May 16, 1967 W. A. DE SMIDT 3,320,395

OPERATING MECHANISM FOR MANUALLY ACTUATED SWITCHES

Filed Feb. 1, 1966 2 Sheets-Sheet 1

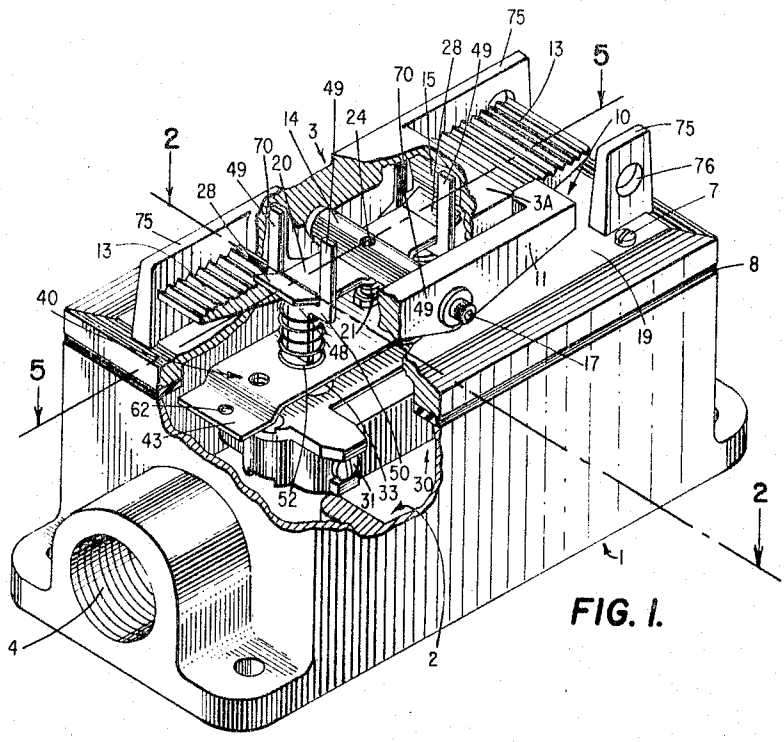


FIG. 1.

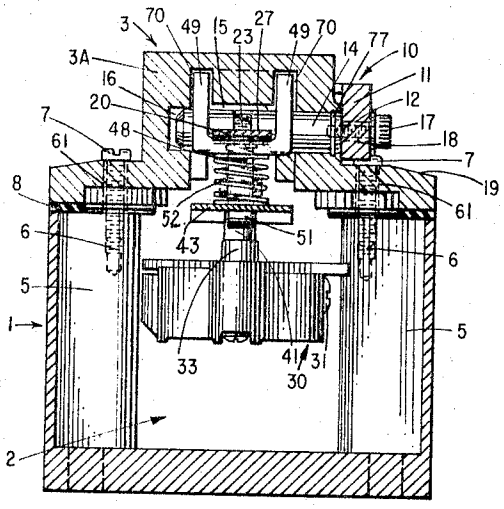


FIG. 2.

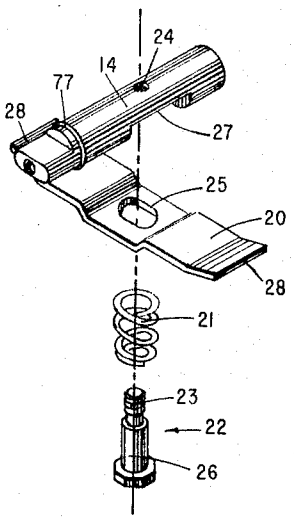


FIG. 3.

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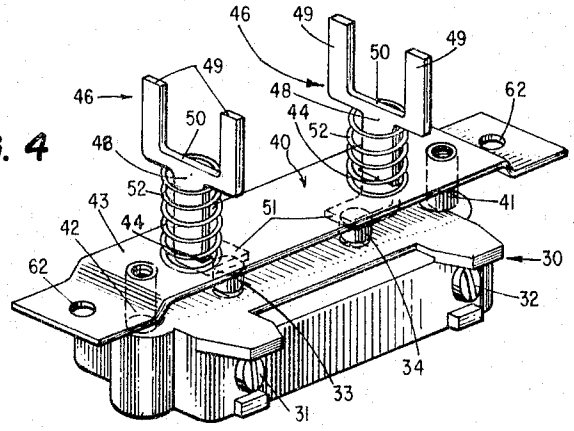
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OPERATING MECHANISM FOR MANUALLY ACTUATED SWITCHES

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FIG. 4



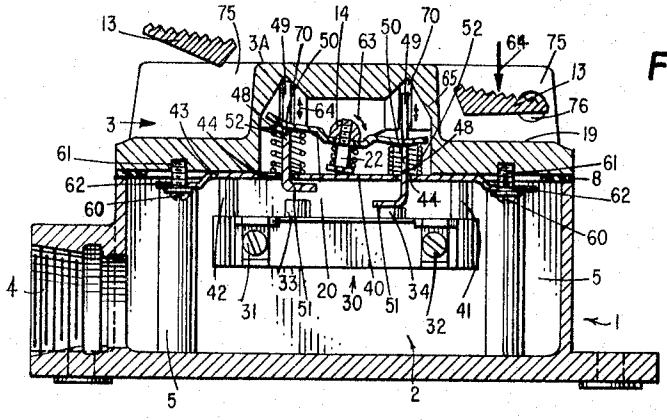


FIG.5.

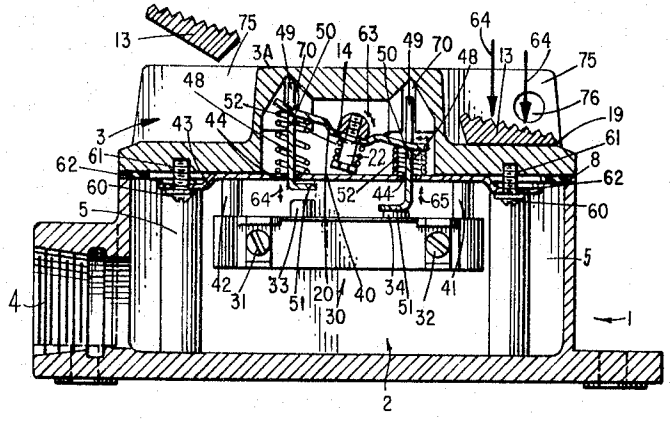


FIG. 6.

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OPERATING MECHANISM FOR MANUALLY ACTUATED SWITCHES

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Filed Feb. 1, 1966, Ser. No. 524,158
11 Claims. (Cl. 200—168)

This invention relates to an enclosed electrical switching station and it resides more specifically in a combination of an electrical switch assembly contained within an enclosed housing and a manual actuating means for controlling operation of the switch assembly from a position external to the housing. The combination comprises an operating shaft projecting from the interior of the housing to the exterior thereof with the exterior portion of the shaft engaging a manually actuatable lever. Within the housing, the station includes means for converting the rotary motion of the operating shaft to linear reciprocal motion, which means controls operation of the switch assembly. The invention further teaches that the combination may include means for absorbing abnormally large forces in the actuating means without the abnormal forces being transmitted to the switch assembly and also means for minimizing "overtravel."

Electrical switches such as push button switches are frequently used at switching stations to "start" and "stop" electrical machinery. Frequently these stations are located at hazardous, explosive locations and the switches must be enclosed within housings to effectively seal the electrical switch contacts from the ambient surroundings. Such hazardous surroundings include those encountered in grain elevators, flour mills, filling stations, dry cleaning establishments, petroleum refineries, distilleries, etc. For satisfactory protection in such locations, care must be exercised in providing dust, gas or liquid tight switch compartments. Besides use in hazardous locations, there are other switch applications requiring watertight housings or housings that exclude oil products, dirt and dust to a greater degree than standard switch enclosures.

Heretofore enclosed switches meeting these requirements have had operating shafts projecting from within the housing to the exterior with external manually operated actuators. One type of such enclosure is illustrated in United States Patent 2,702,845 granted to Woodrow A. De Smidt on Feb. 22, 1955, and assigned to the assignee of the present invention. The present invention is an improved version of the patented version. The present design converts the rotary motion of the external shaft to reciprocal internal motion for actuating the switch assembly. This permits the housing to be smaller in dimensions. To accomplish the conversion, there is an internal arm attached to the operating shaft such that the internal arm rotates concurrently with the external arm. Engaging opposing ends of the internal arm are a pair of plungers which reciprocate linearly along an axis perpendicular to the axis of the rotating shaft. As the internal arm rotates, it engages a plunger and applies a force component parallel to the direction of movement of the plunger. At the same time, the arm slides across the plunger in a plane normal to the movement of the plunger, thereby changing the effective moment arm.

To absorb abnormal forces applied to the external manual actuator, the internal arm has an enlarged aperture intermediate the distal ends. A pin member, with an absorbing spring encircling its shank, protrudes through the oblong aperture and engages the rotating shaft, with the spring urging the internal arm against the rotating shaft. When the plunger assumes its bottoming position, a continued abnormal force is absorbed in the absorbing

spring and the enlarged aperture of the internal arm permits the arm to slide about the shank of the pin member and across the plunger in a plane substantially normal to the direction of the reciprocal motion.

The present invention may be further designed such that "overtravel" of the actuating arm is minimized and absorbed by the plunger assembly. The plungers may be designed such that they resist the rotational movement of the internal actuating arm. When an arm, in returning to its normal position after engaging a plunger travels beyond the normal operating point, the opposing plunger tends to retard further rotation. The end of the plunger and associated switch may be spaced such that the plunger must travel a minimum distance before engaging the switch. The spacing may be selected so that "overtravel" alone will not cause the plunger to exceed the spaced distance. Thus, the overtravel is substantially absorbed by the plunger assembly without the switch buttons being engaged.

The foregoing features and advantages of the invention will appear in the description to follow. Reference is made in the description to the accompanying drawings which form a part hereof and in which there is shown by way of illustration and not of limitation one specific form in which the invention may be embodied.

In the drawings:

FIG. 1 is a perspective view, with parts broken away and in section, of a switch housing enclosing a push-button switch assembly and having an actuating means constructed in accordance with this invention.

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

FIG. 3 is an exploded view of the operating shaft, the internal arm, the absorbing spring and the fastener of the actuating means of FIG. 1.

FIG. 4 is a perspective view of the standard push-button switch assembly and the associated plunger assembly of the housing of FIG. 1.

FIG. 5 is a longitudinal sectional view of the housing of FIG. 1 with the assembly in a normal activated position.

FIG. 6 is a longitudinal sectional view of the housing of FIG. 1 with the actuating means in an abnormal activated position due to abnormal forces applied to the external arm.

Referring now to the drawings, there is shown in FIGS. 1 and 2 an enclosed electrical switch housing referred to by the general reference character **1**. In FIGS. 1 and 2 the switch assembly is shown resting on a horizontal plane and in a neutral non-activated position. The walls of the switch housing **1** define an internal spacing including a rectangular-shaped base cavity referred to by the general reference character **2**. The housing **1** further includes a cover assembly referred to by the general reference character **3**, and having a raised boss portion **3***a*. The base cavity **2** and cover assembly **3** may comprise an aluminum alloy die casting structure. The base cavity **2** carries a pipe tap **4** having internal threads for attachment to a metallic conduit (not shown) surrounding electrical lead wires. The base cavity **2** further carries a plurality of internal ribs **5** having threaded apertures **6** for receiving a plurality of threaded fasteners **7** securing the cover assembly **3** to the base cavity **2**. Intermediate the cover assembly **3** and base cavity **2** is a gasket **8** providing means for sealing the internal operating components against a contaminating atmosphere.

In the illustrated housing **1**, the switch actuating assembly is primarily secured to the cover assembly **3**. The assembly **3** includes an external actuating arm referred to by the general reference character **10**, which in FIG. 1 is partially broken away. The actuating arm **10** includes a shank **11** having a substantial triangular shape with a

relatively flat top surface and a bottom surface inclined from a central opening **12** towards its opposite ends. The opposing ends of the shank **11** provide a pair of serrated finger pads **13** extending substantially normal to the longitudinal axis of the shank **11** and spaced above the cover assembly **3**. At the aperture **12**, the actuating arm **10** engages a rotatable operating shaft **14**, one end of which extends externally through a sidewall of a raised boss portion **3***a* of the cover **3**. The other end of the shaft **14** is contained internally within a cavity **15** of the boss portion **3***a* of the cover assembly **3**. The shaft **14** is rotatably supported within the cover assembly **3** by an annular bore **16** (see FIG. 2) disposed transversely of the boss **3***a* and intercepting the cavity **15**. The shank **11** of the actuating arm **10** is fastened to the external portion of the shaft **14** by means of a set screw **17**, the threads of which coincide with the threaded aperture **18** of the operating shaft **14**. Thus, the external actuating arm **10** responds to alternative pressure applied to the finger pads **13**. The arm **10** rotates about the axis of the shaft **14** and the exterior walls of the boss **3***a* in a direction dependent upon which of the pads **13** is manually depressed. This action serves to rotate the operating shaft **14** in a corresponding direction about its longitudinal axis. Around the base of the boss **3***a* is a flange **19** part of which is beneath the opposite ends of the external actuating arm **10**. The actuating arm **10** bottoms on the flange **19** when the arm **10** is rotated a sufficient amount.

Intermediate the ends of the shaft **14** and within the cavity **15** is an internal actuating plate arm **20** engaging the shaft **14**. The actuating arm **20** is disposed normal to the rotational axis of the shaft **14** and is secured thereto by means of a resilient member in the form of a spiral compression spring **21** and a fastener pin **22** threaded at an end **23** to engage a threaded transverse aperture **24** in the shaft **14**. The spring **21** and pin **22** are illustrated in the exploded view of FIG. 3. As illustrated in FIG. 3, the actuating arm **20** has a transverse rectangular cross section and is provided with a centrally disposed oblong aperture **25**. The major axis of the oblong aperture **25** is parallel to the longitudinal axis of the arm **20**. The pin **22** has a shank portion **26** of cross-sectional dimensions larger than the threaded portion but slightly less than the internal diameter of the compression spring **21** such that the spring **21** can be slid over and encircle the shank **26**. The external diameter of the spring **21** is larger than the minor axis of the oblong aperture **25** such that the compression spring **21** will provide a biasing pressure against the lower surface of the arm **20**. To receive the arm **20**, the shaft **14** is provided with a flat bottomed seat **27** to coincide with the flat surface of the arm **20** at the point the aperture **25** aligns with the aperture **24**. The present embodiment is designed such that when the shaft **14**, the actuating arm **20**, the compression spring **21** and the pin **22** are secured in place, the arm **20** is positioned flush against the bottom of the seat **27** of the shaft **14**, and the spring **21** surrounds the shank **26** urging the arm **20** against the shaft **14**. At the same time, when a force parallel to the longitudinal axis of the arm **20** is applied to the arm **20**, and which force is greater than the frictional longitudinal force resulting from the compression spring **21**, the arm **20** will be permitted to slide along its longitudinal axis normal to the axis of the pin **22**. The arm **20** further carries a pair of angled wings **28** disposed oppositely of the aperture **25**.

FIGURE 4 illustrates a standard push-button switch assembly designated by the general reference character **30**. The switch assembly **30** has a pair of contact terminals **31** and **32** for respectively receiving a pair of electrical wires (not shown). The switch assembly **30** further carries a pair of push-buttons **33** and **34** one of which may be used to alternatively "close" and "open" an electrical circuit between the terminals **31** and **32**.

Mounted upon the switch assembly **30** is a plunger assembly designated by the general reference character **40**. The plunger assembly **40** is designed to convert the arcuate motion of the internal actuating arm **20** to reciprocal linear motion for operating the push-buttons **33** and **34**. The switch assembly **30** is connected to the plunger assembly **40** by means of a pair of fasteners **41** and **42** which engage a supporting plate **43**. The supporting plate **43** is pierced to provide a pair of rectangular apertures **44** respectively receiving a pair of substantially Y-shaped, laterally spaced plungers **46**. Each of the plungers **46** comprises an upstanding post **48** received by the aperture **44**, a pair of upraised arms **49**, and a crossbar **50** intersecting the post **48** and arms **49**. The free end portion of each of the posts **48** is located at the opposite side of the supporting plate **43** and are bent at an angle to form a tab **51**. The tab **51** is formed to be substantially perpendicular to the post **48** and the crossbar **50**. The tabs **51** are respectively positioned to actuate the push-buttons **33** and **34**. Supporting each plunger **46** in a vertical position relative to FIG. 4 and biasing its tab **51** away from the respective push-buttons **33** and **34** is a resilient member in the form of a spiral biasing spring **52** disposed between the crossbar **50** and the support plate **43**. The tabs **51** serve a dual purpose, one purpose of which is to engage an associated push-button when the associated plunger **46** is in a depressed position and secondly, act as a stop for preventing the plunger **46** from escaping the associated aperture **44** due to the force of the associated spring **52** when in a neutral position. It may be noted at this point that the spacing between plungers **46** is less than the longitudinal length of the internal actuating arm **20**. Also, the length of the crossbars **50** joining the arms **49** is slightly greater than the width of the internal actuating arm **20** such that the opposing ends **28** of the actuating arm **20** may engage the plungers **46** and be embraced by the arms **49**.

The switch assembly **30** and the plunger assembly **40** are supported by the cover assembly **3** by means of a pair of spaced fasteners **60** which extend through apertures **61** of the cover plate **3** and the apertures **62** of the supporting plate **43** (see FIGS. 5 and 6). Assuming a normal or neutral position of the actuating arm **10**, as shown in FIG. 1, the plungers **46** will be biased away from the push-buttons **33** and **34** by the force of each of the biasing springs **52**.

Upon manual depression of one of the finger pads **13**, (the right pad as illustrated in FIG. 5) the external actuating arm **10** will be rotated externally of the hollow boss **3***a* and the rotatable operating shaft **14**. The internal actuating arm **20** will be rotated correspondingly. The rotation of the shaft **14** is illustrated by an arcuate double arrow **63** in FIGS. 5 and 6. If the external pressure applied to the right hand finger pad **13**, as indicated by an arrow **64**, is sufficient to overcome the force resulting in part from friction and the biasing spring **52**, the internal arm **20** forces the associated plunger towards the switch assembly **30**, and the right hand tab **51** will engage the associated push-button, which in FIG. 5 is push-button **34**. The reciprocal linear motion of the plungers **46** is illustrated by the straight double arrows **65**.

Upon removal of the pressure applied to the finger pad **13**, the expansion force of the biasing spring **52** acting against the crossbar **50** of the respective plunger **46** causes the plunger **46**, the internal actuating arm **20** and the external actuating arm **10** to return towards their neutral positions. Upon return of the actuating arm **20** towards the neutral position, it will normally have a tendency to "overtravel" and go beyond the neutral point due to the force of the spring **52**. However, in the present design "overtravel" is minimized. When the actuating arm **20** reaches the neutral point and attempts to go beyond in the opposite direction, a counteracting force is applied by the opposing biasing spring **52** thereby minimizing the "overtravel." Though there may be slight "overtravel" and movement of the opposing plunger **46**, since the tabs **51** are spaced from the associated push-button, the move-

ment will not be sufficient to engage the push-button, assuming care is taken in selecting the springs **52** and the spacing between the tabs **51** and their associated push-buttons. Minimizing "overtravel" minimizes accidental actuation of the opposing push-button.

FIG. 5 illustrates switch actuation during normal operation of the switch mechanism. However, it is not uncommon for abnormal forces to be applied to the externally actuated arm. These forces may result from an overenthusiastic operator or a falling object coming into contact with the external actuating arm **10**. The situation of an excessive force being applied to a finger pad **13** is demonstrated in FIG. 6 by the two arrows **64**. The present design permits the application of such abnormal forces without having said forces absorbed by the switch assembly **30** itself unless the housing **1** is destroyed. When an abnormally large force is applied to a finger pad **13**, the external actuating arm **10** has a tendency to rotate until it bottoms on the exterior flange **19** of the cover assembly **3** as illustrated by the right hand pad **13** of FIG. 6. With the exterior arm **10** rotating to this extreme position, the internal plate **20** likewise attempts to follow. In viewing and comparing the position of the right hand finger pad **13** in FIGS. 5 and 6, it will be noted that the distance travelled in FIG. 6 is substantially greater than that of FIG. 5. However, the distance travelled by the internal arm **20** is approximately the same in both instances. This results from the feature that when the tension on the bias spring **52** in conjunction with the restraining force of the actuated push-button reaches a certain point, it exceeds the counteracting force of the compression spring **21** surrounding the pin **22**. The force of the spring **21** varies according to the position of the internal arm **20**. At the point the force of the spring **21** is exceeded, and because of the oblong configuration of the aperture **25** of the arm **20**, the actuating plate **20** will shift away from the plunger to thereby shorten the moment arm. Accordingly, the associated plunger **46** does not advance beyond the point which would otherwise cause excessive and detrimental forces to be applied to the push-button switch assembly **30**. When the abnormal force is released from the finger pad **13**, the force of the biasing spring **52** will return the actuating arm **20** towards its neutral position. It may be noted that when the plunger **46** engages its respective push-button in FIGS. 5 and 6, that the end **28** of the arm **20** is substantially normal to the upraised arm **49** and crossbar **50** of the associated plunger **46**. Further, it may be noted that the bottom surface of the triangular shaped shank **11** of the external actuating arm **10** is designed to bottom on the flange **19** of the housing **1** concurrently with the bottoming of the associated finger pad **13**. Thus, the abnormal forces are distributed over a greater portion of the arm **10** and housing **1**.

Referring more specifically to the cavity **15** of the cover plate assembly **3**, it will be noted that it is grooved at **70** to receive the free ends of the upraised arms **49** of a respective plunger **46**. The slots **70** guide the reciprocal linear movement of the plungers **46**. It may be noted from FIG. 2 that when the actuating arm **10** is in its neutral position, the upraised arms **49** bottom at the top of the slots **70** such that when in the neutral position there is little, if any, pressure applied to the internal actuating arm **20**.

The cover assembly **3** is preferably provided with external ribs **75** flanking the finger pads **13** (see FIG. 1). These ribs serve to protect the pads **13** from receiving blows from large objects. The ribs **75** along with the exterior walls of the cavity **15** further serve as guides for an operator feeling for the finger pad when his attention may in part be diverted to other portions of the particular machinery under control of the switch. The embodiment further illustrates that the ribs **75** may have a pair of aligned circular apertures **76** coinciding with one finger seat **13**. These apertures **76** permit a padlock or other similar device to be placed through the holes to maintain an associated seat **13** in a depressed position. Normally the apertures **76** coincide withe the "stop" or "off" finger seat **13**. The present embodiment further features an O-ring **77** disposed about the shaft **14** (see FIGS. 2 and 3). The O-ring **77** has an inner dimension slightly less than the diameter of the shaft **14** thereby permitting a snug fit. The outer dimensions of the O-ring **77** are slightly greater than the interior diameter of the aperture through which the shaft **14** protrudes. The O-ring **77** discourages gases, moisture or foreign objects from entering the cavity **15**. The O-ring **77** further creates a drag. The drag aids the springs **52** in dissipating the inertial energy of the actuating arms **10** and **20** when pressure is released from the finger pads **13** and minimizes "overtravel."

In the illustrated embodiment, the aperture **25** of the actuating arm **20** has been shown (FIG. 3) and discussed as oblong. However, the invention is not so limited. To realize the shifting feature of the arm **20** when abnormal forces are applied it is only necessary that the dimensions of the aperture parallel to the longitudinal axis of the arm exceed the dimensions of that part of the shank **26** extending through the aperture. For example, the aperture may be circular with the diameter greater than the diameter of the shank **26** but less than the diameter of the spring **21**.

I claim:

1. An enclosed electrical switching station comprising, in combination:

a housing, the walls of which define an internal cavity therein and a shaft receiving aperture therethrough;

an electrical switch assembly supported in said housing cavity;

a rotatable operating shaft having a portion extending internally of said housing through said apertrue;

an external actuating arm engaged with and arranged to operate said shaft;

a second actuating arm residing in said housing cavity and operably engaging the internal portion of said shaft, said second actuating arm positioned substantially normal to the rotational axis of said shaft;

overtravel takeup means interposed between said second actuating arm and said shaft permitting said second actuating arm to be laterally movable relative to the axis of said shaft;

a reciprocally, linearly movable plunger supported in said housing cavity independently of said second actuating arm and said switch assembly, and adapted to actuate said switch assembly, said plunger slidably engaging said second actuating arm at a point spaced from said shaft;

whereby rotational movement of said shaft will be transmitted to said plunger to provide linear motion of said plunger.

2. An enclosed electrical switching station in accordance with claim **1** in which

the second actuating arm engages the shaft at a point intermediate the opposing longitudinal ends of the second actuating arm, the second actuating arm having an aperture coinciding with the point at which the second actuating arm engages the shaft, a pin member protruding through said aperture and engaging the shaft, said pin member having a shank of cross-section dimensions less than the size of the aperture permitting the second actuating arm to slide about said shank, a resilient member surrounding said pin member and without said aperture, said resilient member urging the second actuating arm towards the shaft.

3. An enclosed electrical switching station comprising, in combination:

a housing, the walls of which define an internal cavity therein and a shaft receiving aperture therethrough;

an electrical switch assembly supported in said housing cavity;

a rotatable operating shaft having a portion extending internally of said housing through said aperture;

an external actuating arm engaged with and arranged to operate said shaft;

a second actuating arm residing in said housing cavity and operably engaging the rotatable operating shaft at a point intermediate the opposing longitudinal end points of the second actuating arm and extending substantially normal to the rotational axis of said shaft;

a pair of plungers independently supported within the housing for independent linear motion substantially normal to the axis of the operating shaft and substantially normal to the longitudinal axis of the second actuating arm, the opposing longitudinal ends of the second actuating arm each slidably engaging one of the plungers, whereby the plungers are alternatively urged towards the switch assembly depending on the rotational direction of the second actuating arm;

whereby rotational movement of said shaft will be transmitted to said plungers to provide linear motion to said plungers.

4. An enclosed electrical switching station in accordance with claim **3** including resilient means biasing the plungers in a neutral position away from said switch assembly when the second actuating arm is in an unactuated neutral position, the resilient means further resisisting movement of the plungers towards said switch assembly when the second actuating arm rotates beyond the neutral position towards the switch assembly.

5. An enclosed electrical switching station in accordance with claim **1** in which

the second actuating arm engages the shaft at a point intermediate the opposing longitudinal end points of the second actuating arm, the second actuating arm having an aperture coinciding with the point at which the second actuating arm engages the shaft, a pin member protruding through said aperture and engaging the shaft, said pin member having a shank of cross-section dimensions less than the size of the aperture permitting the second actuating arm to slide about said shaft, a resilient member surrounding said pin member and without said aperture, said resilient member urging the second actuating arm towards the shaft; and

including resilient means biasing the plunger in a neutral position away from said switch assembly when the second actuating arm is in an unactuated neutral position, the resilient means further resisting movement of the plunger towards said switch assembly when the second actuating arm rotates beyond the neutral position towards the switch assembly.

6. An enclosed electrical switching station in accordance with claim **2**, and including

a pair of plungers independently supported within the housing for independent linear motion substantially normal to the axis of the shaft and substantially normal to the longitudinal axis of the second actuating arm, opposing longitudinal ends of the second actuating arm each slidably engaging one of the plungers, whereby the plungers are alternatively urged towards the switch assembly depending on the rotational direction of the second actuating arm; and

resilient means biasing the plungers in a neutral position away from said switch assembly when the second actuating arm is in an unactuated neutral position, the resilient means further resisting movement of the plungers towards said switch assembly when the second actuating arm rotates beyond the neutral position towards the switch assembly.

7. An enclosed electrical switching station in accordance with claim **6**, in which

the first actuating arm has a shank portion and a pair of finger pads at opposite ends, each of said pads extending backward to overlie a wall surface of the housing, said shank portion engaging the external portion of the shaft at a point intermediate said pads such that when pressure is applied to one pad the shaft rotates in one direction and when pressure is applied to the other seat the shaft rotates in the opposite direction.

8. An enclosed electrical switching station in accordance with claim **7**, in which

said internal cavity of the housing includes a first and second cavity the walls of said second cavity having said shaft receiving apertures therethrough, said first and second cavities adjoining each other with the exterior dimensions of the walls of said second cavity being less than the exterior dimensions of the walls of said first cavity, an exterior ledge intermediate said first and second cavities and parallel to the longitudinal axis of the shank portion of the first actuating arm, said flange adapted to limit the rotation of the first actuating arm to a predetermined amount.

9. An enclosed electrical switching station in accordance with claim **8** including

an O-ring surrounding the shaft, the O-ring concurrently engaging the shaft and the interior wall surfaces of the shaft receiving aperture, whereby the O-ring dissipates inertial energy developed by rotation of the shaft.

10. An enclosed electrical switching station in accordance with claim **6** in which

the plungers have a pair of upraised arms and an upstanding post joined in a substantial Y-shaped configuration with the arms branching out from one end of the post, said arms of each plunger embracing the respective ends of the second actuating arm; and in which

the resilient means comprise a pair of biasing springs, one biasing spring engaging an arm member of one plunger and the other biasing spring engaging an arm member of the other plunger, said biasing springs urging their respective plunger away from said switch assembly.

11. An enclosed electrical switching station in accordance with claim **10**, including

a support plate positioned above said switch assembly, the support plate pierced by a pair of apertures slightly greater than the cross-section dimensions of the post portion of the Y-shaped plungers, and in which

said post portion of one plunger extends through one aperture and said post portion of the other plunger extends through the other aperture, each post carrying a tab on the opposite end which tab is substantially normal to the axis of the respective post; and

a pair of biasing springs, one biasing spring concurrently engaging the support plate and an arm member of one plunger, and the other biasing spring concurrently engaging the support plate and an arm member of the other plunger.

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