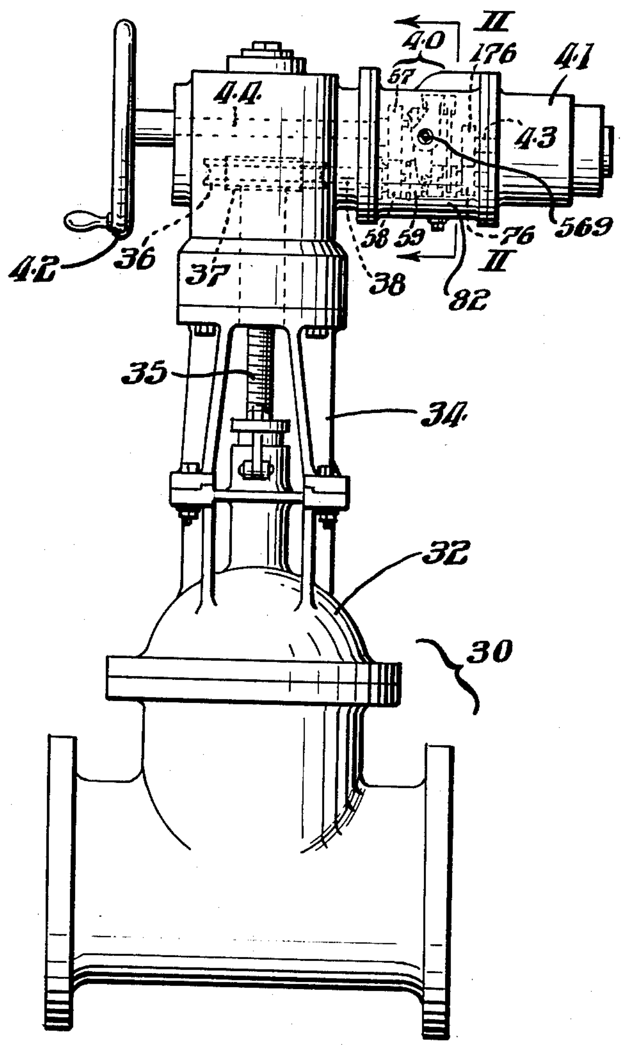
Feb. 9, 1965 S. I. CALDWELL ETAL 3,168,841

HANDWHEEL DECLUTCH DEVICE

Filed May 25, 1961 12 Sheets-Sheet 1

FIG. 1



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Feb. 9, 1965 S. I. CALDWELL ET AL 3,168,841

HANDWHEEL DECLUTCH DEVICE

Filed May 25, 1961 12 Sheets-Sheet 2

FIG. 2

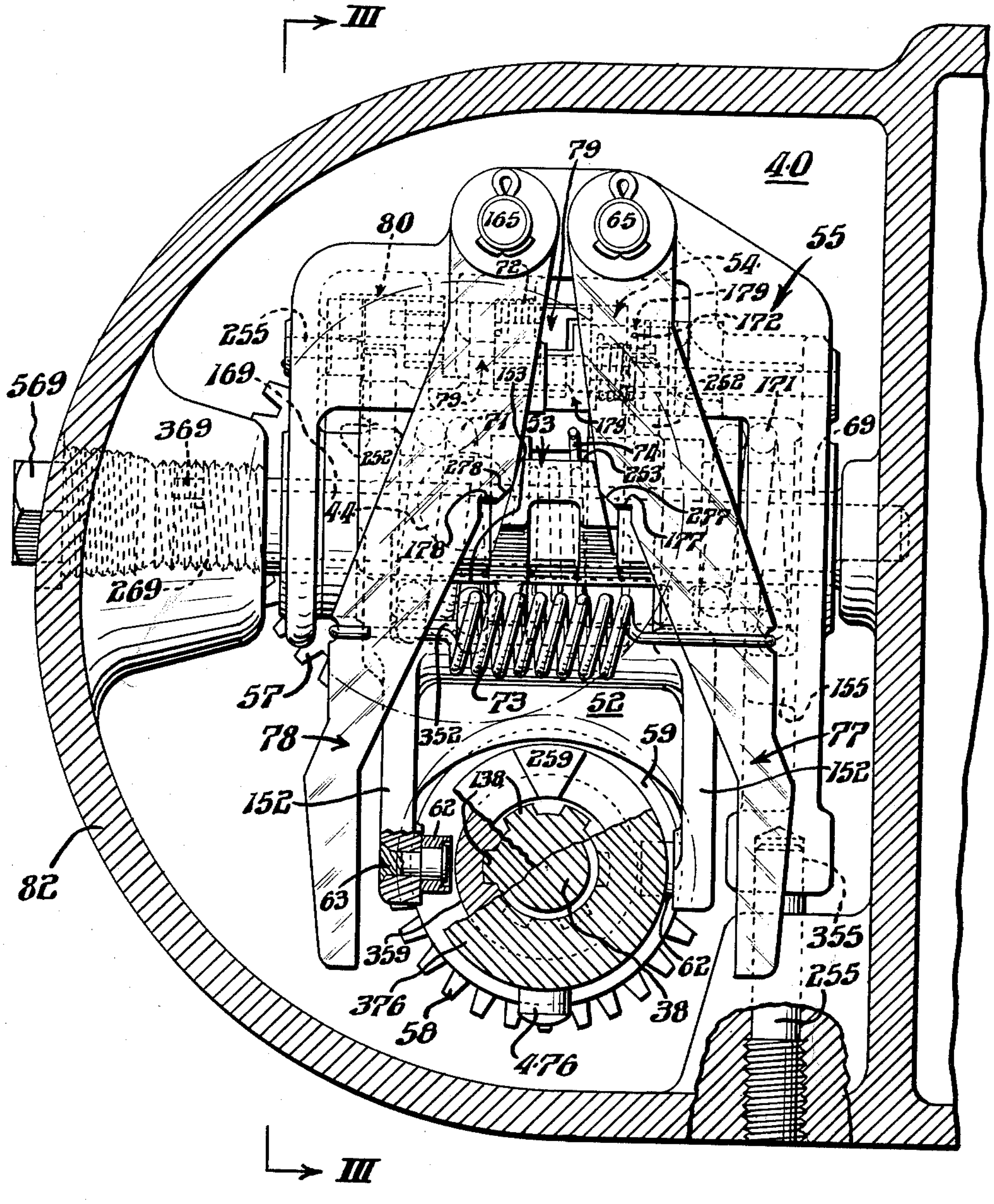

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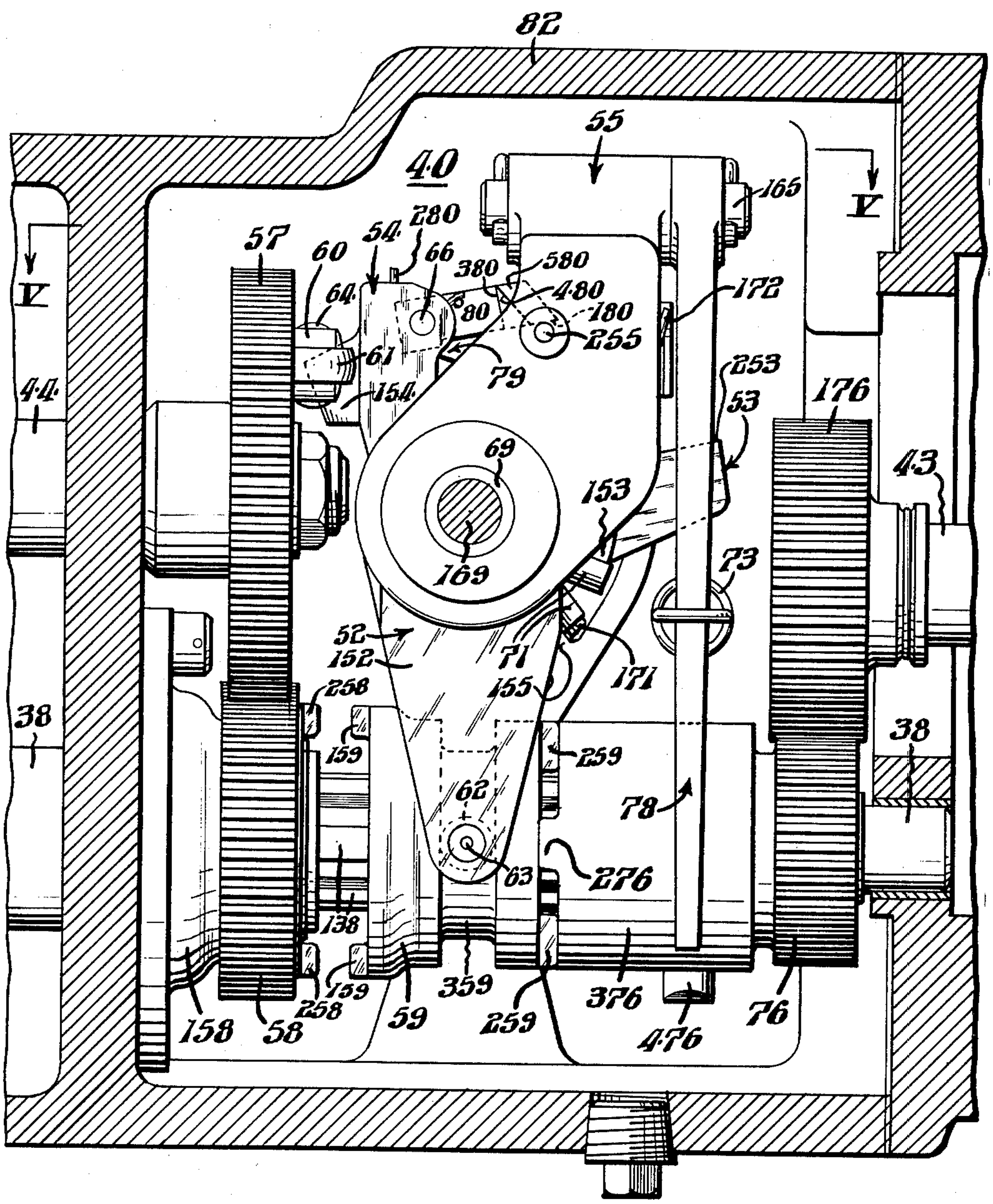
FIG. 3



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Filed May 25, 1961

12 Sheets-Sheet 4

FIG. 4

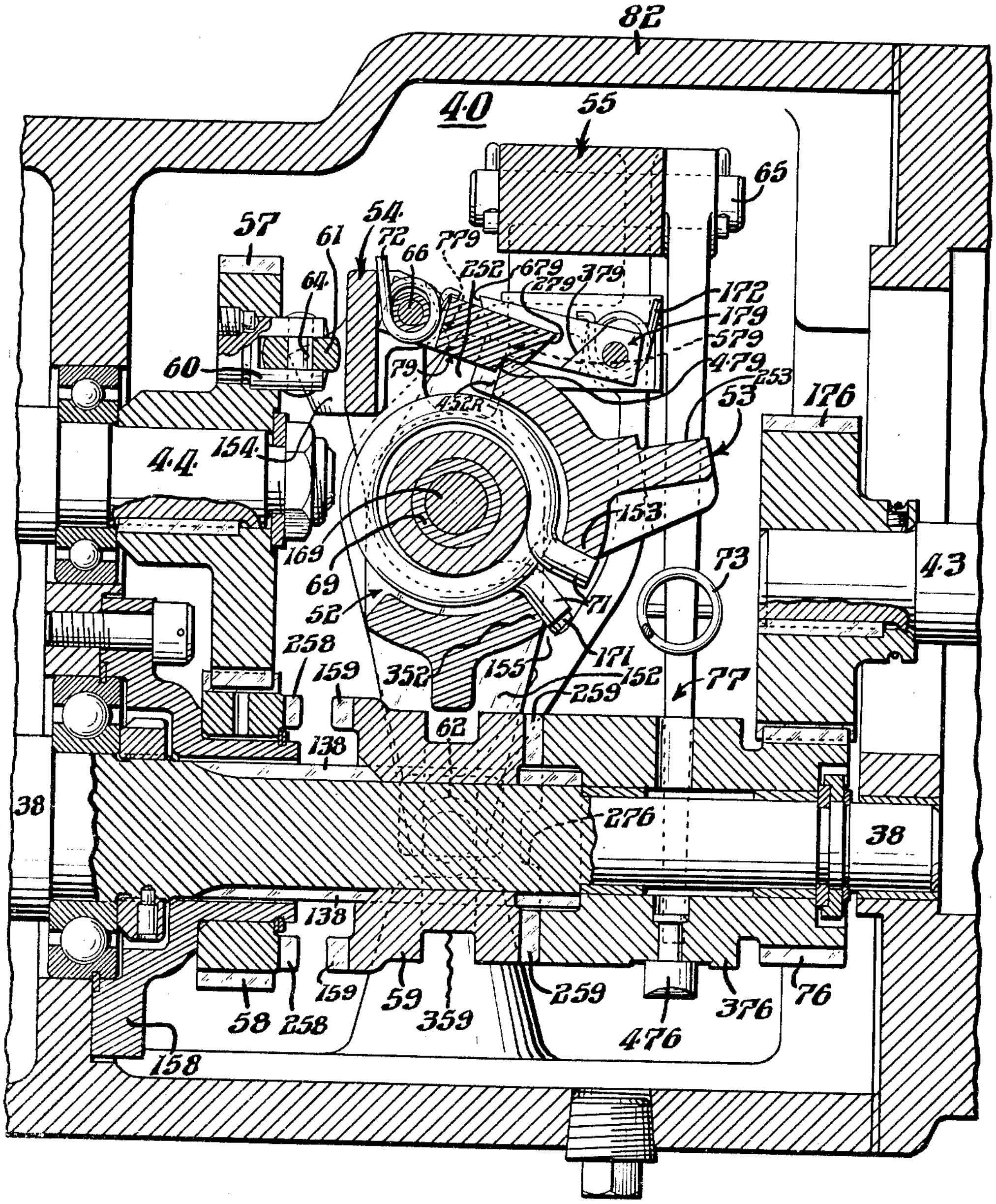

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FIG_5_

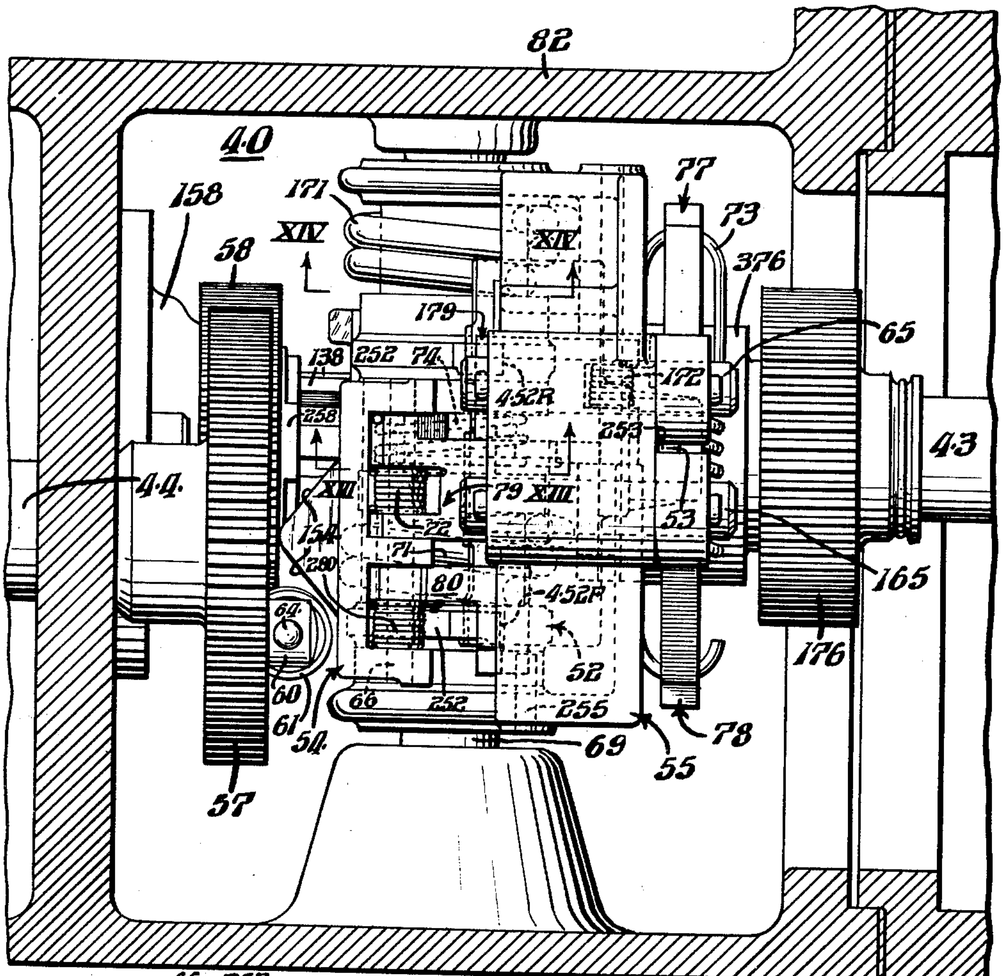

FIG_13_

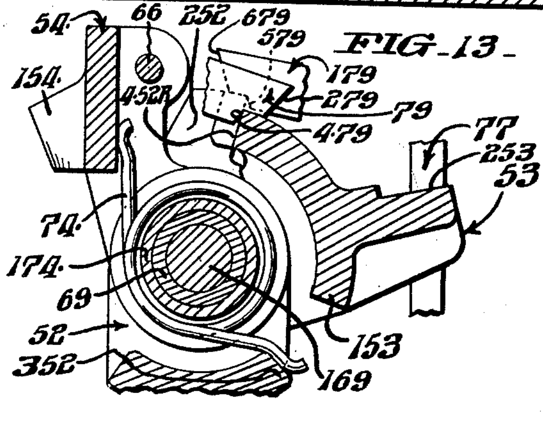

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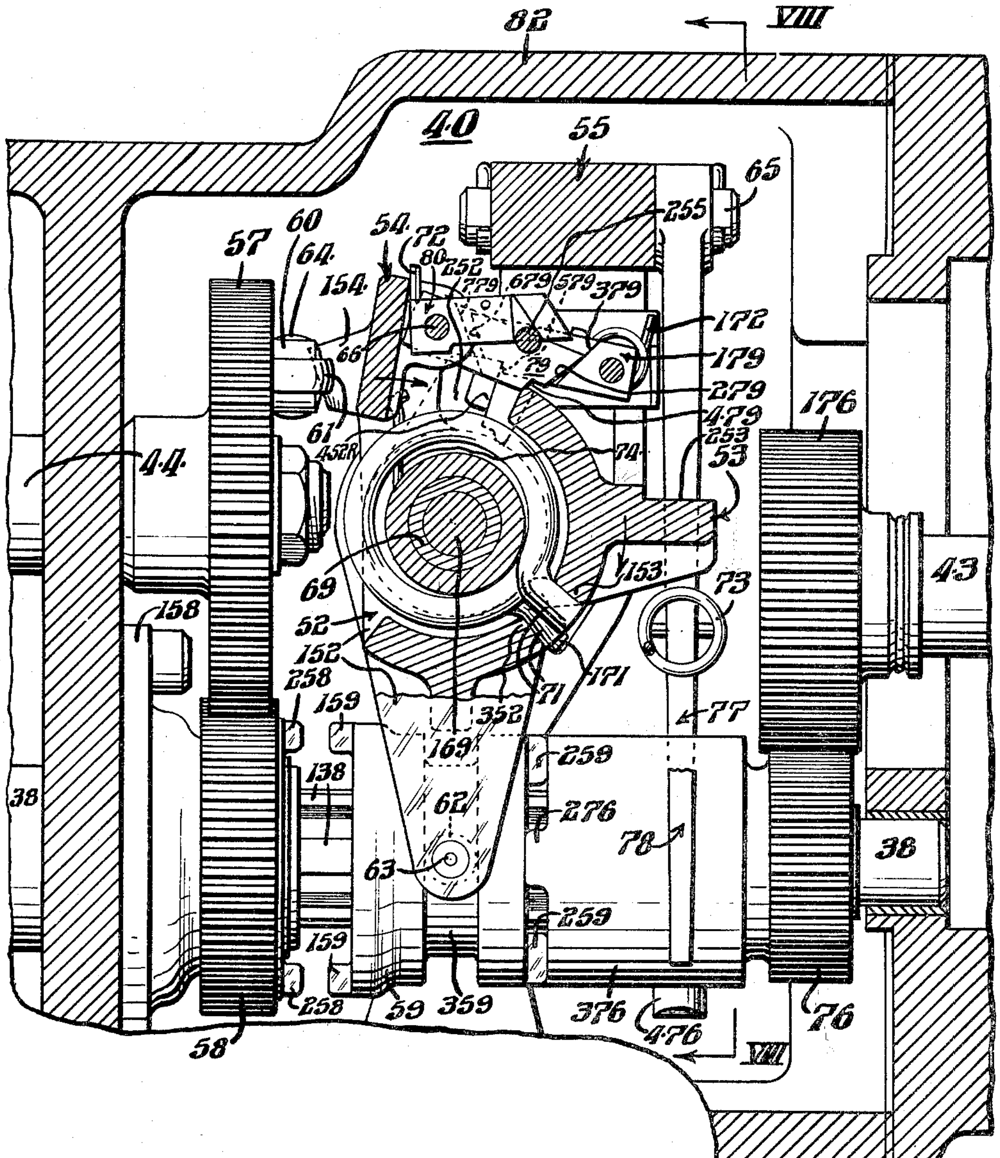
FIG. 6



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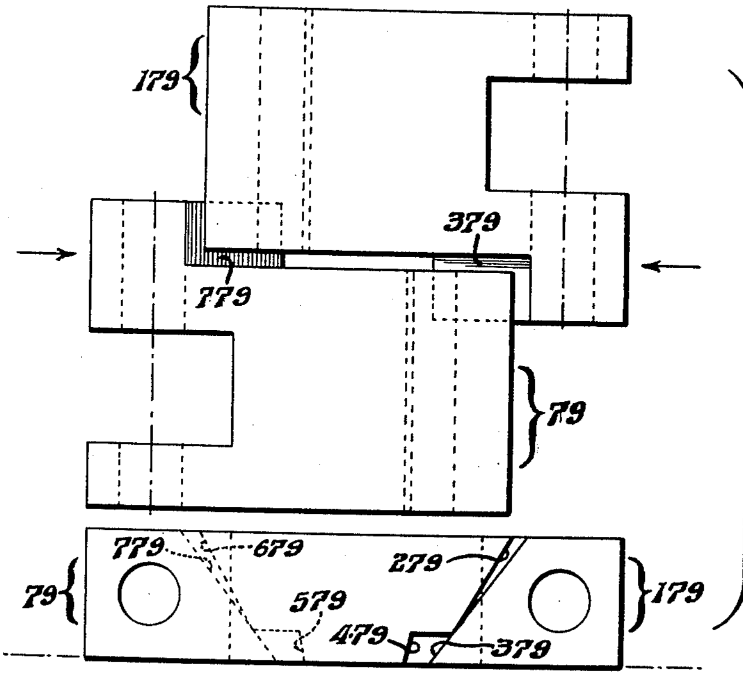

FIG. 7.

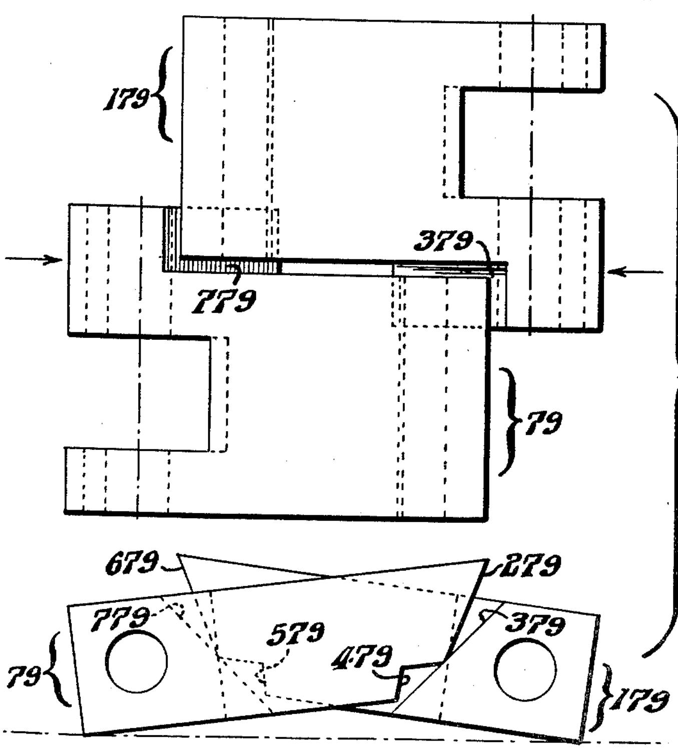

FIG. 7a.

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Feb. 9, 1965 S. I. CALDWELL ETAL 3,168,841

HANDWHEEL DECLUTCH DEVICE

Filed May 25, 1961 12 Sheets-Sheet 8

FIG. 8

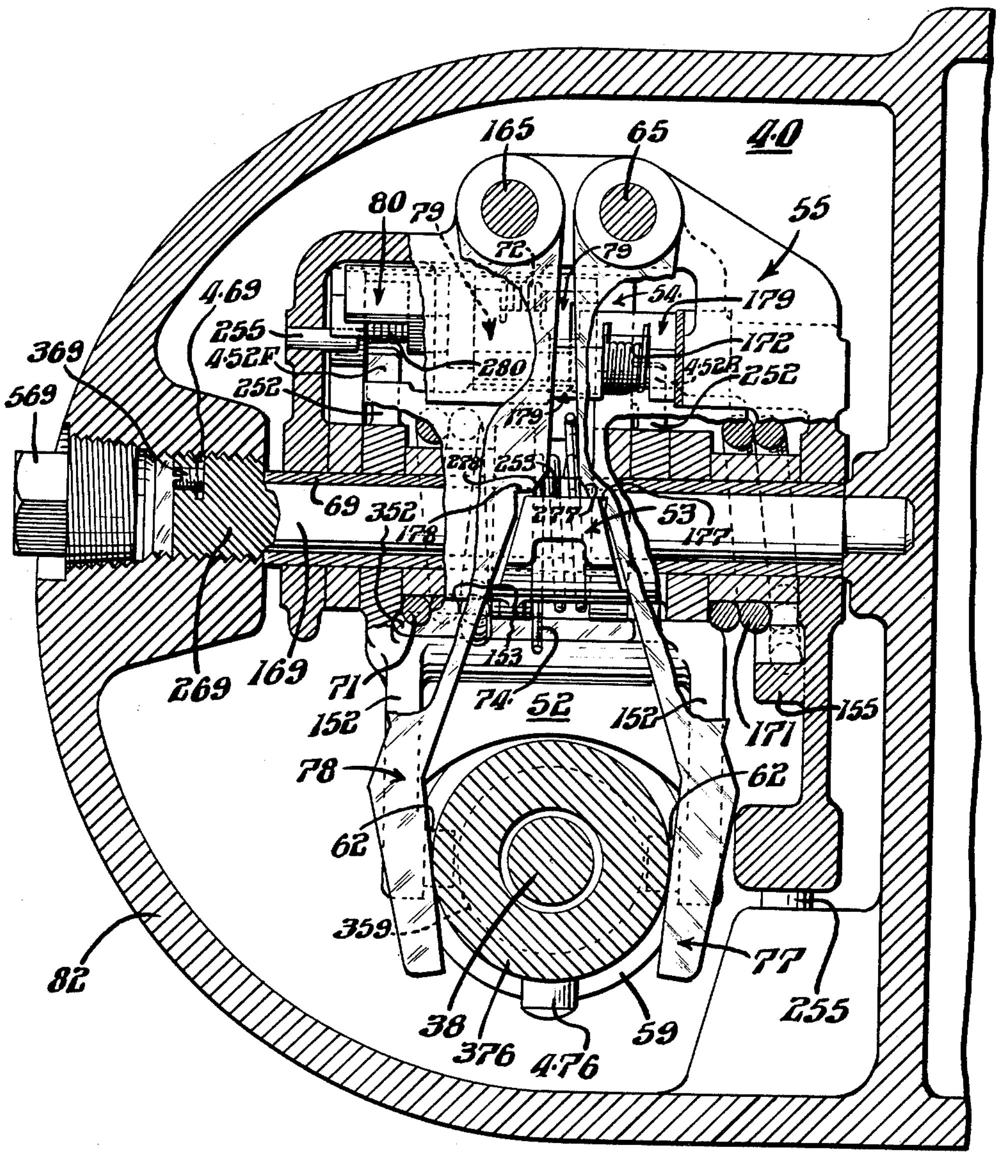

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FIG. 9

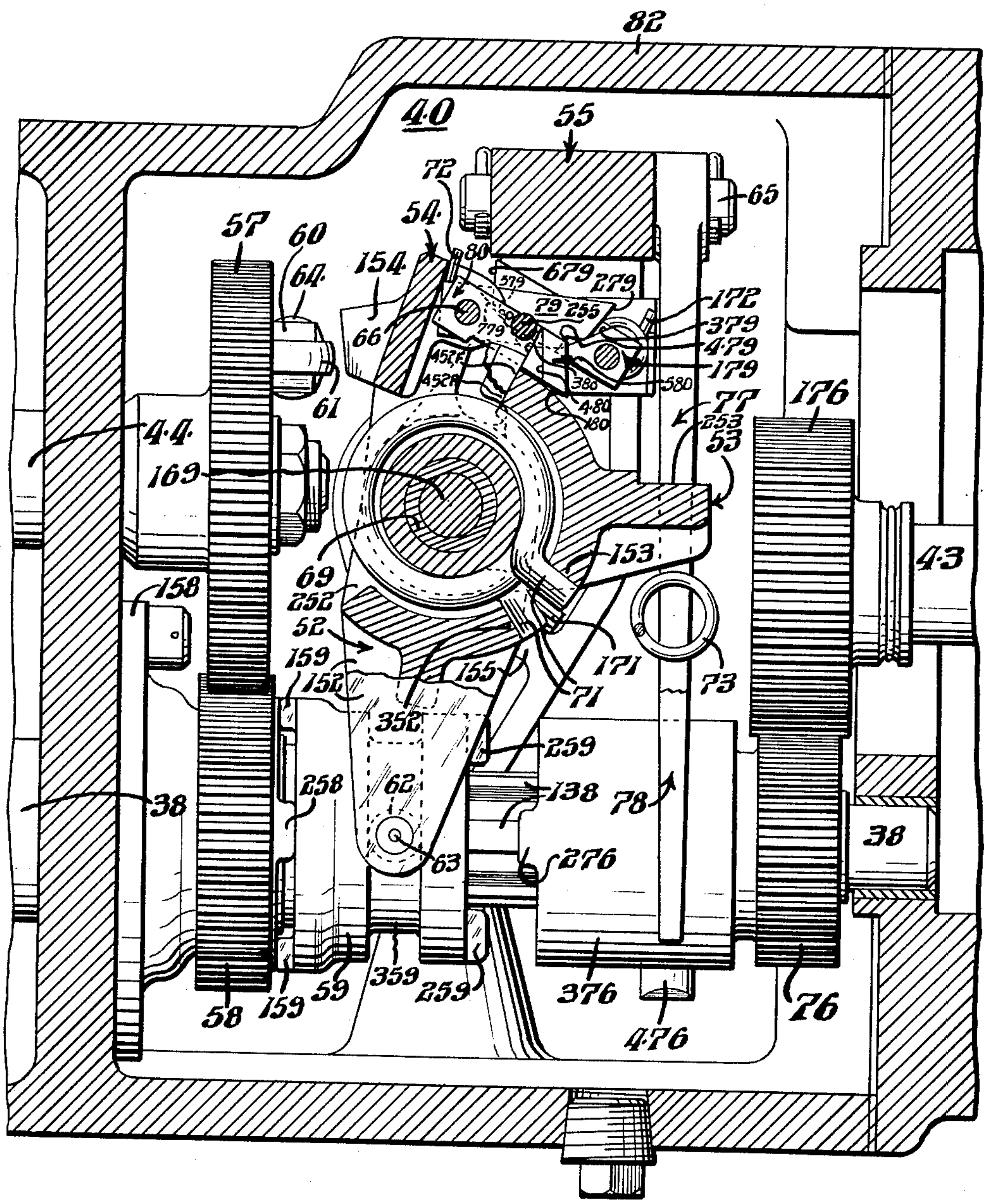

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FIG-10-

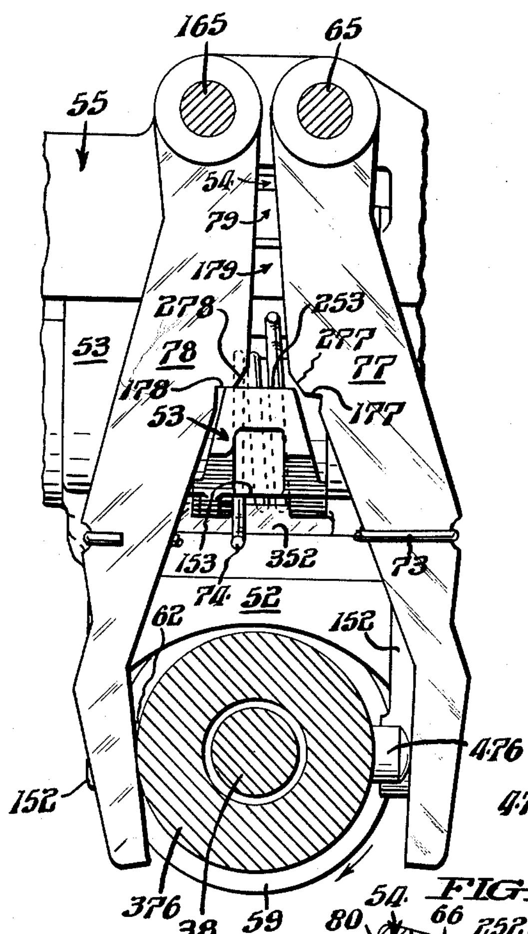


FIG-11-

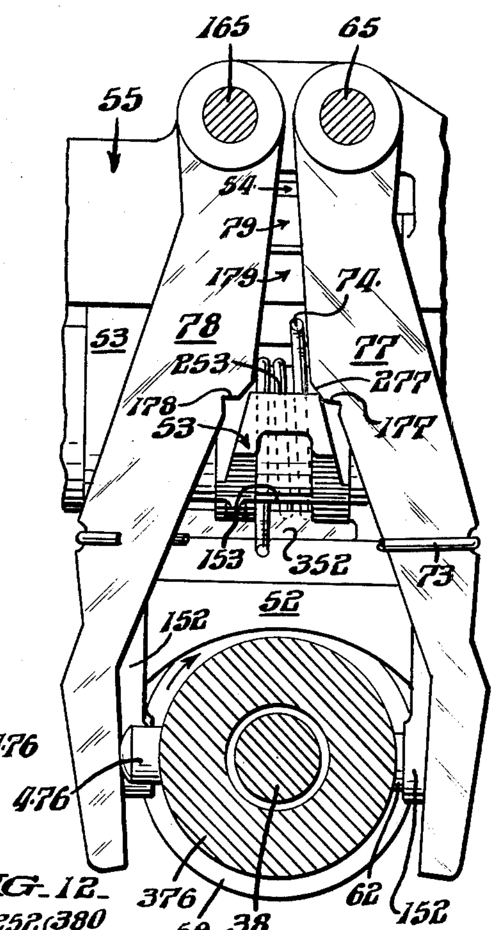
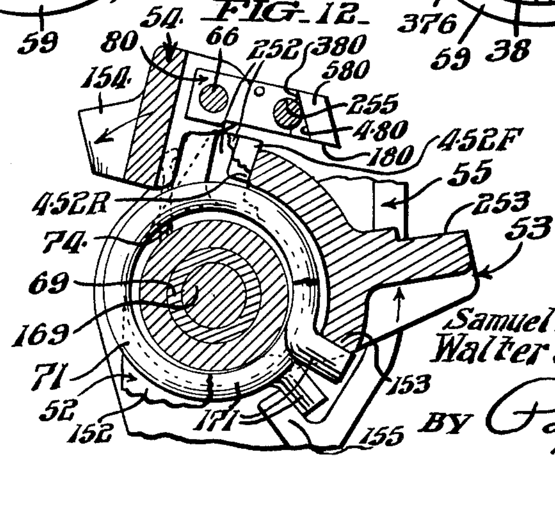


FIG-12-



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HANDWHEEL DECLUTCH DEVICE

Filed May 25, 1961 12 Sheets-Sheet 11

FIG. 15

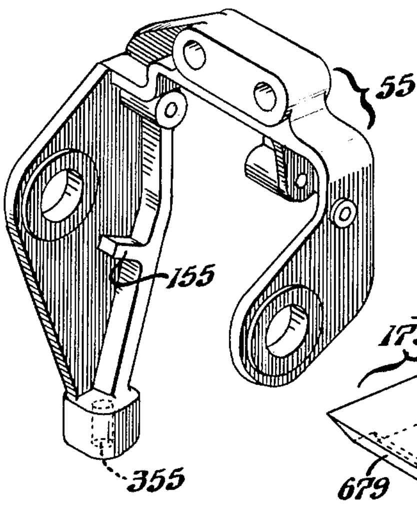


FIG. 16

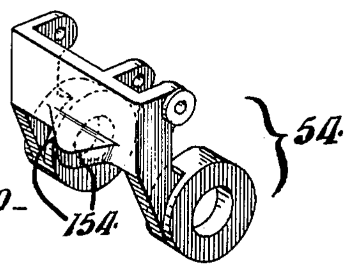


FIG. 20

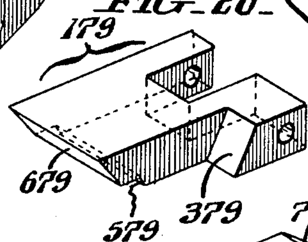


FIG. 21

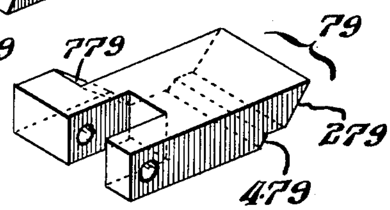


FIG. 17

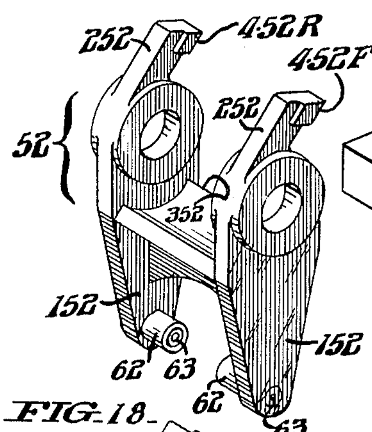


FIG. 22

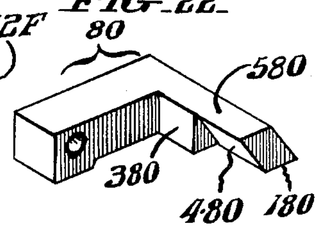


FIG. 14

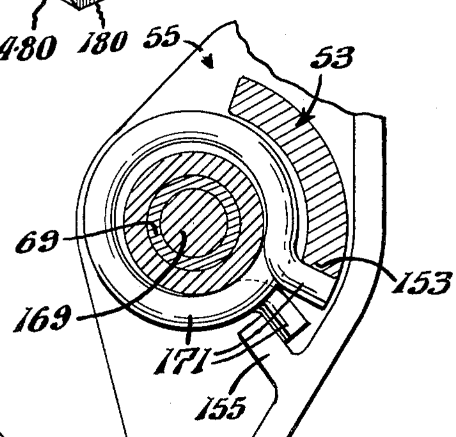


FIG. 18

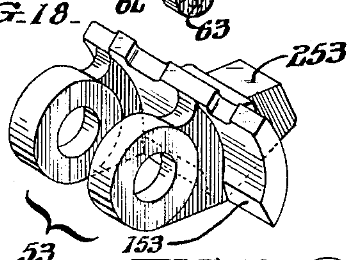
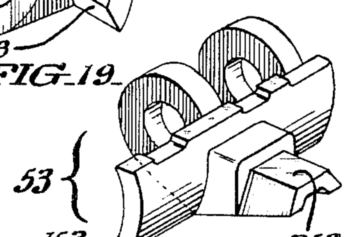


FIG. 19



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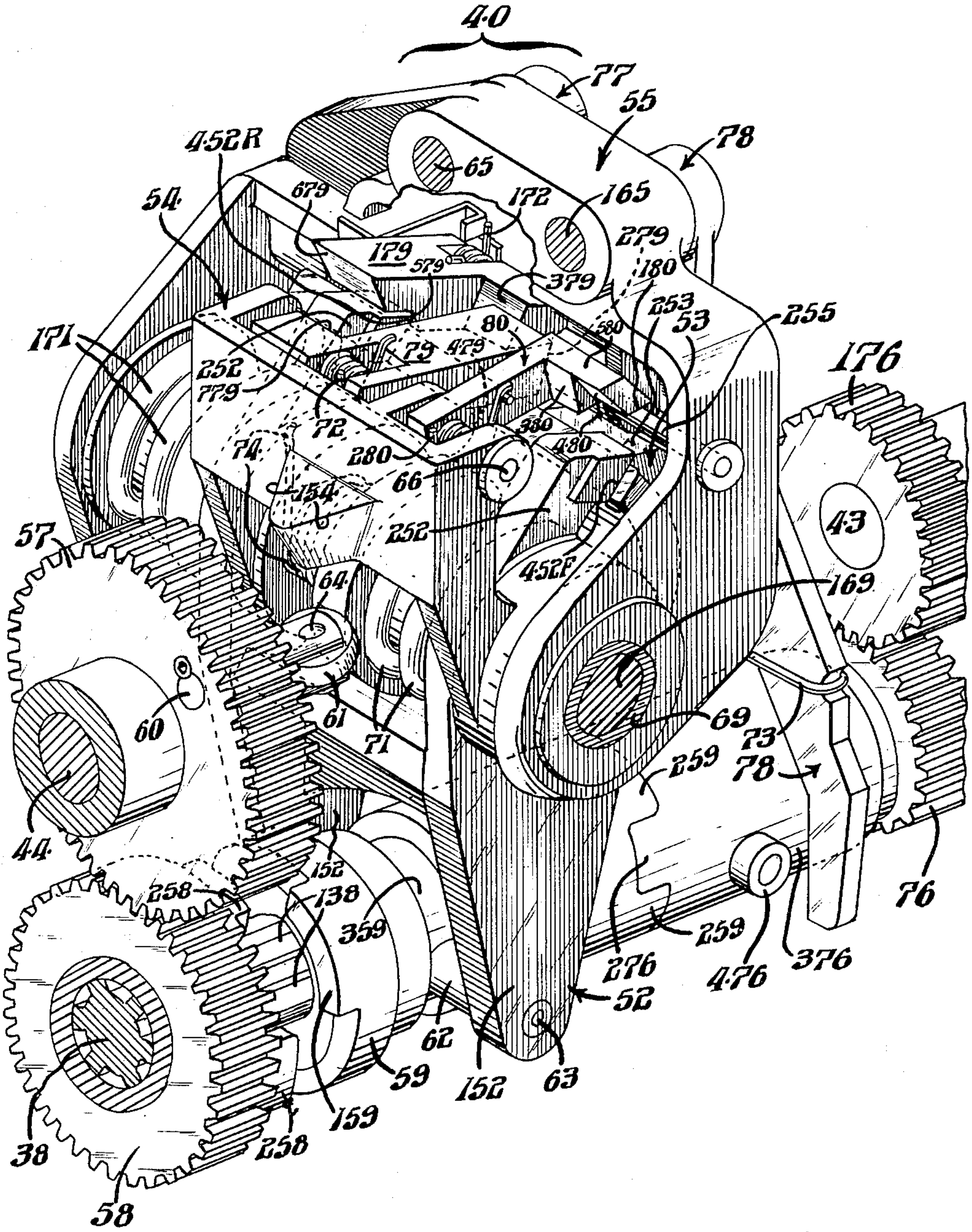
Feb. 9, 1965 S. I. CALDWELL ETAL 3,168,841

HANDWHEEL DECLUTCH DEVICE

Filed May 25, 1961 12 Sheets-Sheet 12

FIG. 23



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3,168,841
Patented Feb. 9, 1965

3,168,841

HANDWHEEL DECLUTCH DEVICE

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Filed May 25, 1961, Ser. No. 125,888
8 Claims. (Cl. 74—625)

This invention relates to clutch means adapted for automatically disconnecting a driven device from one inactivated driving means and connecting it to another activated driving means in response merely to the activation of said other driving means at a time when said one driving means at a time when said one driving means is inactive.

The invention relates particularly to clutch means adapted for automatically disconnecting a driven device from motor drive and coupling it to manual drive in response to the mere rotation of a hand wheel at a time when the power is off and the motor is not running, and for automatically returning to motor drive and de-coupling the manual drive in response merely to the energization and rotation of the motor.

The invention is particularly adapted for use with valves which are intended for motor operation but for which handwheel operation must be provided to take care of power failure or other emergency situations.

While, as just indicated, the invention is particularly adapted for use with motor-driven valves, and while the invention will be described in detail as applied to a motor-driven valve, the utility of the invention is not limited thereto, as will be apparent from the description which follows.

A broad object of the present invention is, therefore, to provide clutch means adapted for disconnecting from a driven device a de-energized motor drive and connecting thereto manual drive means in response merely to the rotation of the manual drive means at a time when the motor drive is rotationally immobile, and adapted for reconnecting the motor drive and de-coupling the manual drive means in response merely to the energization and rotation of the motor drive means, without need for operating any levers or any other selection mechanisms to effect transfer from motor drive to manual drive, and vice versa.

Another object is to provide, for valves which in the normal course of operation are motor driven, clutch means adapted for disconnecting the motor drive and connecting the handwheel drive in response merely to the rotation of the handwheel at a time when the motor drive is motionless, and adapted to return the valve to motor drive in response merely to the rotation of the motor drive.

Another object is to provide, for a motor-driven valve, clutch means adapted to disengage a de-energized motor drive and to engage a handwheel drive in response to the mere rotation of the handwheel, and to disengage the handwheel drive and engage the motor drive in response to the mere rotation of the motor drive, without the employment of any levers or other selection means, and without allowing the slidable clutch element to get into a neutral position that the valve is not connected to either motor drive or handwheel drive.

The foregoing and other objects and advantages of the invention are accomplished by a clutch mechanism which includes an axially slidable clutch element which is shifted by spring action in both directions. The slidable clutch element is spring-shifted in one direction to disengage the motor drive and engage the handwheel drive, and is spring-shifted in the opposite direction to disengage the handwheel drive and engage the motor drive.

To effect the shifts, two springs are employed, one for each direction, but only one spring is effective at any one time. Being spring-shifted in both directions, the slidable clutch element never remains in a mid or neutral position. Except for the extremely short interval of time necessary for the slidable clutch element to pass from one position to the other, the slidable clutch element is always in either motor drive or handwheel drive engagement.

The invention will be clearly understood from a consideration of the following detailed description of a preferred embodiment selected for illustration in the drawing in which:

FIG. 1 is a side elevational view of a valve of the type in which the handwheel de-clutch device of the present invention may be usefully employed;

FIG. 2 is an end view, partly in section, partly broken away, along the line II—II of FIG. 1 looking in the direction of the arrows, showing the position of the parts when in motor drive engagement;

FIG. 3 is a side view, partly in section, along the line III–III of FIG. 2 looking in the direction of the arrows, showing the position of the parts when in motor drive engagement;

FIG. 4 is a side view similar to FIG. 3 but with the parts broken away and in section;

FIG. 5 is a top or plan view, partly in section, along the line V—V of FIG. 3 looking in the direction of the arrows;

FIG. 6 is a side view similar to that of FIG. 4, but with the parts shown moved to the positions occupied at the start of the shift to handwheel engagement;

FIGS. 7 and 7*a* are diagrammatic illustrations helpful in explaining the scissors-like action of the loading and holding pawls;

FIG. 8 is an end view, partly broken away and in section, along the line VIII—VIII of FIG. 6 looking in the direction of the arrows, showing one possible position of the parts during the shift to handwheel engagement;

FIG. 9 is a side view similar to FIG. 6 showing the parts in the positions which they occupy after completion of the shift to handwheel engagement;

FIGS. 10 and 11 are views similar to that of a portion of FIG. 8 showing the positions of the trippers when the motor is running and the motor clutch gear is rotating during the shift back to motor operation;

FIG. 12 is a view showing the positions of the parts during the shift back to motor engagement;

FIG. 13 is a view of a portion of FIG. 5 along the line XIII—XIII of FIG. 5 looking in the direction of the arrows showing the positions of the tripper lever and cam after the shift back to motor engagement;

FIG. 14 is a view of a portion of FIG. 5 along the line XIV—XIV of FIG. 5 looking in the direction of the arrows showing the spring which effects the shift back to motor engagement;

FIGS. 15–22 are perspective views of a number of the component parts of the clutch mechanism of the present invention; and

FIG. 23 is a perspective view of the clutch mechanism showing the positions of the parts when in motor engagement.

In describing the preferred embodiment of the invention illustrated in the drawing, specific terminology has been resorted to for the sake of clarity. However, it is not our intention to be limited to the specific terms so selected, and it is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar purpose.

Also, attention is called to the fact that, in describing the mechanism and its operation, it has been convenient at times to identify parts or components as having an "upper surface," or a "lower portion," or as moving "clockwise," etc. In each case, such terms as these refer, of course, to the mechanism as viewed in the drawing of this patent application. It is to be understood that the actual mechanism will function in any position and is not dependent for its satisfactory operation upon being in an upright, or for that matter, any other position.

Referring now to the drawing, FIG. 1 shows a typical valve utilizing the clutch mechanism of the present invention. As shown in FIG. 1, the valve comprises a valve casing 30 (containing a valve gate, not shown), a valve bonnet 32, a valve yoke 34, and a valve spindle or stem 35 driven by a worm gear 36 and a worm 37. By means of the clutch mechanism 40 of the present invention, the worm drive shaft 38 is coupled to either the motor 41 or to the handwheel 42. Thus, the worm shaft 38, worm 37, worm gear 36 and valve stem 35 are driven either by the motor 41 or by the handwheel 42 as determined by the position of the slidable clutch element 59.

Since the valve will normally be motor operated, the clutch mechanism 40 is arranged normally to connect the motor drive shaft 43 to the worm drive shaft 38. When the motor drive becomes de-energized, as by power failure or other cause, and handwheel operation is to be employed, the operator merely turns the handwheel in one direction or the other, according to whether he wants to open or close the valve gate. The mere rotational movement of the handwheel is sufficient to cause the slidable clutch element 59 of the present invention is disengage from the motor drive and to connect the handwheel shaft 44 to the worm drive shaft 38. The clutch element 59 then remains in handwheel drive engagement until the motor drive is energized, at which time the mere rotation of the motor drive means causes the clutch element 59 to return to motor drive engagement.

FIG. 3 is a view partly in section of a clutch mechanism 40 which embodies the present invention. The clutch per se is a three-element clutch assembly comprising as a first element the motor clutch gear 76, as a second element the handwheel clutch pinion 58, and as a third element the slidable clutch element 59. The motor clutch gear 76 is mounted on bushings and is free to rotate on the worm shaft 38. The handwheel clutch pinion 58 is mounted on a projection of the bearing cap 158 and is free to rotate on it. The motor clutch gear 76 is in constant engagement with the motor drive shaft gear 176. Similarly, the handwheel clutch pinion 58 is in constant engagement with the handwheel spur gear 57. The motor drive shaft gear 176 is fixed to the motor shaft 43 and rotates therewith. The handwheel spur gear 57 is fixed to the handwheel shaft 44 and rotates when the shaft 44 is rotated by the handwheel 42.

The motor clutch gear 76 has a barrel 376 integral therewith and extending to the left, as viewed in FIG. 3. The barrel 376, and also the handwheel clutch pinion 58 have lugs, 276 and 258, respectively, cut on one face thereof, and the gear 76 and pinion 58 are so positioned on the worm shaft 38 that these lugs extend toward each other. That portion of the worm shaft 38 which is located between barrel 376 of the motor clutch gear 76 and the handwheel clutch pinion 58 is equipped with splines 138. Riding upon and engaging with the splines is a slidable clutch element 59 having jaws, 259, 159, cut on each end for the purpose of engaging either the lugs of the barrel 376 of motor clutch gear 76 or the lugs of the handwheel pinion 58. The axial distance between the lugs of the gear barrel 376 and pinion 58 is made sufficiently long so that the jaws 259 at one end of clutch element 59 must completely disengage from the lugs 276 of barrel 376 before the jaws 159 at the opposite end of the clutch element 59 can make contact with the lugs of the pinion 58, and vice versa. Thus, the jaws of the clutch element 59 are never engaged at the same time with the lugs of both the motor clutch gear and the handwheel clutch gear.

Clutch element 59, being splined to worm drive shaft 38 and movable axially therealong, functions as the means of transmitting power from either gear 76 or pinion 58 to the worm drive shaft 38. Except for a brief instant during transfer, clutch element 59 is always engaged with either motor clutch gear 76 or handwheel clutch pinion 58. At no time is the clutch element 59 held suspended in an intermediate position, except momentarily when in moving from one gear to the other the jaws of the clutch element may hit the lugs of the gear. However, since the gear with which the clutch element 59 will be endeavoring to engage, will, in accordance with the operation of the device of the present invention, necessarily be rotating, the lug-on-jaw condition lasts but momentarily.

In prior-art models of which we have knowledge, the clutch element is spring shifted in one direction only. In such prior art models, the clutch element is either lever shifted or cam shifted in the opposite direction againts the force of the spring.

In contra-distinction to these prior art models, clutch element 59 of the present device is spring shifted in both directions. Two identical springs are used. One spring, identified as spring 71 in the drawing, causes clutch element 59 to shift to handwheel drive. The other spring, identified as spring 171, is used to shift the clutch element back to motor drive.

The mechanism of the present invention includes a main sub-assembly, which may be preferably bench assembled, on a pivot sleeve 69 which passes through a bracket 55. The form of bracket 55 is shown in FIG. 15. Within the arms of bracket 55, and pivotally mounted on the pivot sleeve 69, are three elements, namely, a fork 52, a tripper lever 53 and a cam 54. These elements are visible in a number of the assembly figures of drawing, including FIGS. 2 and 3, but, for clarifying purposes, their complete forms are separately shown in FIGS. 17 (fork 52), 18–19 (tripper lever 53) and 16 (cam 54).

As will be seen from FIG. 17, fork 52 has two pairs of arms, 152 and 252. Rotatably attached to arms 152, as by roller pins 63, are rollers 62. Rollers 62 extend inwardly towards each other, with their axes coinciding. They are spaced far enough apart axially so that they may engage in a circumferential groove 359 which is cut into the periphery of clutch element 59, as seen in FIGS. 2, 3 and other figures of the drawing. Thus, by limited rotation of the fork 52 about the pivot sleeve 69, clutch element 59 is moved axially along the splines 138 of worm shaft 38, within the bounds established by the motor clutch gear 76 and the handwheel clutch pinion 58.

As has already been indicated, the handwheel spur gear 57 is mounted upon and keyed to the handwheel shaft 44, and is in continuous mesh with the handwheel clutch pinion 58. Thus, rotation of the handwheel 42 (FIG. 1) produces an opposite and proportionate rotation of the handwheel clutch pinion 58.

As seen in FIGS. 3, 4, 5, 6, 9 and other figures of the drawing, a cam roller 61 is mounted by means of a bracket 60 on the face of handwheel spur gear 57, facing toward cam 54. Cam roller 61 is rotatably mounted on a roller pin 64 within bracket 60. This assembly, which is seen in cross section in FIG. 4, is so mounted and positioned on the spur gear 57 that the axis of the roller 61, when extended, intersects with the axis of the handwheel shaft 44, as seen in FIG. 4. The cam 54 is so positioned in the bracket assembly 55 that the cam lobes 154 coincide with the path of the cam roller 61. Thus, rotation of the handwheel 42 forces the cam 54 to be displaced angularly, in a clockwise direction as viewed in FIGS. 3, 4, 6, 9, 12 and 13, about the pivot sleeve 69. Clockwise cam rotation is continuously opposed by the cam return spring 74. During the shift into handwheel engagement, clockwise cam rotation is opposed by both shift springs 71 and 171 up to the instant when the drive or load pawl 79 is lifted out of engagement with the upper portion of skirt 153 of tripper lever 53. After this happens, neither shift spring has any effect on the counterclockwise rotation of the cam 54 for the remainder of the cycle.

Assume that, with the motor drive deenergized, handwheel 42 is rotated and that, as a result, cam roller 61 on spur gear 57 has forced cam 54 to be displaced angularly clockwise about the pivot sleeve 69. As a result the spring 171 becomes deflected beyond its normal deflection and hence becomes further loaded. At this point in the operation, no motion has been transmitted to fork 52. The spring 171 in its deflected loaded condition, just described, is not employed in making the shift from motor drive to handwheel drive but is employed later in the cycle of operation to effect the return shift from handwheel drive to motor drive.

Mounted upon the cam 54 is a pawl 79 which functions as a drive or load pawl. Pawl 79 is pivoted on a pin 66, and its free end is urged in a clockwise direction toward the pivot center of cam 54 by the action of a torsion spring 72. This is one of three identical torsion springs used in the device to bias three separate pawls. The free end of the pawl 79 is slanted (see FIG. 21) and forms a cam 279 which will engage upon a ramp 379 located on the side of an identical pawl 179 which is mounted in an opposing position within the bracket 55, and functions as a holding or firing pawl. Pawl 179 is rotatively urged in a counterclockwise direction toward the main assembly pivot center by a torsion spring 172.

As seen in FIGS. 21 and 20, on the lower side of each of the pawls 79 and 179, at the free ends thereof, is cut a shoulder, 479 and 579, respectively. These shoulders are used to push or to hold another component, as is required. Shoulder 479 of pawl 79 is used to push the tripper lever 53. Shoulder 579 of pawl 179 is used to hold the fork 52. The relative respective positions of these shoulders to the tripper lever 53 and to the rearward upper arm 252 of fork 52 may be seen in FIG. 4.

The action of the two pawls 79 and 179, when the pivotal axis of pawl 79 is moved, by the angular clockwise movement of cam 54, toward the fixed axis pawl 179, may best be explained by referring to the sheet of drawing containing FIGS. 7 and 7*a*. For the purpose of this explanation it may be assumed that the two pawls 79 and 179 are lying on a flat surface in the positions shown in the FIG. 7 with the axes of the pivot holes parallel to the flat surface and to each other, with the pivot-hole ends remote from each other, with the sides having the shoulders 479, 579 facing down, with the cam surface 279 of pawl 79 facing the ramp surface 379 of pawl 179, and with the cam surface 679 of pawl 179 facing the ramp surface 779 of pawl 79.

With the pawls 79 and 179 in the relative positions shown in FIG. 7, if the pawl 79 be slid toward pawl 179 in a direction to reduce the distance between their pivot holes, the cam surface on each pawl will contact the ramp surface of the opposing pawl and continued movement of pawl 79 towards pawl 179 will cause the camming ends of both pawls to rise in a scissors-like motion, as illustrated in FIG. 7*a*.

The scissors-like motion of pawls 79 and 179 shown in FIG. 7*a* and just described above is duplicated in the handwheel de-clutch main assembly of the present invention and results first in pawl 79 dropping contact with the tripper lever 53, as seen in FIG. 6, and then pawl 179 releasing the clutch fork 52.

The action of the clutch trippers 77, 78 will now be described. When the cam 54 is forced to move clockwise by the roller 61 on handwheel gear 57, the movement of the cam 54 is transmitted by loading pawl 79 to tripper lever 53 through the medium of shoulder 479 on the bottom of loading pawl 79 (see FIGS. 4 and 6) and tripper lever 53 is then caused to rotate clockwise in the same direction as the cam 54 is moving. During the time that tripper lever 53 is rotating, both of the shift springs 71 and 171 are being deflected, and thus further loaded. Force-wise, one of the shift springs, namely 71, is located between the arcuate skirt 153 of tripper lever 53 and the arcuate skirt 352 of fork 52. See FIGS. 4, 17, 18, and 19. It is spring 71 which causes the shift into handwheel operation. The other spring, namely spring 171, is positioned directly behind spring 71 and is located force-wise between the skirt 153 of tripper lever 53 and the lug 155 of stationary bracket 55, as has been previously stated. It is spring 171 which effects the return shift into motor engagement.

As the tripper lever 53 is being rotated clockwise, the trippers 77 and 78 (FIGS. 2, 3, 4, 6, 8, 9, 10, 11 and 23) are being pivoted toward the latching surface 253 of tripper lever 53 by the tension exerted upon them by the tripper spring 73. These two trippers 77 and 78 are pivotally mounted to the stationary bracket 55 by means of pivot pins 65 and 165, respectively, and are retained by cotter pins. The latching surface 177 of tripper 77 is approximately $\frac{1}{32}''$ farther from its pivot pin 65 than is the latching surface 178 of tripper 78 from its pivot pin 165. Therefore, tripper 77 will be the one of which latches tripper lever 53 in a majority of the operations, as will become clear. Continued clockwise rotation of tripper lever 53 (downward as viewed in FIGS. 2, 8, 10 and 11) will permit both trippers 77 and 78 to converge until they each rest upon the barrel 376 of the motor clutch gear 76, as seen in FIG. 8. Barrel 376 of gear 76 is equipped with a cam pin 476 which is so positioned on the barrel 376 relative to trippers 77, 78 that rotation of motor clutch gear 76 will cause the pin 476 to strike first one and then the other of the trippers 77 and 78, thereby moving the trippers, during the striking interval, far enough outward to release tripper lever 53 for return or counterclockwise movement, (upward movement FIGS. 8, 9, 10).

Immediately following movement of the trippers 77 and 78 into contact with barrel 376 of gear 76, i.e., into position to prevent the return of the tripper lever 53, load (or drive) pawl 79 disengages from tripper lever 53 because of the rising action of the pawl 79 in its contact with the holding pawl 179. Immediately upon release of tripper lever 53 by pawl 79, the shift springs 71 and 171 force the tripper lever 53 back (counterclockwise in FIG. 6, upwards in FIG. 8) through the short distance required to establish contact between the latching surface 253 of lever 53 and one of the latching surfaces 177, 178 of the trippers 77, 78. In the event that either one of the trippers 77 or 78 is resting on the now-motionless cam pin 476, then the other tripper will be in position to latch the tripper lever 53 and prevent it from returning. In the event that neither of the trippers is resting on the cam pin 476, then the lever 53 will be latched and held by latching surface 177 of tripper 77 since surface 177 is a little closer to surface 253 than is surface 178 of tripper 78. It will be understood that when the motor gear 76 is stopped, the angular position at which cam pin 476 stops cannot be predicted or controlled, since the pin will be located angularly wherever it happens to be when the motor drive comes to a complete stop.

As the rotational movement of the handwheel gear 57 continues, roller 61 drives cam 54 farther in a clockwise direction and pawl 79 is moved farther into its contact with holding pawl 179. The rising scissors-like action continues and causes the holding pawl 179 to lift out of engagement with fork 52, as in FIG. 9. This permits shift spring 71, which is located force-wise between the arcuate skirt 153 of tripper lever 53 and the arcuate skirt 352 of fork 52, to shift fork 52 clockwise, thereby shifting clutch element 59 to the left and into engagement with the handwheel clutch pinion 58, as seen in FIG. 9.

Located on the stationary bracket 55 and extending inwardly from it is a pin 255 on which rests the undersurface 180 of a latch 80 when in motor drive engagement, as seen in FIGS. 3 and 23. The generally L-shaped form of latch 80 is shown in FIG. 22. The function of latch 80 is to keep the lobes of cam 54 during handwheel operation in a position beyond the clockwise position to which cam 54 is moved by roller 61 during the shift from motor drive to handwheel drive. This keeps the lobes of cam 54 out of the path of roller 61 as gear 57 is rotated in handwheel operation. Latch 80 is pivotally mounted on the same pin 66 which positions the drive pawl 79 to the cam 54. Thus, the pivotal axis of latch 80 moves with cam 54. Urging the free end of latch 80 toward the pivotal center of cam 54 is a spring 280.

Referring now to FIGS. 17, 18 and 19 which show perspective views of fork 52 and tripper lever 53, attention is called to the upper legs 252 of fork 52 (FIG. 17) and to the upper surface of the skirt 153 of the tripper lever 53. This skirt is adjacent to both of the faces 452R and 452F of the upper legs 252 of fork 52. As best seen perhaps in FIG. 4, the shift spring 71 bears against the lower surface of the skirt 153 of tripper lever 53 and also against the motor-end surface of skirt 352 of fork 52, thus tending to force these two components, 53 and 52, to move apart, this movement being limited by the extremities of the parts, 53 and 52. The initial position of these parts when in motor drive engagement is shown in FIG. 4.

When the handwheel shift cycle is first started, as has already been described with regard to some of the parts, the fork 52 is held from rotating clockwise by the holding pawl 179 whose shoulder 579 is in contact with the face 452R of the rear upper leg of legs 252 of the fork 52, while the driving or loading pawl 79 is pushing, by means of its shoulder 479, the uppermost portion of the skirt 153 of tripper lever 53, thus separating the previously contacting surfaces 452F and 153 of the two parts 52 and 53 at this point. At the same time, the adjacent surfaces of skirts 153 and 352 which had been separated by the ends of shift spring 71, when in motor engagement, are pushed closer together, as seen in FIG. 6, thus effecting the loading of spring 71, as previously mentioned. As the clockwise movement of cam 54 and tripper lever 53 progresses, the lower edge of cam surface 480 of the latch 80 arrives at the stationary pin 255 which extends inwardly from bracket 55. At this time, the latch 80, which is being urged downwards by its spring 280, slides down over the pin 255, the latch sliding down on its ramp or cam surface 480. Thus, it will be seen that when the foot portion 580 of latch 80 clears pin 255, the contacting surface 380 of the latch 80 is lowered, by the action of spring 280, into the path of the outermost and uppermost portion of face 452F of the front leg of legs 252 of fork 52. When the holding or firing pawl 179 is forced out of contact with the face 452R of the rear leg of legs 252 of fork, 52, the shift spring 71 unwinds and forces a clockwise movement of fork 52, as seen in FIG. 9. Tripper lever 53 is latched against counterclockwise movement by one of the latching surfaces 177 or 178 of trippers 77 or 78, as seen in FIG. 8. The outermost upper portion of face 452F of the front leg of fork 52 now strikes the contacting surface 380 of the latch 80, carries it along in clockwise direction, and holds it there for the duration of the shift of the fork 52 into handwheel drive. Since latch 80 is pinned by pin 66 to cam 54, cam 54 is pulled clockwise, this being the same direction in which cam cam 54 was originally traveling. In this way, the lobe portion 154 of cam 54 is moved and held out of the path of roller 61, thereby avoiding further contact between roller 61 and the cam lobes during successive rotations of the handwheel gear 57.

The above completes a description of the first part of the shift cycle in which the valve (or other device) is disconnected mechanically from motor drive and is connected mechanically to handwheel drive. Successive turns of the handwheel will now drive the worm shaft 38 and through the worm 37 and worm gear 36 will drive the

valve stem 35 of the valve illustrated in FIG. 1. The action just described in shifting from motor drive to handwheel drive, while seemingly long due to the length of the word description, actually takes place in a fraction of a second, the action being very rapid and continuous.

The mechanism is now in handwheel engagement. In handwheel engagement, illustrated in FIGS. 8 and 9, the positions of the various components are as follows: The motor pinion is (as always) meshed with the motor clutch gear 76, and the handwheel gear 57 is (as always) meshed with the handwheel slidable clutch element pinion 58. The jaws of clutch 59 are engaged with the handwheel clutch pinion 58. The motor clutch gear 76 and its barrel 376 are free to rotate on the worm shaft 38. One or both of the trippers 77, 78 are in contact with the barrel 376 of motor clutch gear 76, and as seen in FIG. 8 one of the trippers is in holding contact with the upper surface 253 of tripper lever arm 53. The tripper tension spring 73 (FIG. 2) is in its least extended position and maintains trippers 77 and 78 in their converged positions (FIG. 8). The tripper lever 53 has been rotated (clockwise in FIG. 9; downward in FIG. 8) against both the shift springs 71 and 171. The shift spring 171, which is force-wise located between tripper lever 53 and lug 155 of stationary bracket 55 (FIG. 12) is loaded and is bearing on the lower surface of the skirt 153 of tripper lever 53, tending to force tripper lever 53 in a counterclockwise direction. However, this force is arrested by one of the latching surfaces 177 or 178 of one of the trippers 77 or 78. The fork 52 is once again arrested at its two upper legs 252 by the upper surface of the skirt 153 of the tripper lever 53 as seen in FIG. 9, and is held in its shifted-to-handwheel-engagement position by the now relaxed shift spring 71, which is located force-wise between the lower surface of skirt 153 of tripper lever 53 and the motor end of skirt 352 of fork 52. The latch 80 is holding the lobes of cam 54 out of the path of the handwheel gear roller 61 and the two pawls 79 and 179 are at rest on each other, their shoulders 479 and 579 having been lifted out of contact with fork 52 and tripper lever 53, respectively, due to the proximity of their respective pivot pins. The pawl and latch springs 72, 172 and 280 are continuing to urge their respective parts towards the pivot center of the main assembly but their force is arrested at this time.

Cam return spring 74, which continuously opposes clockwise rotation of cam 54, is utilized to return cam 54 to its original position when the assembly is shifted from handwheel drive back to motor drive. Cam return spring 74 is a torsion spring of much lower force than either of the shift springs 71 or 171. The cam return spring 74 is guided on a spacer 174 on the pivot sleeve 69. One end of spring 74 bears against the motor side of skirt 352 of fork 52, and the other end bears against the longitudinal web of cam 54 and exerts a force on cam 54 which tends to rotate the cam in a counterclockwise direction relative to fork 52 regardless of the position of fork 52.

It should perhaps be mentioned at this point that all springs become loaded to some extent when the mechanism is originally assembled. The springs are therefore constantly exerting some proportion of their capacity loads at all times. The movements of the components during operation of the mechanism alters the original pre-loaded conditions, and the reactions of the various springs to these movements completes the desired sequence of action.

In the case of cam return spring 74, this spring becomes farther loaded as a result of the action of the handwheel gear roller 61 in moving cam 54 clockwise. Hence, at this time, i.e., when the mechanism is in handwheel engagement, spring 74 is being held in its most heavily loaded state by the retaining action of the cam-mounted over-travel latch 80 which is being held in a clockwise-shifted position by the upper front face 452F of fork 52.

The shift from handwheel drive back into motor drive will now be described. When the motor 41 is energized, the motor pinion 176 rotates and drives rotationally the motor clutch gear 76 which is rotationally free on worm shaft 38. The motor-clutch gear cam pin 476 on the barrel 376 of gear 76 is driven rotationally and in so doing strikes the lower extremity of first one and then the other of the trippers 77, 78 causing each in turn to move away from their previous contact with the barrel 376 of the motor clutch gear 76. Assume that, when the motor was stopped, cam pin 476 stopped in such position, such as shown in FIG. 8, that it does not prevent either of the trippers 77 or 78 from coming to rest on the barrel 376 of the motor clutch gear 76. It should be noted that if tripper 77 is not prevented from returning to rest on barrel 376 by pin 476, then the latching surface 253 of tripper lever 53 is always held by the latching surface 177 of tripper 77 when the mechanism is in handwheel drive. Thus, when the motor 41 is energized, if gear 76 were driven by motor pinion 176 in a clockwise direction as viewed in FIG. 8 (this being one of its two possible directions of rotation), the cam pin 476 would first strike tripper 78 which has a shorter distance from its latching surface 178 to its pivot center than does tripper 77. In such case, outward movement of tripper 78 has no effect on tripper lever 53, and after the cam pin 476 has passed, tripper 78 will be pulled back against barrel 376 by the tripper spring 73. As gear 76 and its barrel 376 continue their clockwise rotation, cam pin 476 will come into contact with tripper 77 and will drive tripper 77 outward, away from the surface of barrel 376. As tripper 77 moves outward its latching surface 177 is carried away from restraining contact with latching surface 253 of the tripper lever 53. The shift spring 171 (FIG. 12) which has remained loaded from the first part of the de-clutching cycle, now tends to shift tripper lever 53 counterclockwise in FIG. 12, upwards in FIG. 8. However, after moving about $\frac{1}{32}''$, the latching surface 253 of tripper lever 53 now is impeded by the latching surface 178 of tripper 78, as shown in FIG. 10. After pin 476 passes, tripper 77 is pulled inward by tripper spring 73. Since tripper lever 53 moved upward (FIG. 10) on the previous outward movement of tripper 77, when tripper 77 now comes to rest, its beveled surface 277 now rests on the tripper lever arm 53, since the latching surface 177 of tripper 77 is now below the upper or latching surface 253 of tripper lever 53.

As barrel 376 continues to rotate, cam pin 476 next strikes tripper 78, as shown in FIG. 11, causing tripper 78 to once again move away from the barrel 376 and to carry its latching surface 178 away from above the latching surface 253 of the tripper lever 53. At this point, there is nothing to prevent the shift spring 171 (FIG. 12) from shifting tripper lever 53 all the way (counterclockwise in FIG. 12; upwards in FIG. 11) to effect the shift to motor-drive engagement, and such shift takes place. The tripper spring 73 (FIG. 2) tends always to pull the trippers 77 and 78 together, but now that the tripper lever 53 has moved upward (FIG. 2), the latching surface 253 of tripper lever 53 is now located above the latching surfaces 177 and 178 of the trippers 77 and 78, and the trippers can approach each other only to an extent limited by the presence of the tripper lever arm 53. It should be noted that the sides of tripper lever 53 which contact the trippers 77, 78 are sloping, the lower edge being wider than the upper edge. It should be also noted that the trippers 77 and 78 each possess a beveled edge 277, 278 adjacent to and slightly above their respective latching surfaces, 177, 178. At a point during the shift back to motor drive, the beveled edges 277, 278 of the trippers 77 and 78 contact the sloping sides of the tripper lever 53 (FIG. 11) and the rising motion of the tripper lever 53 spreads the trippers 77 and 78 apart against the urging of the tripper spring 73. The lower extremities of the trippers 77 and 78 are thus caused to move outwardly from the barrel 376 of motor clutch gear 76 and are thus held out of the path of the cam pin 476 on its successive revolutions. Thus, objectionable noise or chatter caused by contact between the trippers and the cam pin is avoided.

The details of how the shift takes place will now be described.

When final tripper 78 releases tripper lever 53, the shift spring 171, which is located force-wise between the lug 155 of stationary bracket 55 and the lower surface of skirt 153 of tripper lever 53, causes tripper lever 53 to rotate counterclockwise (FIG. 12) and the force is transmitted through the skirt 153 of the tripper lever to the two upper arms 252 of fork 52. Thus, fork 52 is driven counterclockwise and carries clutch 59 with it. This moves slidable clutch element 59 to the right and into engagement with jaws 276 of barrel 376 of gear 76.

The cam 54 remains locked to fork 52 by the over-travel latch 80 during the first portion of the counterclockwise shift of fork 52 (FIG. 9). However, when the rear ramp surface 480 of over-travel latch 80 contacts pin 255 which is held fixed in stationary bracket 55 and extends into the path of ramp 480 on the return movement of latch 80, the over-travel latch 80 is forced to rise on the pin 255 (FIG. 12) and this action raises the latching surface 380 of the over-travel latch 80 above the top of the front arm of upper arms 252 of fork 52. The cam return spring 74 (FIG. 13) assists in overcoming the resistance between the ramp 480 of the over-travel latch 80 and the pin 255. Spring 74 also forces the cam 54 all the way back to its original position, provided the handwheel is in such position that the handwheel gear roller 61 is not in the way of cam lobes 154.

As cam 54 returns to its original position, the pivotal axis of pawl 79 is moved away from the fixed pivotal axis of pawl 179 and as a result the two pawls 79 and 179 are pulled apart and their free ends are urged towards the pivot center of the main assembly by their respective springs 72 and 172. As soon as clutch element 59 has assumed full engagement with the motor clutch gear 76, the rear arm of the upper arms 252 of the fork 52 will have been moved back a sufficient distance to allow the shoulder 579 of holding pawl 179 to drop into place in front of the latching face 452R of the rear upper arm of the fork 52. Thus, this portion of the assembly is once again in position to begin a new shift cycle. The action just described will go to completion each time the motor is energized.

In the event that at the time of the shift from handwheel to motor drive, the handwheel gear roller 61 is in the path of the returning lobes 154 of cam 54 and thus prevents cam 54 from completing its portion of the reloading cycle, the action of cam 54 is merely suspended at the point of interference. However, the tripper lever 53, fork 52, and clutch element 59 will still complete their portions of the shift, even though the cam 54, over-travel latch 80, and the two pawls 79 and 179 may be suspended.

When the mechanism is next shifted from motor drive to handwheel operation, the rotation of the handwheel removes the handwheel gear roller 61 from its obstructing position at which time the cam-return spring 74 moves cam 54, together with its associated pawl 79 and latch 80, back to their respective starting positions.

If, for any reason, the operator should rotate handwheel 42 at a time when the motor drive shaft 43 is rotating, the rotation of the handwheel would be ineffective to disengage clutch element 59 from the motor clutch gear 76. The action would be as follows: Cam roller 61 would move cam 54 clockwise in FIG. 3, downward in FIG. 2, but the rapidly rotating cam pin 476 would repeatedly drive the trippers 77 and 78 outward, away from the barrel 376 of the motor clutch gear 76, and would thus prevent the establishment of a latching surface for tripper lever 53. Hence, when the tripper lever 53 is moved clockwise in FIG. 3, downward in FIG. 2, by the shoulder 479 of pawl 79 the tripper lever 53 does not become latched by the trippers 77, 78. Accordingly, when the shoulder 479 of pawl 79 rises above the upper edge of skirt 153 of tripper lever 53 due to the scissors-like action of the pawls 79 and 179 (FIG. 6) the tripper lever 53 is free to move counterclockwise, in FIG. 3, or upwards in FIG. 2, and does so under the combined urging of springs 71 and 171 until the upper edge of skirt 153 of tripper lever 53 again makes contact with the faces 452R and 452F of upper legs 252 of fork 52 (FIG. 12). Thus, the upper legs 252 of fork 52 are prevented from moving clockwise to the right (FIG. 6) and as a result the lower legs 152 of fork 52 are prevented from moving clockwise to the left (FIG. 6) thus preventing fork 52 from disengaging clutch 59 from the motor clutch gear 76. The action just described takes place just before shoulder 579 of pawl 179 is lifted out of the path of face 452R of fork 52 by the continued scissors action of the pawls 79 and 179 as cam 54 continues to move clockwise. Thus, the removal of the latching shoulder 579 of pawl 179 from the path of fork 52 fails to free fork 52 for clockwise movement, since its path of movement is barred by the skirt 153 of tripper lever 53 held by the combined action of springs 71 and 171.

It is contemplated that the handwheel declutch or shift assembly just described may be bench assembled and then placed in the housing 82. The pivot pin 169 would then be passed through the sleeve 69 to anchor the assembly in the housing.

For the purpose of adjusting, if necessary, the entire assembly to obtain a greater or a smaller travel of cam 54, as may be desired, without substantially affecting the ultimate positions of the clutch element 59, an eccentric adjustment may be provided. As shown most clearly in FIG. 8, such an adjustment may be accomplished by providing pin 169 with an eccentric threaded head portion 269 having a cross slot in the end thereof for receiving a screw driver for adjusting the angular position of pin 169. After adjustment, the pin 169 may be secured firmly in the selected angular position by turning down the set screw 369, thereby to spread the slit 469 in the threaded portion 269. A plug 569 may then be inserted in the housing 82 to cover the end of pin 169. During the angular adjustment just described, the lower portion of the bracket 55 is held fixed, as by the stud 255 inserted through a hole in the housing 82 and into a hole 355 provided in the lower end of the long leg of bracket 55, as seen in FIGS. 2 and 15.

Included in the shift mechanism are spacers for positioning the parts axially on their respective pivots and for obtaining definite load from each spring by assuring that the spring coils remain centered and as nearly concentric as possible.

The features and advantages of the new clutch mechanism are by now clear. The slidable clutch element is shifted by spring action in both directions. There is no neutral position in which the clutch element remains. Thus, the mechanism is always either in motor drive or handwheel drive. The shift action is fast and continuous, being completed in a fraction of a second. No lever is required to be moved to disengage the motor drive before the handwheel may be turned; and no lever is required to be returned to a former position before motor operation can be resumed. Operation of the shift mechanism does not depend on the speed of rotation of the handwheel, nor on the speed of rotation of the motor drive. Thus, the shift operation is not adversely affected by slow rotation, as may be caused by heavy cold grease in cold temperatures. There is no drifting of the handwheel when in motor drive since power is transferred to the splined worm shaft only through the splined clutch element.

While the preferred embodiment of this invention has been described in some detail, it will be obvious to one skilled in the art that various modifications may be made without departing from the invention as hereinafter claimed.

Having thus described our invention, we claim:

1. In combination; a rotatable shaft; a double clutch having first, second and third elements, said first clutch element surrounding said shaft and connectable to first drive means, said second clutch element surrounding said shaft and connectable to second drive means, said third clutch element surrounding said shaft and fixed angularly thereto but slidable axially therealong between said first and second clutch elements; a pivotal shift lever connected to said third clutch element and movable between a first normal position and a second shifted position; a holding pawl normally holding said shift lever in said first normal position, in which said first and third clutch elements are in engagement; a tripper lever normally abutting said shift lever; latching means for said tripper lever; a first torsion spring connected force-wise between said shift lever and said tripper lever; a second torsion spring connected force-wise between said tripper lever and a fixed stop; a drive pawl movable by the second drive means for moving the tripper lever out of its normal abutting relation with said shift lever and into latch position, the said movement of said drive pawl loading said first and second torsion springs and releasing said holding pawl after said first and second spring means have been loaded, thereby to allow said loaded first spring means to shift said shift lever to its shifted position, thereby to shift said third clutch element out of engagement with said first clutch member and into engagement with said second clutch element; and latch releasing means actuable by said first drive means for releasing said tripper lever thereby to allow said loaded second spring means to return said tripper lever and shift lever to normal position, thereby to shift said third clutch element out of engagement with said second clutch element and into engagement with said first clutch element.

2. In combination; a rotatable shaft; a first clutch member encircling said shaft and connectable to a first drive means; a second clutch member encircling said shaft and connectable to a second drive means; a third clutch member encircling said shaft intermediate said first and second clutch members, said third clutch member being secured angularly to said shaft but slidable axially therealong; a shift lever for slidably moving said third clutch member; holding means for normally holding said third clutch member in engagement with said first clutch member; a tripper lever; latching means for said tripper lever; a first torsion spring connected between said shift lever and said tripper lever; a second torsion spring connected between said tripper lever and a fixed stop; cam means actuable by said second drive means for first pushing said tripper lever to latched position, thereby loading both said first and second spring means, and for thereafter dislodging said holding means to trigger the release only of energy stored in said loaded first spring to shift said shift lever, thereby to shift said third clutch member in a direction to disengage said third clutch member from said first clutch member and to engage said third clutch member with said second clutch member, and latch release means actuable by said first drive means for triggering the release of said tripper lever thereby to allow release of energy stored in said second spring to shift said shift lever in the opposite direction to disengage said third clutch member from said second clutch member and to engage said third clutch member with said first clutch member.

3. Apparatus according to claim 2 characterized in that both said shift lever and said tripper lever are pivotally supported on a fixed cross-shaft which also supports both said first and second torsion springs.

4. In combination; a load shaft; a double clutch having

a first clutch member encircling said load shaft and connectable to a motor drive, a second clutch member encircling said load shaft and connectable to a handwheel drive, and a third clutch member splined to said load shaft intermediate said first and second clutch members and slidable along said load shaft to engage with either said first or second clutch members; a fork shift lever pivotal between a normal position and a shifted position for shifting said third clutch member; a tripper lever normally abutting said fork lever; latching means for said tripper lever; a holding pawl for holding said fork shift lever in normal position to hold said third clutch member normally in engagement with said first clutch member; a first torsion spring connected between said fork shift lever and said tripper lever; a second torsion spring connected between said tripper lever and a fixed stop; cam means movable by the handwheel drive; a drive pawl movable by said cam means, the movement of said drive pawl moving said tripper lever to latch position; said first and second spring means being adapted to be loaded by the said movement of said tripper lever for storing energy in both said spring means; said holding pawl being adapted to dislodge said drive pawl from said tripper lever after said tripper lever has been moved into a position to be latched by said latching means, said drive pawl being adapted thereafter to dislodge said holding pawl from said fork shift lever, thereby to release energy stored in said first spring to move said fork shift lever in a direction to disengage said third clutch member from said first clutch member and to engage said third clutch member with said second clutch member.

5. Apparatus as claimed in claim 4 further characterized by the provision of latch release means actuable by said motor drive for releasing said tripper lever from

said latching means, thereby to release energy stored in said second spring to move said fork shift lever in a direction to disengage said third clutch member from second clutch member and to engage said third clutch member with said first clutch member.

6. Apparatus as claimed in claim 5 further characterized by the provision of an over-travel latch connected to and movable by said cam means into a position to be further moved by said fork shift lever when said fork shift lever is moved to disengage said third clutch member from said first clutch member, thereby to move said cam out of engagement with said handwheel drive means during handwheel operation.

7. Apparatus as claimed in claim 6 further characterized in that said handwheel drive means includes a gear having roller means protruding therefrom for engagement with said cam, said roller means occupying a relatively small angular sector of said gear.

8. Apparatus as claimed in claim 7 further characterized in that said tripper lever latching means comprises a pair of opposed arms pivotally mounted in fixed support means such that one of said arms is on each side of said tripper lever, said arms being spring biased toward each other, each arm having a notch therein adapted to engage and latch said tripper lever, the notch in one of said arms being slightly closer to its pivot point than is the notch in the other of said arms.

References Cited in the file of this patent

UNITED STATES PATENTS

858,914	Sheppard	July 2, 1907
915,298	Klemm	Mar. 16, 1909
2,989,878	Denkowski et al.	June 27, 1961