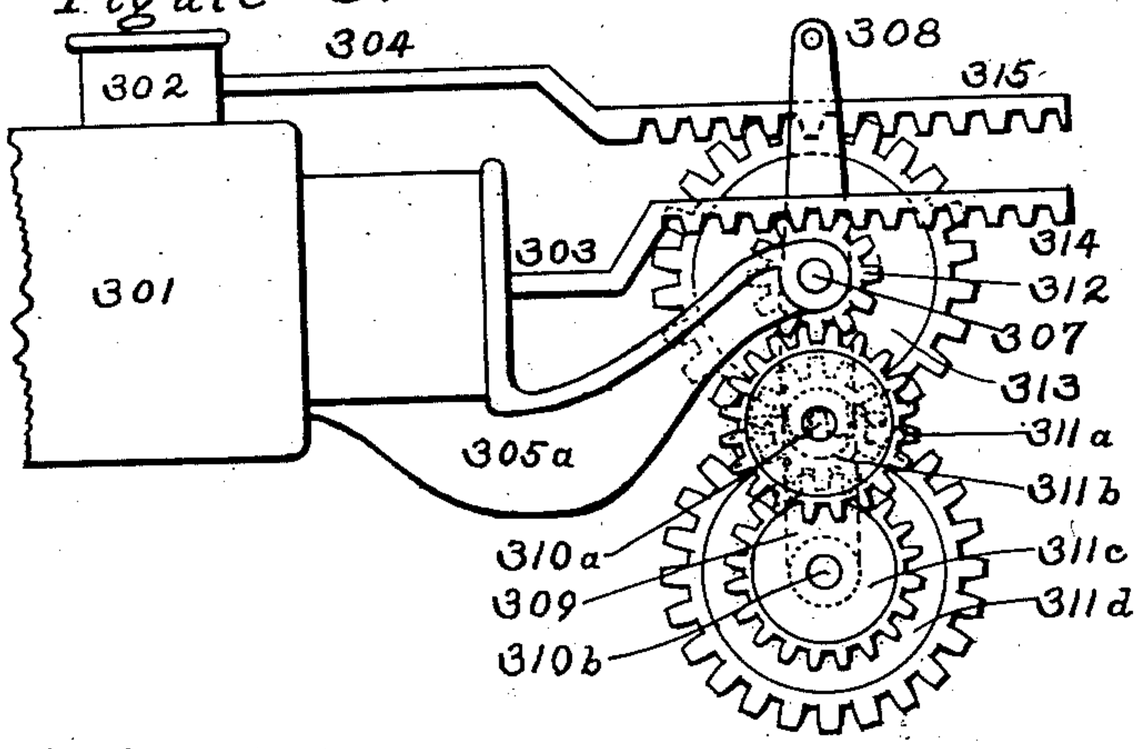
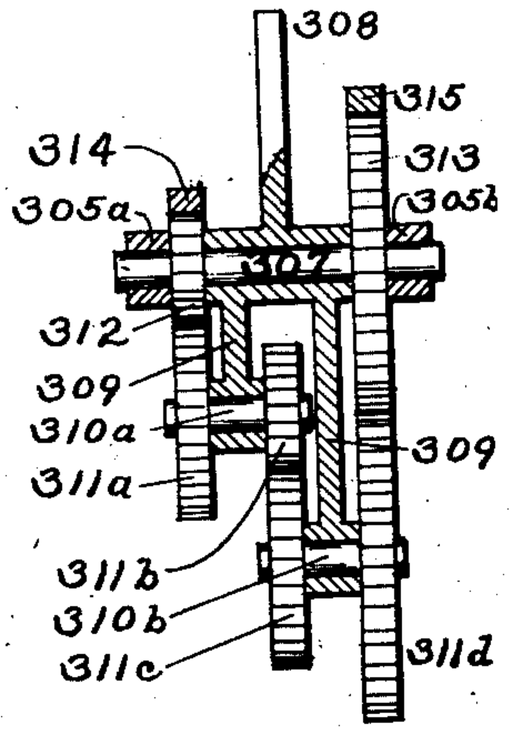


Fig. 6.



WITNESSES:

Fred. E. Knight.

G. A. Mitchell.

INVENTOR:

William F. Cole.

(No Model.) 2 Sheets—Sheet 2.

W. F. COLE.

VALVE GEAR.

No. 525,693. Patented Sept. 11, 1894.

Figure 7.

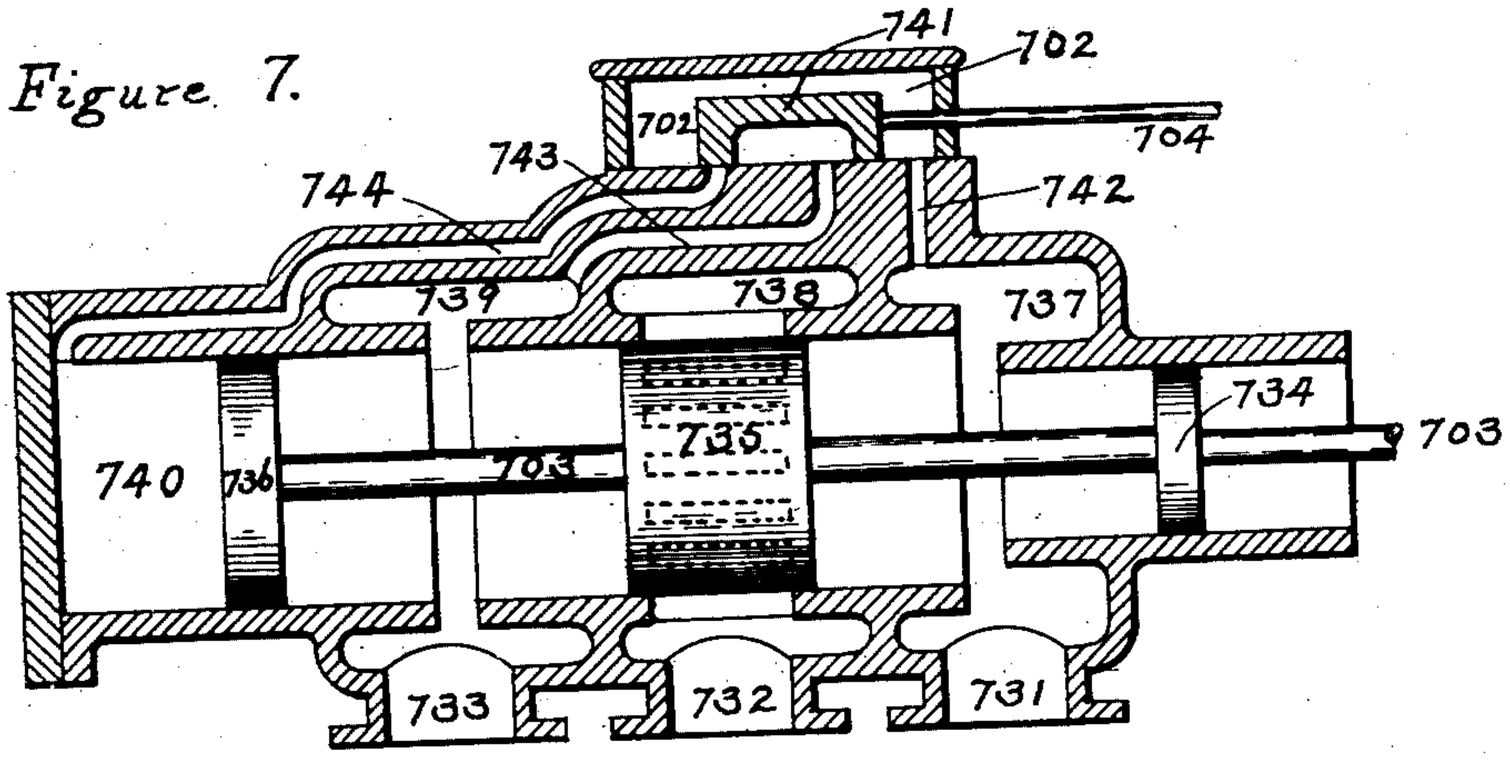


Figure 8.

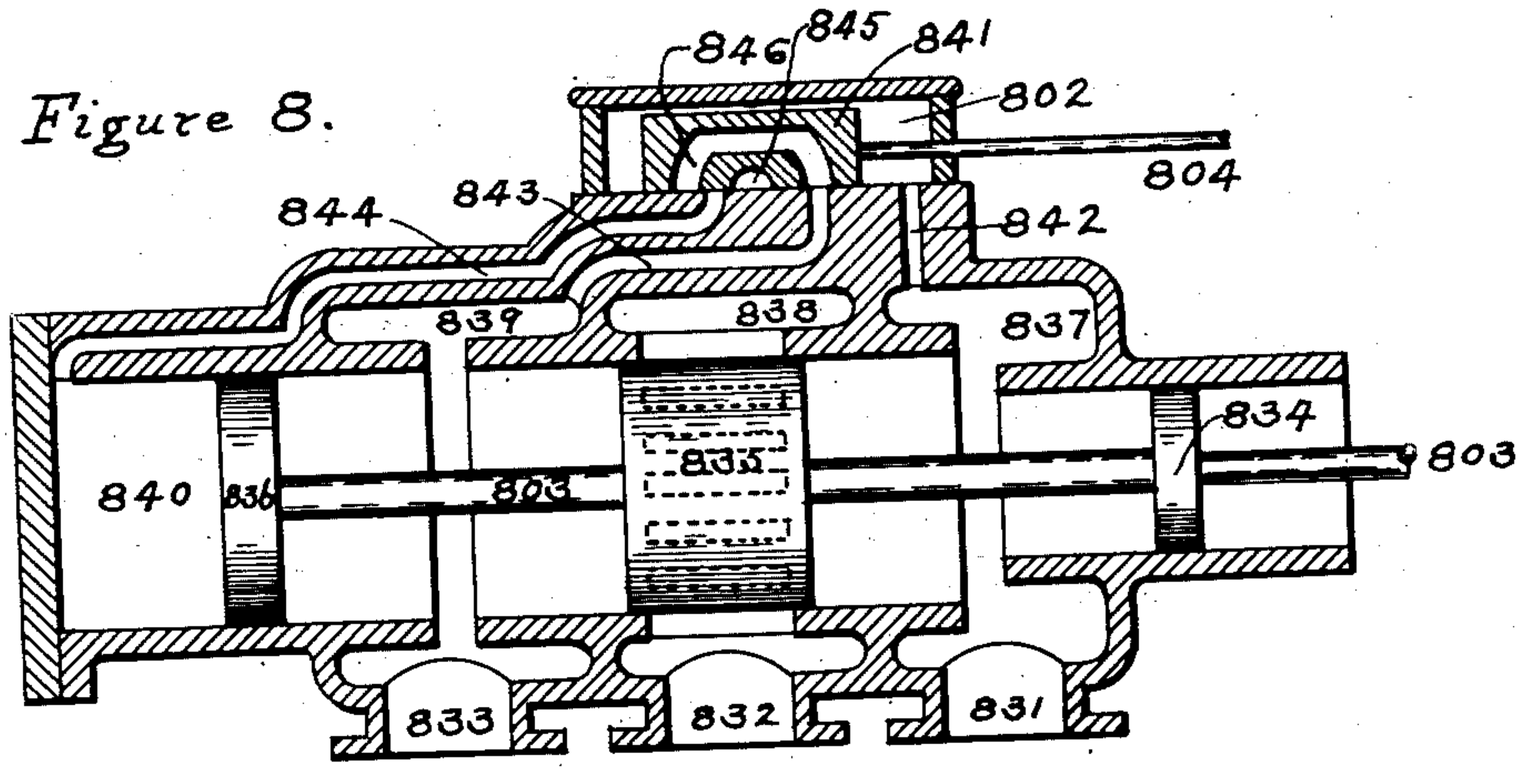
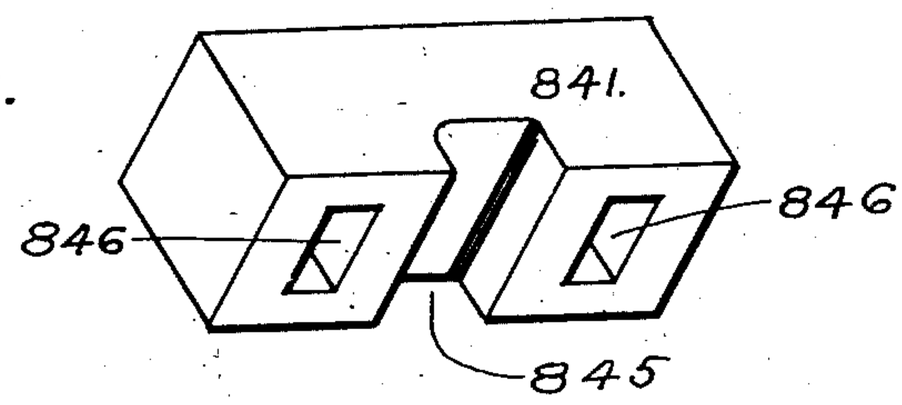


Figure 9.



WITNESSES:
C. W. Dodge
W. B. Wells.

INVENTOR:
Wm. F. Cole.

UNITED STATES PATENT OFFICE.

WILLIAM F. COLE, OF WORCESTER, MASSACHUSETTS.

VALVE-GEAR.

SPECIFICATION forming part of Letters Patent No. 525,693, dated September 11, 1894.

Application filed January 24, 1894. Serial No. 497,879. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM F. COLE, a citizen of the United States, residing at Worcester, in the county of Worcester and State of Massachusetts, have invented a new and useful Valve-Gear, of which the following is a specification.

My invention relates to that class of valves which are operated by fluid pressure controlled by a secondary valve. Such valves are commonly known as "pilot valves" and are largely employed in hydraulic elevator work. They consist essentially, in addition to the main valve itself, of a motor cylinder within which works a piston suitably connected with the main valve stem for the purpose of shifting the same, a secondary valve for controlling the flow of motive fluid to this motor cylinder, and of peculiar connections between the main valve stem and the secondary valve. The requirements of these connections are, first, that they shall permit the secondary valve to be opened by an operating handle, and second, that the resulting motion of the main valve stem shall by them be transmitted to the secondary valve so as to close the same and without disturbing the adjustment of the operating handle. The main valve stem will thus be brought to rest in a new position incident to the amount of travel required to close the secondary valve. This depends upon the initial opening given it by a greater or less movement of the operating handle so that for every position of this handle there exists a corresponding position to which the main valve stem is driven and there brought to rest. It is to peculiar and novel methods of constructing connections between the main valve stem and the secondary valve, the functions and requirements of which I have just set forth, that my invention more particularly relates. These connections I make in the following manner: To each the main valve stem and the secondary valve stem, I attach in any convenient manner a toothed gear, and so arrange these two gears that their pitch lines shall at all times be parallel to each other. This can be done with circular gears, by setting them upon the same or concentric axes, in which case the parallel pitch lines become concentric circles, or it may be done by employing gears of infinite radius, that is, racks, in which case the parallel pitch lines will become parallel straight lines. In the former case it is immaterial whether both gears be external or spur gears. Whether one gear be an external and one an internal gear, or whether both gears be internal gears, the principle remains the same. To simplify the further description and also for the sake of brevity, the gear connected with the main valve stem will hereinafter be denominated the "primary gear" and the gear connected with the secondary valve stem will be denominated the "secondary gear." The word "gear" too, will be used in a sense sufficiently comprehensive to include the rack, which is but the segment of a spur gear of infinite radius. I now arrange a third gear (or as will be hereinafter explained, a train of gears), to mesh with both of the two gears aforesaid and mount this gear (or train of gears) upon a stud that is adjustable along a path parallel to the pitch line of the first two mentioned gears. Hence, in whatever adjustment this stud may be, its distance from the axes of the primary and secondary gears is constant so that this third gear or "intermediate gear" as I shall hereinafter denominate it, always remains in mesh with the other two. I also provide an operating handle to effect and maintain adjustment of the stud upon which the third gear revolves.

The operation is as follows: Whenever the operating handle is shifted one way or the other the axis of the intermediate gear is moved along a path parallel to the pitch line of the primary gear. But as the main valve stem is yet at rest, the primary gear can partake of no motion. Consequently as the intermediate gear is rolled over the face of the primary gear it will be compelled to rotate upon its axis and as it is also in mesh with the secondary gear its rotation will transmit motion to this latter gear and thereby open the secondary valve. This permits passage of motive fluid to or from the motor cylinder and motion in a proper direction is thus given to the main valve stem. So soon, however, as the main valve stem begins to move, the accompanying motion of the attached primary gear causes the intermediate gear again to rotate upon its axis in whatever adjustment

this may be, and this rotation once more transmits motion to the secondary gear, this time in a direction to close the secondary valve. So soon as this closing has been fully effected the flow of motive fluid is stopped and the main valve stem is brought to rest.

Having thus set forth the object and nature of my invention, I will now describe the same in detail. To aid in the description, reference will be made to the accompanying drawings. The details of a valve, with motor cylinder attached, provided with a secondary valve for controlling the flow of motive fluid to same and the construction of such are well understood by builders of this class of machinery. I have accordingly omitted all details of such parts from the first sheet of my drawings, and have shown in full only my peculiar method of making the connections between the main valve stem and the secondary valve, as it is with these alone that my invention has to do. I have, however, shown on a second sheet some common constructions of valves to which my invention may be applied.

Figure 1 shows the side view of so much of a valve as has to do with my invention. In this figure the primary gear takes the form of a segment of an internal gear, the secondary gear a segment of an external gear while the intermediate gear is formed by a single pinion. Fig. 4 is an end section of the same, the section being made through the centers of all three gears. Figs. 2 and 5 show another form of my invention, Fig. 2 in side elevation, and Fig. 5 in end elevation and part section on a line through the center of the intermediate gear. In this form racks are used for both the primary and secondary gears while the intermediate gearing consists of a compound gear or two gears of different diameters both connected to the same shaft. Figs. 3 and 6 show a third form of my invention, Fig. 3 in side elevation, and Fig. 6 in end section, this section being likewise made through the centers of the gears. In this form spur or external gears are used for both the primary and secondary gears while the intermediate gearing consists of a somewhat complex train of four gears. Figs. 7 and 8 show some common constructions of "pilot valves," and Fig. 9 shows detail of the secondary valve employed in the form shown in Fig. 8.

The same numerals are used to designate the same parts in the side and end views of the same form, and the three digit notation used is such that the last two digits of the numerals used designate like parts or parts performing similar functions in all forms, while the first digit designates the particular form upon which the part referred to is used. For example, the operating handle is designated in all three forms by numerals whose last two digits are 08, while the first digit corresponds with the form to which reference is made, the numerals used to designate this piece in the three respective forms shown being 108, 208, and 308. But before following out the action of my invention, it will first be necessary to briefly describe the construction of a "pilot valve." Figs. 7 and 8 show longitudinal sections of such valves. The two differ only in the construction of their secondary valves 741 and 841, a difference to be presently explained.

The supply pipe is connected at 731, Fig. 7 (the description applies also to Fig. 8 by reading the first digit 8 instead of 7). The delivery pipe connects at 732 and the exhaust pipe at 733. The piston 734 is of smaller diameter (preferably half the area) than the other pistons 735 and 736 which are all connected by the main valve stem 703. The chamber 737 is called the supply chamber. The chamber 738 communicating with the barrel of the valve by ports is called the delivery chamber. The chamber 739 is the exhaust chamber and the chamber 740 constitutes a motor cylinder. It is obvious that admission of supply water to this chamber 740 will drive the stem 703 to the right. Its exhaust from this chamber will cause the stem 703 to be forced to the left by the pressure on the differential pistons 734 and 735, while its confinement in the chamber 740 will prevent all motion of the stem 703. Flow of water to or from the chamber or motor cylinder 740 is controlled by a secondary valve 741, which works in the secondary valve chest 702. Water is supplied to this chest through the passage 742.

743 is a passage leading to the exhaust chamber 739 and the passage 744 connects the chest 702 with the chamber 740. The secondary valve 741 in Fig. 7 is of the common D slide valve form, so that moving this valve to the right admits water through the passage 744 to the chamber 740, setting the main valve stem 703 in motion in the same direction, while moving the secondary valve 741 to the left exhausts the water from the chamber 740, setting the main valve stem in motion toward the left also.

In Fig. 8 a modified form of D slide valve is employed. This valve 841 is shown further in Fig. 9. The cavity 845 is open at the sides to take in supply water while the passage 846 is closed at the sides so as to give communication only between the passages 844 and 843, when its adjustment is such as to connect them. To admit water to the passage 844 and set the stem 803 in motion toward the right, the secondary valve 841 must be moved to the left; while to cause the main stem 803 to travel to the left, the secondary valve 841 is shifted to the right. In Fig. 7 then, the motions of the main and secondary valve stems are in the same direction, while in Fig. 8 they are in opposite directions. We are now ready to take up the connections between the stems of the main and secondary valves which form the subject of my invention.

Referring to Figs. 1 and 4, 101 is the body of a valve with connected motor cylinder.

102 is the chest within which works the secondary valve controlling the supply of motive fluid to the motor cylinder.

103 is the main valve stem, and 104 the secondary valve stem.

105 is a bracket extending out from the body of the valve and terminating in a bearing which supports and within which may freely revolve the shaft 107. To one end of this shaft is rigidly fastened the operating handle 108, and to the other end the arm 109. This arm 109 carries at its extremity a stud 110, upon which rotates a gear 111.

112 is a segmental internal gear revolving loosely upon the shaft 107.

113 is a segmental external gear which revolves freely upon the hub 118 of the gear 112. The gear 112 is provided with lugs 116 to which is pivoted the link 114 connecting with the main valve stem 103. The gear 113 is also provided with lugs 117, to which is likewise pivoted another link 115 connecting with the secondary valve stem 104. These two gears 112 and 113 perform respectively the afore described functions of primary and secondary gears and will according be hereinafter so denominated. The gear 111 meshes both with the primary and secondary gears 112 and 113 and performs the afore described function of an intermediate gear. It will be so denominated hereinafter. In the position shown, the secondary valve is assumed to stand in such position as to close the ports leading to the motor cylinder. This confines the motive fluid and prevents any motion of the main valve stem.

The operation is as follows: When it is desired that the main valve stem 103 be shifted to the left, the operating handle 108 is moved to the right. This causes the arm 109 to travel toward the left and the stud 110 to describe the arc of a circle parallel to the pitch line of both the primary and secondary gears 112 and 113. Any movement of the stud 110 along this line will not change the distance between the centers of the gears and consequently they will continue to mesh. As the primary gear 112 is prevented from rotating by being connected through the link 114 with the yet stationary main valve stem, the motion of the stud 110 compels the intermediate gear to rotate, the top of gear traveling in the same direction that the arm 109 is moved. Accordingly the arm 109 being moved to the left, the gear 111 rotates left handed or contrariwise to the hands of a watch, and the secondary gear 113 meshing with it will be made to rotate right handed or with the hands of a watch. This carries the lugs 117, connecting link 115 and secondary valve stem 104 all to the right which opens the secondary valve to so permit the flow of fluid to or from the motor cylinder as to move the main valve stem 103 to the left, the direction desired. So soon, however, as the main valve stem 103 begins to move, its motion is transmitted through the link 114 to the lugs 116 causing the primary gear 117 to revolve, in this case right handed or with the hands of a watch. The intermediate gear 111 now acts as an idler and the necessary gear 113 revolves left handed moving the link 115 and the secondary valve stem 104 back to the left until the secondary valve is again closed and the main valve stem 103 thus brought to rest in its new position. In a similar manner the main valve stem can be shifted to the right by moving the operating handle 108 to the left. This form of my invention requires a construction of pilot valve in which the motions of the main and secondary valves are in opposite directions. One such construction has been shown in Fig. 8. Others with different arrangements of pistons and passages can be readily devised.

In the modified form shown in Figs. 2 and 5 the primary and secondary gears take the form of parallel racks, designated respectively by the numerals 212 and 213, and connected direct to the main and secondary valve stems 203 and 204. Two projecting brackets 205 and 206 are provided each with a guide 220 and 219 through which slides a bar 209 in a direction parallel to the pitch lines of the racks. Near its middle this bar is provided with a hub 221 which makes a center bearing for the shaft 210. This shaft 210 has rigidly attached to it at one end a gear 211^a meshing with the secondary rack 213 and at the other end another gear 211^b, likewise rigidly attached, meshing with the primary rack 212. These two gears 211^a and 211^b taken together make a compound intermediate gear and by making them of different diameters I get an easy means of multiplying or reducing the motion between the primary and secondary racks. The racks are held in line by lugs projecting from the brackets 205 and 206. The operating handle 208 is attached directly to the bar 209. The operation is so similar to that just described for the first form, that the following epitome will suffice to make it clear. Movement of the operating handle 208 to the right moves the secondary valve stem 204 in the same direction which, by opening the secondary valve, causes the main valve stem and primary rack connected with it to move to the right. This in turn makes the intermediate gears 211^a and 211^b rotate left handed, pushing the secondary valve stem 204 back to the left, closing the secondary valve, and thus bringing the main valve stem to rest. With this and also with the following form of my invention, a construction of valve in which the motions of main and secondary valves are in the same direction must be employed. The valve shown in Fig. 7. is of such construction as are also numerous other of the pilot valves now in use.

Attention may here be called to the well known principle of pilot valve construction that the arrangement of the secondary valve and ports leading therefrom to the motor cyl-

inder must be such that when the secondary valve is opened by movement of the operating handle the motion thereby set up in the main valve stem shall be in such direction that the movement transmitted to the secondary valve will be in a direction opposite to that given it by the initial movement of the operating handle. This is necessary in order that movement of the main valve stem shall close the secondary valve.

In the third modification of my invention shown in Figs. 3 and 6, 312 is the primary gear and 313 the secondary gear. Both these gears revolve freely upon the shaft 307, which shaft is supported by the brackets 305^a and 305^b. These primary and secondary gears are connected with the main and secondary valve stems by the racks 314 and 315. A projecting lug can be attached to the bracket arm 305^a (see Fig. 6) to hold the rack 314 in place and another lug to the bracket arm 305^b to hold the rack 315 in place; but as these lugs form no part of my invention and can be readily supplied by any intelligent mechanic I have omitted them from my drawings since their presence would tend to obscure the other parts.

309 is a two armed bracket swinging freely on the shaft 307. One arm of this bracket carries the shaft 310^a, and the other arm carries the shaft 310^b. These two shafts carry the intermeshing train of intermediate gears 311^a, 311^b, 311^c and 311^d, the first 311^a, meshing with the primary gear 312, and the last, 311^d, meshing with the secondary gear 313. The sizes of the intermediate gears 311^a, 311^b, 311^c, and 311^d, may be so proportioned as to secure any desired reduction or multiplication of motion between the primary and secondary gears. The operating handle 308 is connected directly to the bracket 309. The operation is as follows: Movement of the operating handle 308 to the right swings the diametrically opposite arm 309 to the left carrying with it the shafts 310^a and 310^b. The first intermediate gear 311^a meshing with the yet stationary primary gear 312 is made to rotate right handed. The second intermediate gear 311^b rotates in the same direction since both the gears 311^a and 311^b are made fast to the same shaft 310^a. The third intermediate gear 311^c meshing with the gear 311^b must rotate in the opposite direction or left handed. The fourth intermediate gear 311^d is connected with the third intermediate gear 311^c by the shaft 310^b and hence must rotate left handed also. This makes the secondary gear 313 rotate right handed, carrying the rack 315 and connected secondary valve stem, to the right. This so opens the secondary valve as to cause the main valve stem 303 to be shifted to the right, carrying the rack 314 in the same direction. This causes the gears to rotate as follows: 312 right handed, 311^a and 311^b left handed, 311^c and 311^d right handed and 313 left handed. The rack 315 is now carried to the left moving the secondary valve stem 304 in the same direction, closing the secondary valve again and thus bringing the main valve stem to rest.

It will be observed that in all the forms shown the arrangement of the intermediate gearing is such that it changes the direction of the motion transmitted from the primary to the secondary gear. It is essential that either the direction or velocity of motion of the primary and secondary gears be thus changed, for otherwise during adjustment of position, the intermediate gearing would roll over the faces of both primary and secondary gears alike, and no motion would be imparted to the latter.

Other methods of arranging and combining the gears will occur to the intelligent mechanic and it is also evident that any of the ordinary substitutes for toothed gearing, such as belts or bands of flexible tape or chains may be employed instead; but toothed gearing being simpler and more reliable is to be preferred. Therefore without limiting myself to any particular forms or arrangement or gears,

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination with a hydraulic valve, a motor cylinder attached thereto, and a secondary valve for controlling the flow of motive fluid to or from the motor cylinder, of two gears arranged with their pitch lines parallel and connected one gear with the main valve stem and the other gear with the secondary valve stem, a third gear in mesh with both the two afore mentioned gears and adjustable along a path parallel to their pitch lines, and means for adjusting the position of this intermediate gear, all substantially as and for the purpose specified.

2. The combination with a hydraulic valve, a motor cylinder attached thereto, and a secondary valve for controlling the flow of motive fluid to or from the motor cylinder; of a primary gear suitably connected with the main valve stem, a secondary gear suitably connected with the secondary valve stem, intermediate gearing adjustable by translation but always remaining in mesh with both the afore mentioned primary and secondary gears, and means for adjusting the position of this intermediate gearing, all for the purpose specified.

3. The combination with a hydraulic valve, a motor cylinder attached thereto, and a secondary valve for controlling the flow of motive fluid to or from the motor cylinder, of two gears suitably connected, one with the main valve stem, the other with the secondary valve stem, intermediate gearing mounted upon a movable carriage and adapted to transmit motion from one of the above gears to the other, said movable carriage, and means for effecting change in position of the carriage, all for the purpose set forth and specified.

4. The combination with a hydraulic valve, a motor cylinder attached thereto, and a sec-

ondary valve for controlling the flow of motive fluid to or from the motor cylinder, of two gears set upon a common axis, a radial arm adjustable about this same axis, suitable connections from one of the gears to the main valve stem and from the other gear to the secondary valve stem, a third gear mounted upon the radial arm and meshing with each of the two afore mentioned gears, and suitable means for effecting adjustment of the radial arm, all substantially as described and for the purpose set forth.

5. The combination with a hydraulic valve, a motor cylinder attached thereto, and a secondary valve for controlling the flow of motive fluid to the motor cylinder, of a "primary" piece so connected with the main valve stem as to always move therewith, a "secondary" piece connected with the secondary valve so as to always move therewith, and through a path parallel to the path traversed by the afore mentioned "primary" piece, an axis adjustable along a path parallel to the paths of motion of the primary and secondary pieces, means for effecting adjustment of this axis; a wheel revoluble upon this adjustable axis, and connections between this wheel and both primary and secondary pieces, adapted to transmit motion from one to the other.

WILLIAM F. COLE.

Witnesses:
FRED. E. KNIGHT,
G. A. MITCHELL.

Corrections in Letters Patent No. 525,693.

It is hereby certified that in Letters Patent No. 525,693, granted September 11, 1894, upon the application of William F. Cole, of Worcester, Massachusetts, for an improvement in "Valve-Gear," errors appear in the printed specification requiring correction as follows, viz: In line 57, page 1, the period following the word "gears" should be stricken out and a comma inserted instead, and the following word "Whether" should begin with a small "w," thus making a continuous sentence; in line 26, page 3, the word "according" should read *accordingly*, and in line 71, same page, the word "necessary" should read *secondary;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 2d day of October, A. D. 1894.

[SEAL.]

JNO. M. REYNOLDS,
Assistant Secretary of the Interior.

Countersigned:

S. T. FISHER,
Acting Commissioner of Patents.