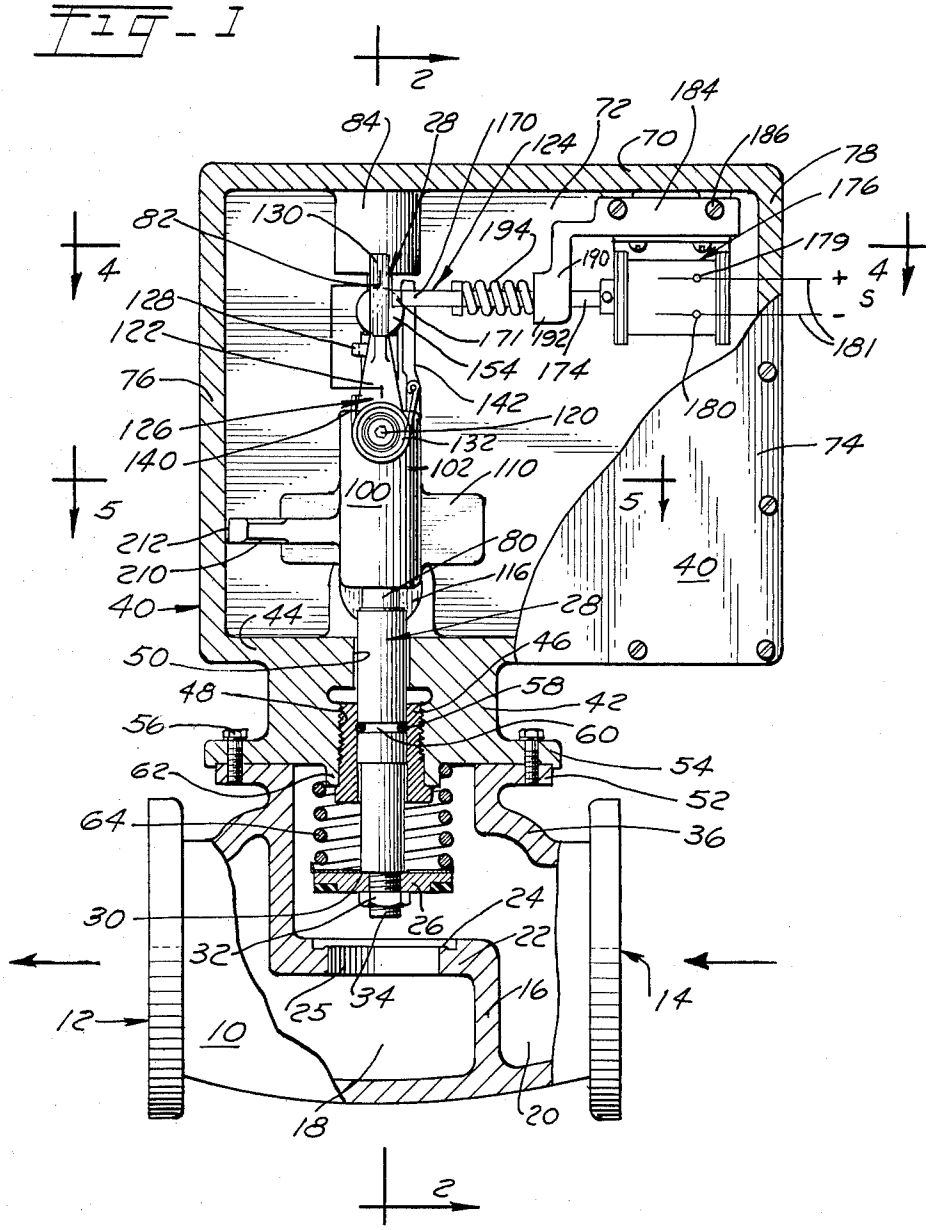
July 5, 1966 K. F. SHARP 3,259,357

AUTOMATIC SHUT-OFF VALVE

Filed Sept. 6, 1963 4 Sheets-Sheet 1

FIG. 1



INVENTOR.
KARL F. SHARP
BY Herman R. Gerlach
ATTORNEY

July 5, 1966 K. F. SHARP 3,259,357

AUTOMATIC SHUT-OFF VALVE

Filed Sept. 6, 1963 4 Sheets-Sheet 2

Fig. 2

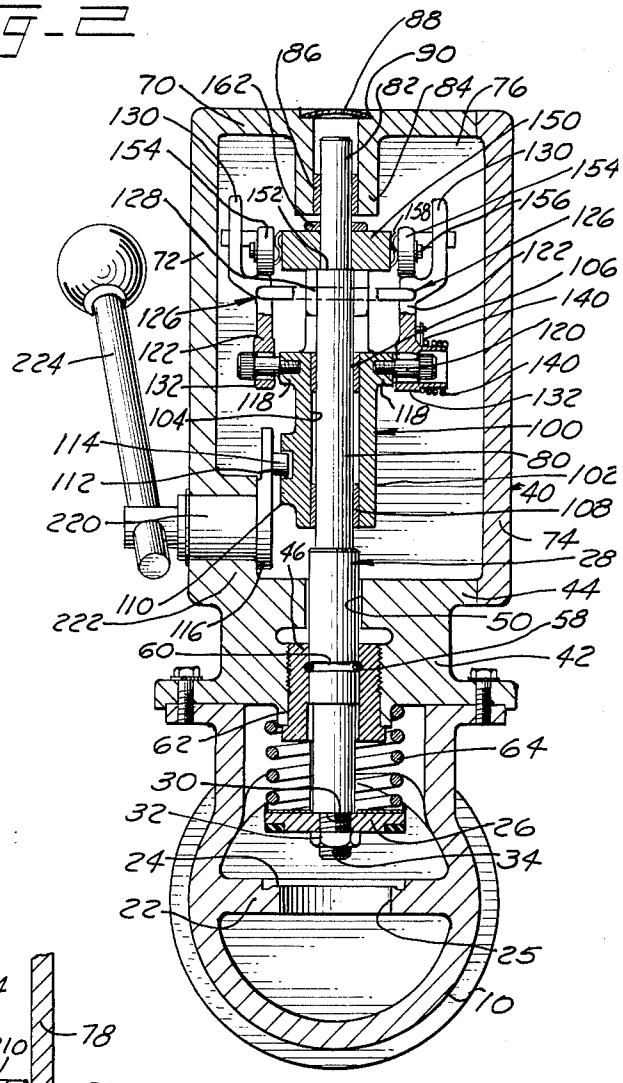
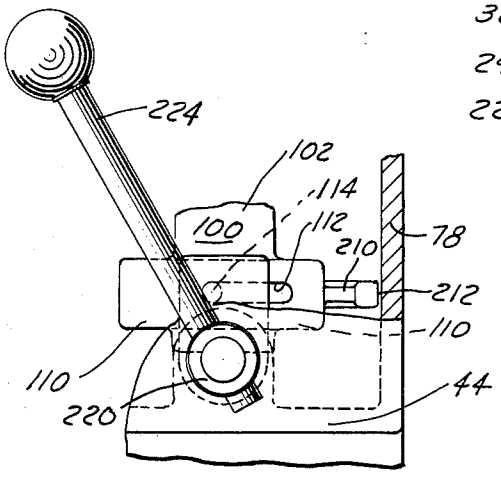


Fig. 3



INVENTOR.
KARL F. SHARP
BY Norman Perlach
ATTORNEY

July 5, 1966 K. F. SHARP 3,259,357

AUTOMATIC SHUT-OFF VALVE

Filed Sept. 6. 1963 4 Sheets-Sheet 3

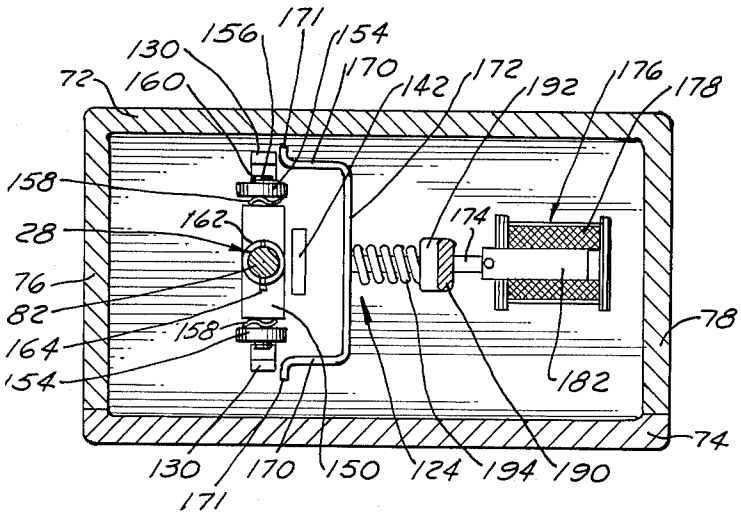


Fig. 4

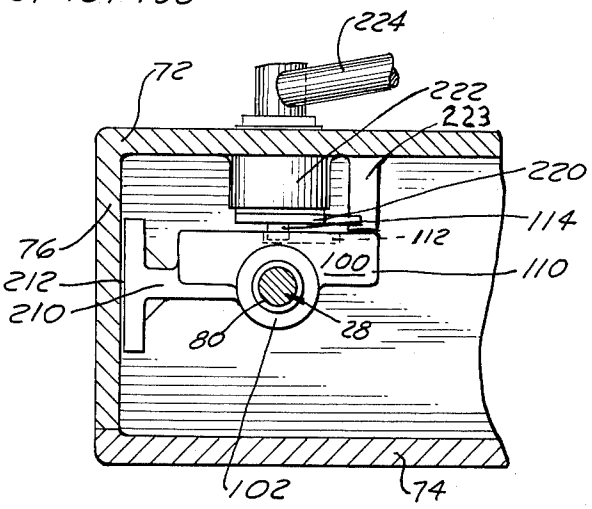
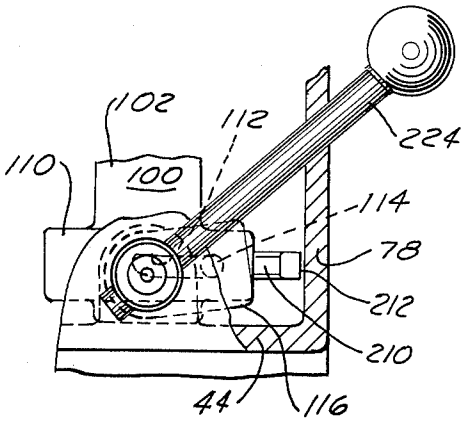


Fig. 5

Fig. 6



INVENTOR.
KARL F. SHARP
BY Norman Herlach
ATTORNEY

July 5, 1966 K. F. SHARP 3,259,357

AUTOMATIC SHUT-OFF VALVE

Filed Sept. 6, 1963 4 Sheets-Sheet 4

FIG. 7

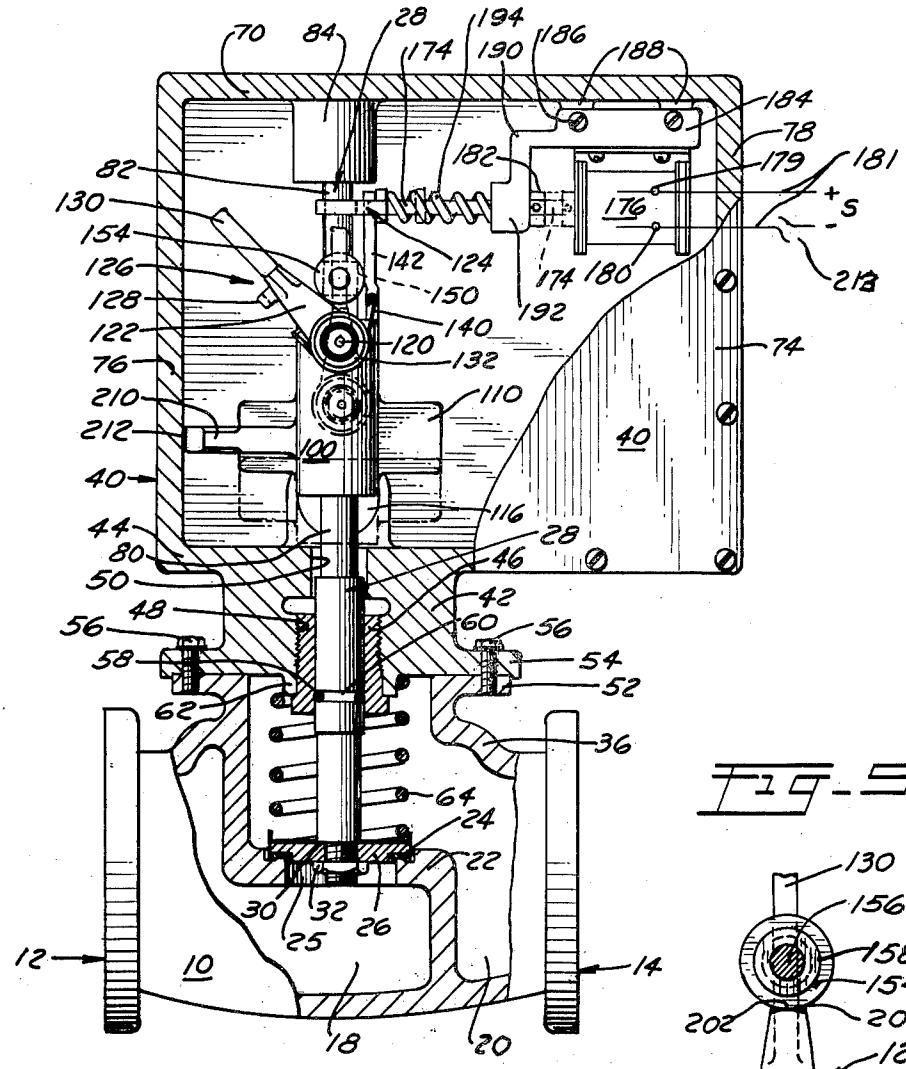
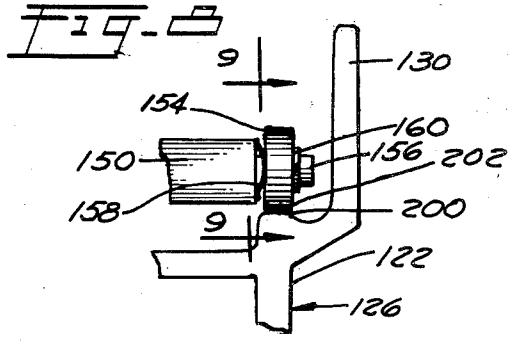


FIG. 5

FIG. 8



INVENTOR.
KARL F. SHARP
BY Norman R. Black
ATTORNEY

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AUTOMATIC SHUT-OFF VALVE

Karl F. Sharp, Rockford, Ill., assignor to Eclipse Fuel Engineering Co., Rockford, Ill., a corporation of Illinois

Filed Sept. 6, 1963, Ser. No. 307,076
16 Claims. (Cl. 251—69)

The present invention relates to an automatic shut-off valve having operating mechanism by means of which the valve may be manually opened and closed during such time as an associated electric circuit remains energized, but which, in the event of failure of the electric circuit, will automatically cause the valve to be immediately closed and maintained closed so that it may not be opened for any appreciable length of time, until such time as the electric circuit is again established.

The industrial applications for the present automatic shut-off valve are numerous. Various types of industrial equipment, in the normal operation thereof, depend upon both the flow of a fluid and the concurrent existence of an electric circuit. One example of such equipment is a heating system which uses gas as a fuel. In such a system, it is customary to employ a pilot burner which burns continuously to the end that it will ignite a main burner whenever there is a demand for heat in the system. A solenoid-actuated safety valve normally remains open under the control of the current that is supplied by a thermocouple. If the pilot flame becomes extinguished, the thermocouple ceases to supply current to the solenoid and a safety valve closes automatically and shuts off the supply of gas to the main burner. As an additional example, a gas or oil-fired boiler, when in operation, may be accompanied by the operation of an electric motor which drives a blower in order to supply air for combustion to the boiler. The electric motor may also operate a pump to supply gaseous or liquid fuel to the burner for the boiler. Many such installations, in the interests of safety, have associated therewith means whereby the supply of fuel to the burner will be immediately terminated in the event that the electric motor fails. The automatic shut-off mechanism of the present invention will be found useful with such industrial equipment, as well as with any fluid control valve, which, under normal conditions while an associated electric circuit is energized, will permit manual control of the valve as long as the circuit remains energized but which will automatically close the valve and render the manual operation thereof ineffective until the electric circuit has been restored.

Heretofore, many valve-actuating mechanisms for accomplishing the same purpose as the valve-actuating mechanism which is associated with, and forms a part of, the present safety shut-off valve depend for their operation upon the use of latch devices, which, upon setting of the associated valves to their open position, cooperate with shoulders on the valve stems to maintain the valves open and are held in their latching position by electromagnetic means. Upon failure of the electromagnetic means, these latch devices are intended to release the valve stems so that the valves, under the influence of biasing springs, may automatically move to their closed position. These latching devices are subject to failure, especially when, after a long or protracted period of remaining in their latching position, frictional forces become sufficiently high that the latching instrumentalities will not move from their latching position and release the associated valve stems.

The present invention is designed to overcome the above-noted limitations that are attendant upon the construction and use of automatic shut-off valves employing latching devices for holding the valve stems in their retracted positions so that the valves remain in their open

positions, and toward this end, the invention contemplates the provision of a novel form of safety latch mechanism in which the latch element which holds the valve stem of the associated valve in a retracted position to maintain the valve open is subject to a positive impact force when a circuit failure is encountered, the impact force being supplied by an impact head which engages the latch element and knocks the same, so to speak, forcibly from its latching position. According to the present invention, the power for driving the impact head against the latch element is supplied by a spring and this power is released upon failure of a circuit for an electromagnet. After the impact head has been released and has delivered its blow to the latch element to dislodge the latter, the impact head remains in a blocking position where efforts to reset the associated valve manually will prevent restoration of the latch element to its latching position until such time as the circuit for the electromagnet is again energized. Reenergization of this circuit withdraws the impact head and stores power in the spring, and allows the latch element to be returned to its latching position where it will remain as long as the circuit for the electromagnet remains energized.

In order further to enhance release of the latch element from the valve stem of the associated valve so that the size of the impact head and the size of the spring which impels it need not be unduly large, the latch element is pivoted for swinging movement about an axis which is effectively upon the center line of the valve stem, and which, when in its operative latching position, presents its own center line so that it is coincident with the axis of the valve stem. The distal end of the latch element underlies an anti-friction shoulder on the valve stem and presents a point of tangency to the shoulder which is perpendicular to the center line of the valve stem. The impact head operates along an axis which is perpendicular to the valve stem and, consequently, to the axis of the latch element. Furthermore, the impact head engages the latch element at a point adjacent to its distal end where it makes tangential contact with the anti-friction shoulder on the valve stem. It is obvious, therefore, that with such an arrangement, there are no external extraneous lateral forces acting on the latch element in any direction, and when the latch element is engaged by the impact head, it is easily pushed from beneath the valve stem shoulder to release the valve stem and allow closing of the valve under the influence of the usual spiral compression spring.

The provision of an automatic shut-off valve such as has been briefly outlined above and possessing the stated advantages being among the principal objects of the invention, numerous other objects and advantages not at this time enumerated will readily suggest themselves as the following description ensues.

In the accompanying four sheets of drawings forming a part of this specification, one illustrative embodiment of the invention is shown.

In these drawings:

FIG. 1 is a view, partly in side elevation and partly in section, showing an automatic shut-off valve embodying the invention and with valve in its open position as the result of the associated electric circuit being energized;

FIG. 2 is a vertical sectional view taken substantially along the line 2—2 of FIG. 1;

FIG. 3 is a fragmentary view, partly in front elevation and partly in section, showing the reset handle of the automatic shut-off valve in its normal position;

FIG. 4 is a horizontal sectional view taken substantially along the line 4—4 of FIG. 1;

FIG. 5 is a horizontal sectional view taken substantially along the line 5—5 of FIG. 1 but showing the parts in a different position;

FIG. 6 is a view similar to FIG. 3 but showing the reset handle in the position which it assumes at the commencement of a reset operation;

FIG. 7 is a view similar to FIG. 1 but showing the valve in its closed position as the result of the associated electric circuit being deenergized;

FIG. 8 is an enlarged detail view of a portion of the structure that is shown in FIG. 1, the view being taken in the vicinity of a roller bearing support which is employed in connection with the improved automatic shut-off valve; and

FIG. 9 is a vertical sectional view taken on the line 9—9 of FIG. 8.

Referring now to the drawings in detail, and in particular to FIGS. 1 and 2, the assembly of parts which comprises the automatic shut-off valve of the present invention includes a valve body 10 which defines a chamber having a fluid inlet 14 and a fluid outlet 12. A partition wall 16 extends across the central portion of the chamber and divides the latter into a fluid inlet compartment 20 and a fluid discharge compartment 18. The partition wall 16 embodies a horizontal shelf portion 22 which is provided with a valve seat 24 and a circular valve port 25. The valve seat 24 is designed for cooperation with a valve member 26 which is vertically shiftable between the open position wherein it is illustrated in FIG. 1 and the closed position wherein it is illustrated in FIG. 7. The valve member 26 is carried at the lower end of a vertically extending and slidable valve stem 28 and is fixedly held in position thereon as the result of being clamped against a shoulder 30 by means of a clamping nut 32 which is mounted on the extreme lower reduced threaded end portion 34 of the valve stem 28. The valve assembly including the valve body 10 is of the globe valve type, and ordinarily the valve stem of the assembly passes upwardly through the top wall of the valve body and projects through a stuffing box which is interposed between the top wall and the valve stem. According to the present invention, however, the stuffing box is dispensed with and the valve stem 28 passes upwards and freely through a large-sized central opening in the top wall 36 of the valve body 10 and projects into a control housing 40 through a downwardly extending tubular boss 42 on the bottom wall 44 of such housing. A threaded bushing 46 is threadedly received within a screw-threaded socket 48 in the central portion of the boss 42, and the valve stem 28 projects completely through the bushing 46 end also through a bore 50 in the housing bottom wall 44. The upper end of the valve stem 28 projects into the housing 40 to a point adjacent to the top wall of said housing. The valve body 10 may be of any suitable construction or shape and is provided with an outwardly extending annular attachment flange 52 for securing it to a similar attachment flange 54 on the depending boss 42 on the bottom wall of the housing 40, clamping screws 56 being provided for fixedly but removably securing the two attachment flanges 52 and 54 together. The valve stem 28 is vertically reciprocable in the threaded bushing 46 for the purpose of moving the valve member 26 between its open and closed positions; and it is sealed to the bushing against axial escape of fluid by means of an O-ring 58 which seats within an annular recess 60 in the valve stem. A circular depending boss 62 surrounds the lower rim of the threaded bore 48 and serves as a pilot guide for the upper end of a vertically extending spiral compression spring 64 which surrounds the lower end of the valve stem 20. The lower end of the spring 64 abuts against the valve member 26 and normally urges the valve member and, consequently, the valve stem 28, downwardly toward the closed position of the valve member.

The housing 40 is generally of rectangular box-like design and, in addition to the previously mentioned bottom wall 44, it embodies a top wall 70, oppositely disposed side walls 72 and 74, and oppositely disposed end walls 76 and 78. The valve stem 28 is provided with a reduced intermediate section 80 of appreciable extent, and, in addition, an upper further reduced section 82. The latter section is piloted in a downwardly extending tubular boss 84 on the housing top wall 70, a cylindrical bushing 86 being interposed between the reduced section 82 of the valve stem and the boss 84 The upper end of the boss 84 is open but is normally maintained closed by means of a yieldable spring closure cap 88 which is pressed into a circular recess 90 in the housing top wall 70.

Slidably disposed on the reduced intermediate section 80 of the valve stem 28 is a lift yoke 100 of irregular design. This lift yoke includes a central tubular body portion 102 with an oversize central vertical bore 104 therein. The valve stem 28 projects through the bore 104 and is slidably maintained by means of upper and lower sleeve bushings 106 and 108. The body portion 102 of the lift yoke is formed with a horizontally extending, laterally displaced and generally rectangular part 110, the outer surface of which is provided with a horizontally extending slot 112 (see FIG. 3). Such slot is designed for cooperation with a horizontal lift pin 114 on a crank arm 116. The crank arm 116 constitutes an element or part of a reset assembly, the nature and function of which will be made clear presently. The upper end region of the tubular body portion 102 of the lift yoke 100 is formed with a pair of radially extending, diametrically opposite, internally threaded bosses 118, each of which threadedly receives the inner end of a horizontal bearing pin 120. The two bearing pins 120 constitute, in effect, trunnions for pivotally supporting a pair of upstanding knock-out arms 122 which function in the manner of latches and serve releasably to support and maintain the valve stem 28 in its elevated or retracted position during normal operation of the shut-off valve. When the valve stem is in its elevated or up position as the result of being supported by the knock-out arms 122, the valve is, of course, in its open condition. The knock-out arms are adapted to be forcibly knocked away from their position of valve stem support under the influence of an impact head 124 in the event that an electric circuit in associated relation with the shut-off valve fails, all in a manner that will be made clear presently.

The knock-out arms 122 extend in parallelism and form integral parts of a generally H-shaped frame-like latch assembly 126. The latch assembly 126 includes an outwardly bowed cross arm 128, the ends of which are joined to the upper ends of the knock-out arms 122. The upper ends of the knock-out arms are provided with upwardly extending extensions 130 which extend in parallelism, thus giving a generally H-shape appearance to the latch assembly 126 as a whole. The lower ends of the knock-out arms 122 are formed with integral bearing sleeves 132 through which the bearing pins 120 extend, thus supporting the entire latch assembly 126 for tilting movement about the horizontal axis of the pins 120. The latch assembly 126 is capable of tilting movement on the lift yoke 100 about the axis of the bearing pins 120 between the substantially vertical position wherein it is illustrated in FIG. 1, and again in dotted lines in FIG. 7, and the inclined position wherein it is illustrated in full lines in FIG. 7. In its vertical position as shown in FIG. 1, the latch assembly serves to support the valve stem 28 and its associated valve member 26 in open position. When, however, the latch assembly 126 is inclined as shown in FIG. 7, it assumes an out-of-the-way position wherein the valve stem 28 and valve 26 are free to move downwardly under the influence of the spiral compression spring 64 and thus cause the valve to become closed. The latch assembly 126 is normally maintained in its vertical position by means of a coil spring 140 which surrounds one of the bearing pins 120 and has one end thereof anchored to an upwardly extending extension 142 on

the body portion 102 of the lift yoke 100. The other end of the coil spring 140 is anchored to the adjacent knock-out arm 122. As viewed in FIG. 2, the spring 140 normally biases the latch assembly 126 in a clockwise direction so that the cross arm 128 bears against one side of the intermediate section 80 of the valve stem 28 and maintains the knock-out arms 122 in their vertical position. The upwardly extending extension 142 serves the further purpose of providing a limit stop for the forward movement of the impact head 124, as will be described subsequently.

As best seen in FIGS. 2 and 4, the upper reduced section 82 of the valve stem 28 has mounted thereon a bearing block 150. This bearing block rests upon an upwardly facing shoulder 152 which is formed at the juncture between the intermediate section 80 and the upper section 82 of the valve stem 28. Said bearing block 150 is of elongated rectangular design. It is generally square in cross section and has mounted on the ends thereof a pair of valve stem supporting rollers 154, each roller being rotatably mounted on a horizontal outwardly extending stud 156 on the adjacent end face of the bearing block 150. The rollers 154 thus assume posiitons on opposite sides of the valve stem 28 and are adapted to be supported upon the extreme upper ends of the knock-out arms 122 when the latter are in their vertical position as shown in FIG. 1. The rollers 154 are centered on the studs 156 by means of dished washers 158 (see FIG. 4) which are interposed between the rollers and the bearing block, and also by means of split washers 160 on the outer or distal ends of the studs 156. The bearing block 150 is fixedly secured in position on the upwardly facing shoulder 152 and is held against axial shifting on the valve stem 28 by means of a collar 162 which is positioned immediately above the block 152 and is anchored to the valve stem by means of a pin 164.

It will be seen from an inspection of FIG. 2 that the upwardly extending extensions 130 on the knock-out arms 122 are laterally offset outwardly a slight distance so that they straddle the rollers 154 and project upwardly above the level of the rollers. This straddling relationship is also apparent in FIG. 4 where it may be observed that the knock-out arms 122, when in this raised vertical position, are in horizontal register with the impact head 124. This impact head is in the form of a wide-based, U-shaped yoke having parallel side arms 170 and a connecting bight portion 172. The latter is carried at the outer or distal end of a horizontally extending plunger 174 which is associated with a solenoid 176. The outer ends of the side arms 170 are bent outwards to form feet 171. The solenoid 176 includes a winding 178 having contact terminals 179 and 180 which are adapted to be connected electrically through suitable circuit wires 181 to a source of energizing current such as has been designated at S in FIGS. 1 and 7. The right-hand end of the plunger 174, as viewed in FIG. 4, is operatively connected to the usual solenoid core 182 which is axially shiftable within the winding 178 of the solenoid 176.

The solenoid 176 is suspended from a bracket 184 which is secured by screws 186 to a pair of depending supporting ribs 188 on the bottom surface of the top wall 70 of the housing 40. The bracket 184 is provided with a depending extension 190, the lower end of which carries a guide sleeve 192 for supporting the solenoid plunger 174 for horizontal sliding movement to and from the valve stem 28. The central portion of the plunger 174 extends through the guide sleeve 192. A coil spring 194 surrounds the plunger 174 and bears at one end against the adjacent end face of the guide sleeve 192 and at its other end against the impact head 124, thus normally urging the plunger and impact head forwardly to the full-line position wherein it is shown in FIG. 7. The forward position of the impact head is limited by means of the upwardly extending extension 142 on the tubular body portion 102 and the lift yoke 100. The coil spring 194 is thus effective when the solenoid 176 is deenergized to urge the plunger 174 and the impact head 124 to their advanced or extended positions. However, upon energization of the winding 178 of the solenoid 176, the core 182 will be retracted into the winding 178, thus shifting the plunger 174 and the impact head 124 to the right, as viewed in FIG. 7, from the position shown in this view to the position shown in FIG. 1.

The upper ends of the knock-out arms 122 are curved or rounded as indicated at 200 in FIGS. 8 and 9 on a radius equal to the effective length of these knock-out arms so that, in the vertical position of the latch assembly 126, the knock-out arms underlie and make line contact as at 202 with their respective rollers 154. The lateral displacement of the bowed cross arm 128 is such that when it bears against the valve stem 28, the knock-out arms 122, although extending substantially vertically, have moved just beyond a dead-center position where the downward force exerted by the compression spring 64 upon the valve stem 28 will under no circumstances oppose the action of the coil spring 140 which serves to bias the knock-out arms in a clockwise direction, as viewed in FIGS. 1 and 7, toward their substantially vertical position. Wide tolerances in the angular position of the knock-out arms 122 beyond the vertical are allowable inasmuch as little or no resistance other than friction is encountered by the impact head 124 in forcing the knock-out arms from beneath the rollers 154 when the plunger 174 is released or shifted towards the valve stem 28 by the action of the compression spring 194 upon deenergization of the solenoid 176.

In the operation of the herein disclosed automatic shut-off valve, in the free state of the various instrumentalities and with no energizing current flowing in the circuit wires 181, the parts will assume the positions wherein they are shown in FIG. 7, and since the valve member 26 is of the normally closed type, it is maintained seated on the valve seat 24 under the influence of the compression spring 64, thus closing the valve port 25 so that no fluid may pass through the valve body 10 from the inlet compartment 20 to the discharge compartment 18. As will be set forth in detail presently, mere energization of the solenoid 176 will not operate automatically to effect valve opening operations inasmuch as certain reset mechanism, subsequently to be described, must be manually operated to move the valve member 26 to its open position, after which it will remain open until such time as current failure at the solenoid 176 takes place. As will also be described subsequently, any efforts to manipulate this reset mechanism to open the valve 26 and maintain it open will be of no avail unless, of course, circuit conditions at the solenoid 176 are satisfactory to maintain the solenoid energized. Assuming, however, that circuit conditions at the solenoid 176 are such that the winding 178 thereof is energized, and assuming that the aforementioned reset operations have been effected after such energization has taken place, the parts will assume the positions wherein they are illustrated in FIGS. 1 and 2.

Assuming now for purposes of discussion that the previously mentioned reset operations have been effected and that the solenoid 176 is energized, the lift yoke 100 will be in its elevated position and will be supported in such position by means of the lift pin 114 of the crank arm 116. The generally H-shaped latch assembly 126 will assume its substantially vertical position wherein the knock-out arms 122 underlie their respective rollers 154 so that these rollers are supported upon and make line contact as at 202 with the curved upper surfaces or ends of the knock-out arms. The knock-out arms 122 will be maintained in their substantially vertical position by means of the spring 140 which urges the arms 122 to a position wherein the outwardly bowed cross arm 128 bears against the reduced portion 82 of the valve stem 28. With the rollers 154 thus supported upon the knock-out arms 122, and with the lift yoke 100 in its elevated position, the

bearing block 150 and, consequently, the valve stem 28 which is carried thereby, will remain elevated and the valve member 26 will be raised from its seat 24, thus uncovering the port 25 and allowing fluid to flow from the inlet compartment 20 to the discharge compartment 18 and pass through the valve body 10. Vertical registry of the knock-out arms 122 with the supporting rollers 154 is maintained by means of a lateral extension 210 (see FIG. 2) on one end of the aforementioned laterally displaced part 110 which is integrally formed on the tubular body portion 102 of the lift yoke 100. This extension 210 is provided with a planar elongated edge surface 212 which extends in close proximity to the inside face of the housing end wall 76 and prevents angular turning movement of the yoke 100 so that in any vertical position of elevation of the yoke there is vertical alignment of the trunnion-like bearing pins 120 with the rollers 154.

As long as energizing current continues to flow in the circuit wires 181, the impact head 124 will assume the retracted position wherein it is shown in FIG. 1 under the influence of the shiftable solenoid core 182 which is drawn into the winding 178, thus retracting the plunger 174 and compressing the spring 194. However, in the event of a circuit failure such as has been indicated at 213 in FIG. 7, the magnetic field of the solenoid winding 178 will collapse and the energy which is stored in the coil spring 194 will immediately be released, thus forcing the plunger 174 and the impact head 124 to the left as viewed in FIGS. 1 and 7. At this point, the impact feet 171 at the distal ends of the side arms 170 of the impact head 124 will simultaneously engage the upwardly extending extensions 130 on the knock-out arms 122, thus forcibly moving the knock-out arms in a counterclockwise direction and withdrawing the support for the rollers 154 so that the spiral compression spring 64 is then free to force the valve member 26 downwardly and cause the same to seat upon the valve seat 24 and close the port 25. During such downward movement of the valve member 26, the rollers 154 ride downwardly along one side of the knockout arms 122 as shown in FIG. 7 and cause these arms to be moved to the extreme out-of-the way position wherein they are illustrated in this view, the spring 140 serving to maintain the arms 122 in contact with the rollers 154. During such downward movement of the valve member 26, the valve stem 28 slides within the bore 104 in the tubular body portion 102 of the lift yoke 100, but the lift yoke itself remains elevated since it is supported upon the pin 114.

After the rollers 154 have moved downwards and thus, by a camming action, have forced the knock-out arms 122 to the extreme angular position wherein they are illustrated in FIG. 7, the impact head 124, being unobstructed, comes to rest against the upward extension 142 where it will remain until such time as the solenoid 176 again becomes energized. With the impact head 124 in this extreme forward position, no reset operations may be accomplished inasmuch as the impact head 124 will block movement of the latch assembly 126 to its substantially vertical position. Thus, the supporting shoulders which are supported by the curved upper ends 200 of the knock-out arms 122 cannot be slid beneath the rollers 154 for the purpose of supporting them. This inability to conduct reset operations in the absence of energization of the solenoid circuit will become more readily apparent when the nature of the reset mechanism has been set forth.

Referring now to FIGS. 1, 3, 5 and 6, the previously mentioned crank arm 116 is provided with a horizontal bearing shaft 220 which is rotatably supported in a thickened portion 222 of the housing side wall 72 adjacent to the bottom of the latter. The bearing shaft 220 projects outwardly of the housing 40 and carries a reset handle 224 exteriorly of the housing. The handle 224 is movable between the normal position wherein it is illustrated in FIG. 3 and the temporary position wherein it is illustrated in FIG. 6, this latter position of the handle being but a momentary one which the handle assumes at the commencement of reset operations. In its normal position, the lift pin 114 assumes an elevated position wherein the part 110 of the tubular body portion 102 of the lift yoke 100 and, consequently, the entire yoke itself, is elevated. In the position of the handle 224 shown in FIG. 6, the lift pin 114 assumes a lowered position wherein the part 110 and the yoke 100 are, as a consequence, lowered. This latter position of the lift yoke is shown in dotted lines in FIG. 7.

In the operation of the above-described reset mechanism, assuming that a solenoid circuit failure has occurred thus closing the valve member 26 upon the valve seat 24 in the manner previously described, and further assuming that the defective circuit condition has been rectified so that the solenoid 176 is again energized, the plunger 174 and the impact head 124 will be maintained in their retracted positions. Since the reset handle 224 assumes the normal position wherein it is illustrated in FIG. 3 at all times except during its brief swing to the right as seen in this view at the commencement of reset operations, the yoke 100 will remain elevated as shown in FIG. 7, while the rollers 154 on the lowered valve stem 28 will assume positions in close proximity to the bearing pins 120. Thus, in order to raise the valve member 26 from its seat 24, it is necessary to lower the yoke 100 a sufficient distance to cause the upper ends of the knock-out arms 122 to slide under the rollers 154 under the influence of the spring 140, thus bringing the knock-out arms into vertical register with the rollers. This is accomplished by swinging the reset handle 224 from the position shown in FIG. 3 to the position shown in FIG. 6, and during such movement of the handle, the lift pin 114 will travel in an arc having a downward component of motion and will move to the right within the horizontal slot 112 in the part 110 of the yoke 100 and cause such part, together with the yoke, to move downwardly to such an extent that the upper curved end surfaces 200 (FIGS. 8 and 9) of the knock-out arms 122 will clear their respective rollers 154 and slide thereunder so that the parts assume the dotted-line positions wherein they are shown in FIG. 7. As soon as this condition occurs, the reset handle 224 is restored to its normal position and the lift pin 114 then raises the part 110 and the yoke 100. As the yoke 100 moves upwardly, the valve stem 28 moves bodily with it until such time as the valve member 26 assumes the fully open position wherein it is illustrated in FIG. 1. This position is maintained by reason of the crank arm 116 of the reset mechanism moving slightly past its dead-center position so that the crank arm 116 bears against a stop lug 223 on the housing 40. In this position of the reset handle 224, the downward pressure exerted by the spring 64 on the valve member 26 and through the valve stem 28, the rollers 154, the knock-out arms 122, the bearing pins 120, the yoke 100, and its integral laterally displaced part 110, will maintain the handle 224 in its normal position with the valve member 26 thus latched in its open position.

It is to be noted at this point that in the operation of the present automatic shut-off valve, under normal conditions with current flowing in the solenoid circuit and with the valve member 26 raised from its seat 24, the various valve-supporting instrumentalities, including the knock-out arms 122 and the supporting rollers 154, assume positions of stable equilibrium where there is no danger of inadvertent dislodging of the knock-out arms 122 from beneath the rollers 154 by reason of the slightly beyond dead-center condition of the knock-out arms, as previously described. Because of the substantial vertical alignment of the knock-out arms 122 with the axis of the valve stem 28, and because of the fact that the valve stem is roller-supported on the curved upper end surfaces 200 of the knock-out arms, and with the radius of curvature of these surfaces being equal to the effective length of the knock-out arms, only frictional opposition

or resistance to the pushing of the knock-out arms from beneath the rollers by the impact head is offered at the time the impact head engages the upward extensions **130** of these knock-out arms. Furthermore, since the impact head **124** engages the extensions **130** at regions well beyond the upper ends of the knock-out arms **122**, the moment of torque which is involved in swinging the relatively short knock-out arms from beneath the rollers **154** is magnified by the leverage action which takes place. Still further, the amplitude of the stroke of the impact head **124** need not be great since all that is necessary is for the impact head to drive the knock-out arms backward past the upper curved end surfaces **200**, after which the spring **64** acting on the valve member **26** assists in moving the knock-out arms still further from beneath the rollers **154**, the rollers riding downwardly on the sides of the knock-out arms and forcing the entire latch assembly **126** to its extreme out-of-the-way position as shown in FIG. 7. This delicate balancing of the parts in the open position of the valve member **26** constitutes one of the principal features of the present invention.

The reset mechanism and the valve stem-supporting instrumentalities of the present automatic shut-off valve are so constructed that it is impossible for an operator to effect the resetting operation unless the electric circuit for the solenoid **176** is complete. While an operator may put the reset handle **224** through the movements required of it in effecting the resetting operation, such movements, in the absence of an energized solenoid circuit, will be of no avail inasmuch as the lowering of the yoke **100** which is attendant upon movement of the reset handle to its right-hand position as shown in FIG. 6 will not effect a sliding entry of the knock-out arms **122** beneath their respective rollers **154**. Such entry of the knock-out arms **122** beneath the rollers **154** is precluded because, if the solenoid is deenergized, the impact head **124** will be in its forward position and the laterally turned feet **171** thereon will be in a blocking position with respect to the extreme upper end regions of the upwardly extending extensions **130**, thus preventing the frame-like latch assembly **126** from assuming its substantially vertical position. In such an instance, restoration of the reset handle **224** to its normal left-hand position as shown in FIG. 3 will merely cause the impact arms **122** to ride upwardly alongside the rollers **154** and to return to their angularly displaced positions wherein they are illustrated in FIG. 7. Only when the impact head **124** is retracted is it possible for the knock-out arms **122** to slide beneath the rollers **154**.

The industrial applications of the present automatic shut-off valve are numerous and the electric circuit represented by the circuit wires **181** may receive its energization in accordance with the dictates of the particular installation involved. For example, the circuit involved may be the electric circuit of a flame-sensing device or a temperature or pressure-limiting device, or the circuit of an electric motor for driving some element of the equipment, as, for example, a blower or a fuel pump. Irrespective, however, of the particular use to which the present invention may be put, the essential features thereof are at all times preserved.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit or scope of the invention. Therefore, only insofar as the invention has particularly been pointed out in the accompanying claims is the same to be limited.

Having thus described the invention what I claim as new and desire to secure by letter patent is:

1. In an automatic and manually resettable shut-off valve operative to pass fluid concurrently with the flow of current in an electric circuit and to terminate the flow of fluid upon circuit failure, in combination, a valve casing providing a valve seat, a valve member movable axially between open and closed positions with respect to the seat, first spring means yieldingly urging said valve member toward said seat, a yoke member axially slidable on said valve member and movable between proximate and remote positions with respect to the seat, means on said valve and yoke members respectively defining a pair of opposed shoulders, a knock-out arm adapted for positioning between said shoulders and operative when so positioned to maintain the valve member open when the yoke member is in its remote position, a solenoid adapted for positioning in the electric circuit and including an impact plunger movable between a projected position wherein a portion thereof is interposed between said shoulders in blocking relation with respect to the knock-out arm and a retracted out-of-the-way position, second spring means yieldingly urging said plunger toward its projected position, said plunger being movable to its retracted position against the action of said second spring means upon energization of the solenoid, said knock-out arm being movable between an advanced position wherein it is disposed between said shoulders and a withdrawn position, third spring means normally urging said knock-out arm toward its advanced position, said plunger being operative when the yoke member is in its remote position and the knock-out arm is positioned between said shoulders and upon deenergization of the solenoid forcibly to engage the knock-out arm and displace the same from between the shoulders against the action of said third spring means, said yoke member when in its proximate position permitting entry of the knock-out arm between said shoulders for valve-opening purposes during movement of the yoke member toward its remote position, and manually operable reset means for moving said yoke member between its proximate and remote positions and for maintaining the same in the latter position.

2. In an automatic and manually resettable shut-off valve, the combination set forth in claim **1** and wherein said knock-out arm is pivotally connected at one end to one of said members for swinging movement into and out of alignment with said shoulders.

3. In an automatic and manually resettable shut-off valve, the combination set forth in claim **1** and wherein the shoulder-defining means on one of said members is in the form of an anti-friction roller.

4. In an automatic and manually resettable shut-off valve, the combination set forth in claim **1** and wherein said knock-out arm is pivotally connected at one end to one of said members for swinging movement into and out of alignment with said shoulders and the shoulder-defining means on said one member is embodied in the pivotal connection for the knock-out arm, and wherein the shoulder-defining means on the other member is in the form of an anti-friction roller.

5. In an automatic and manually resettable shut-off valve, the combination set forth in claim **1** and wherein said knock-out arm is pivotally connected at one end to said yoke member for swinging movement into and out of alignment with said shoulders.

6. In an automatic and manually resettable shut-off valve, the combination set forth in claim **1** and wherein the shoulder-defining means on the valve member is in the form of an anti-friction roller.

7. In an automatic and manually resettable shut-off valve, the combination set forth in claim **1** and wherein said knock-out arm is pivotally connected at one end to said yoke member for swinging movement into and out of alignment with said shoulders and the shoulder-defining means is embodied in the pivotal connection for the knock-out arm, and wherein the shoulder-defining means on the valve member is in the form of an anti-friction roller.

8. In an automatic and manually resettable shut-off valve operative to pass fluid concurrently with the flow of current in an electric circuit and to terminate the flow of

fluid upon circuit failure, a valve casing providing a valve seat, a valve member movable axially between open and closed positions with respect to the seat, first spring means yieldingly urging said valve member toward said seat, a yoke member axially slidable on said valve member and movable between proximate and remote positions with respect to the seat, means on said valve and yoke members respectively defining a pair of opposed shoulders, a knock-out arm adapted for positioning between said shoulders and operative when so positioned to maintain the valve member open when the yoke member is in its remote position, a solenoid adapted for positioning in the electric circuit and including an impact plunger movable between a projected position wherein a portion thereof is interposed between said shoulders in blocking relation with respect to the knock-out arm and a retracted out-of-the-way position, second spring means yieldingly urging said plunger toward its projected position, said plunger being movable to its retracted position against the action of said second spring means upon energization of the solenoid, said knock-out arm being movable between an advanced position wherein it is disposed between said shoulders and a withdrawn position, third spring means normally urging said knock-out arm toward its advanced position, said plunger being operative when the yoke member is in its remote position and the knock-out arm is positioned between said shoulders and upon deenergization of the solenoid forcibly to engage the knock-out arm and displace the same from between the shoulders against the action of said third spring means, said yoke member when in its proximate position permitting entry of the knock-out arm between said shoulders for valve-opening purposes during movement of the yoke member toward its remote position, a reset shaft, cooperating overcenter cam means on said yoke member and reset shaft for moving said yoke member between its proximate and remote positions and operable when in its overcenter position to maintain the yoke member in its remote position, and an operating handle for actuating said overcenter cam means.

9. In an automatic and manually resettable shut-off valve operative to pass fluid concurrently with the flow of current in an electric circuit and to terminate the flow of fluid upon circuit failure, in combination, a valve casing providing a valve seat, a valve member cooperating with said seat and having a vertically and axially shiftable valve stem, spring means yieldingly urging said valve member against said seat, said valve stem extending vertically through a wall of the valve casing, and means exteriorly of the casing for unseating the valve member against the action of said spring means and for maintaining the valve member unseated during current flow in said circuit, said latter means comprising a yoke axially and vertically slidable on said valve stem and movable between raised and lowered positions, an antifriction roller on said valve stem, a pivot pin on said yoke below and in vertical alignment with said roller, a knock-out arm having a proximate end pivoted on said pin and capable of swinging movements between an operative substantially vertical position wherein the distal end thereof underlies said roller and an inoperative out-of-the-way withdrawn position wherein said distal end is displaced laterally from a vertical axis passing through the pivot pin and roller, means yieldingly biasing said knock-out arm toward its vertical position, said knock-out arm engaging and serving to support the roller and consequently maintain the valve member unseated when the yoke is in its raised position and the knock-out arm is in its operative substantially vertical position, a solenoid adapted for positioning in the electric circuit and including an impact plunger movable between a projected position wherein a portion thereof is interposed between the roller and pivot pin in blocking relation with respect to the knock-out arm and a withdrawn position, a spring yieldingly urging said plunger toward its projected position, said plunger being operative when the yoke is in its raised position and the knock-out arm is in its vertical position and upon deenergization of the solenoid to forcibly engage the knock-out arm and displace the same from its vertical position against the action of said biasing means to release the roller and allow the valve member to become seated, said yoke when in its lowered position permitting movement of the knock-out arm to its substantially vertical position, and manually operable reset means for moving said yoke between its raised and lowered positions and for maintaining the same in the former position.

10. In an automatic and manually resettable shut-off valve, the combination set forth in claim 9 and wherein said distal end of the knock-out arm is curved on a radius substantially equal to the effective length of the knock-out arm.

11. In an automatic and manually resettable shut-off valve, the combination set forth in claim 9 and including, additionally, a stop member on the knock-out arm engageable with the valve stem when the knock-out arm is in its operative position for limiting such position thereof.

12. In an automatic and manually resettable shut-off valve, the combination set forth in claim 9 and wherein said knock-out arm is provided with an upward laterally offset extension which projects upwardly beyond the distal end of the knock-out arm when the latter is in its substantially vertical position, and the impact plunger is engageable with said upward extension for knock-out displacement purposes.

13. In an automatic and manually resettable shut-off valve, the combination set forth in claim 9 and wherein said knock-out arm is provided with an upward laterally offset extension which projects upwardly beyond the distal end of the knock-out arm when the latter is in its substantially vertical position, wherein the impact plunger is engageable with said upward extension for knock-out displacement purposes, and wherein the distal end of the knock-out arm is curved on a radius substantially equal to the effective length of the knock-out arm.

14. In an automatic and manually resettable shut-off valve, the combination set forth in claim 9 and wherein the distal end of the knock-out arm is curved on a radius substantially equal to the effective length of the knock-out arm, and wherein the knock-out arm has integrally formed thereon a stop member engageable with the valve stem when the knock-out arm is in its operative position for limiting such position thereof.

15. In an automatic and manually resettable shut-off valve operative to pass fluid concurrently with the flow of current in an electric circuit and to terminate the flow of fluid upon circuit failure, in combustion, a valve casing providing a valve seat, a valve member cooperating with said seat and having a vertically and axially shiftable valve stem, spring means yieldingly urging said valve member against said seat, said valve stem extending vertically through a wall of the valve casing, and means exteriorly of the casing for unseating the valve member against the action of said spring means and for maintaining the valve member unseated during current flow in said circuit, said latter means comprising a yoke axially and vertically slidable on said valve stem and movable between raised and lowered positions, an antifriction roller on said valve stem, a pivot pin on said yoke below and in vertical alignment with said roller, a knock-out arm having a proximate end pivoted on said pin and capable of swinging movements between an operative substantially vertical position wherein the distal end thereof underlies said roller and an inoperative out-of-the-way withdrawn position wherein said distal end is displaced laterally from a vertical axis passing through the pivot pin and roller, means yieldingly biasing said knock-out arm toward its vertical position, said knock-out arm engaging and serving to support the roller and consequently maintain the valve member unseated when the yoke is in its raised position and the knock-out arm is in its operative substantially vertical position, a solenoid adapted for

positioning in the electric circuit and including an impact plunger movable between a projected position wherein a portion thereof is interposed between the roller and pivot pin in blocking relation with respect to the knock-out arm and a withdrawn position, a spring yieldingly urging said plunger toward its projected position, said plunger being operative when the yoke is in its raised position and the knock-out arm is in its vertical position and upon deenergization of the solenoid to move toward its projected position under the influence of energy stored in said spring and forcibly engage the knock-out arm and displace the same from its vertical position against the action of said basing means to release the roller and allow the valve member to become seated, said yoke when in its lowered position permitting movement of the knock-out arm to its substantially vertical position, a reset shaft, cooperating cam means on said yoke member and reset

shaft for moving said yoke member to its raised position, and an operating handle for actuating said cam means.

16. In an automatic and manually resettable shut-off valve, the combination set forth in claim **15** and wherein said cooperating cam means comprises a crank arm on said reset shaft, an eccentric pin on said crank arm, and a slot in said yoke into which the eccentric pin projects.

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M. CARY NELSON, *Primary Examiner.*

A. ROSENTHAL, *Assistant Examiner.*