Dec. 1, 1970 M. B. GREGORY ET AL 3,544,933

COMBINATION STOP ACTION

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FIG.1

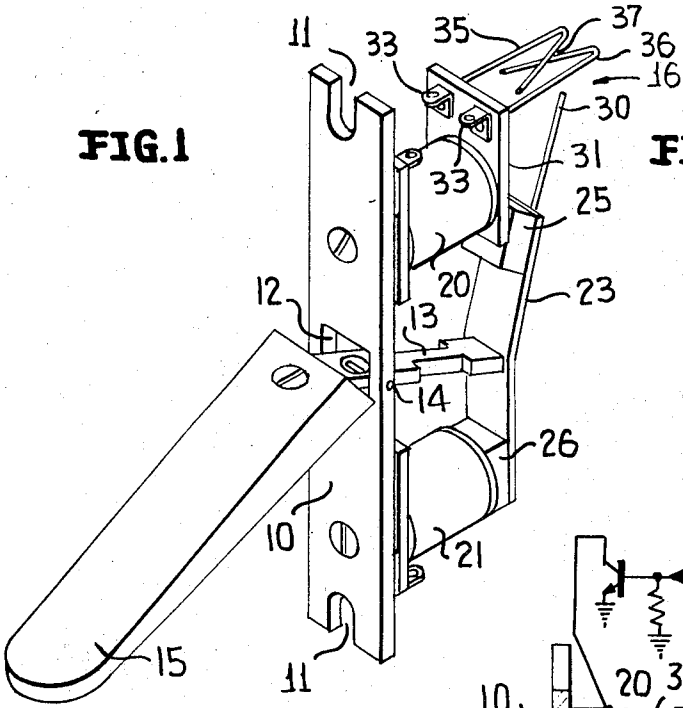



FIG.2

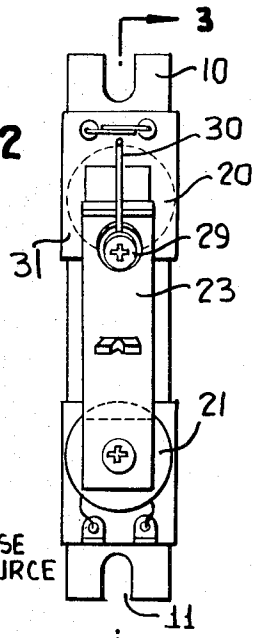



FIG.3

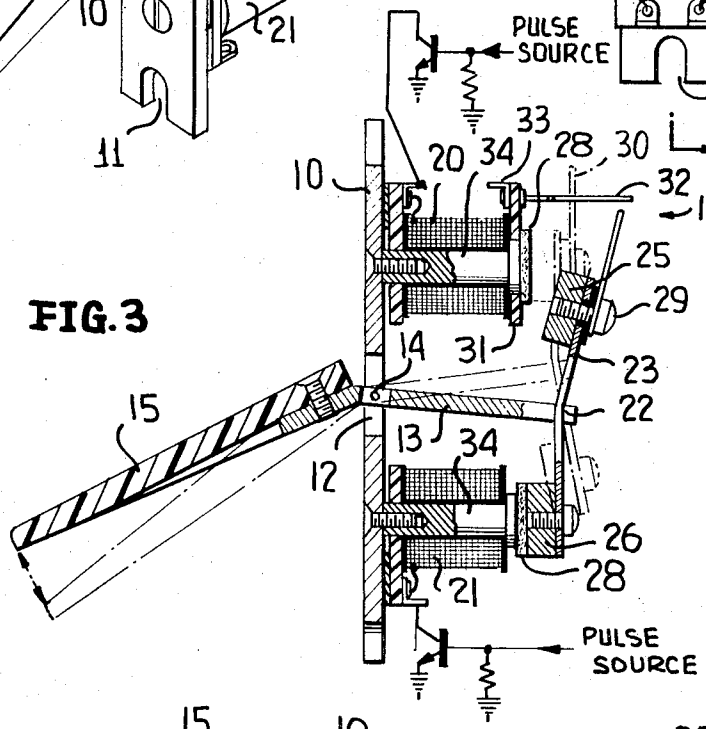
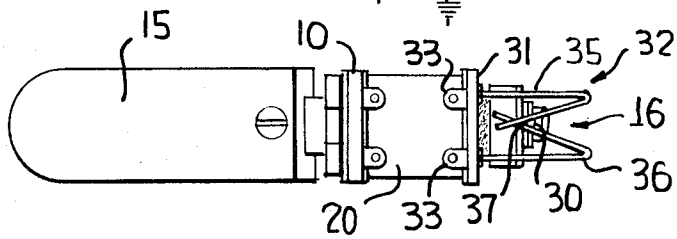



FIG.4




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FIG.5

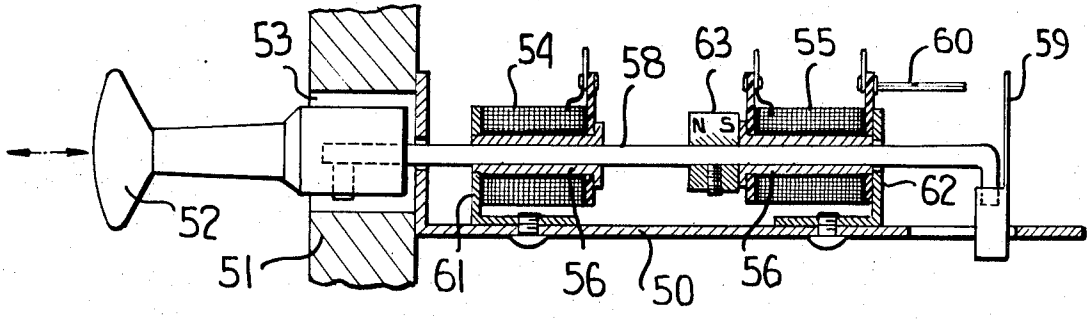



FIG.6

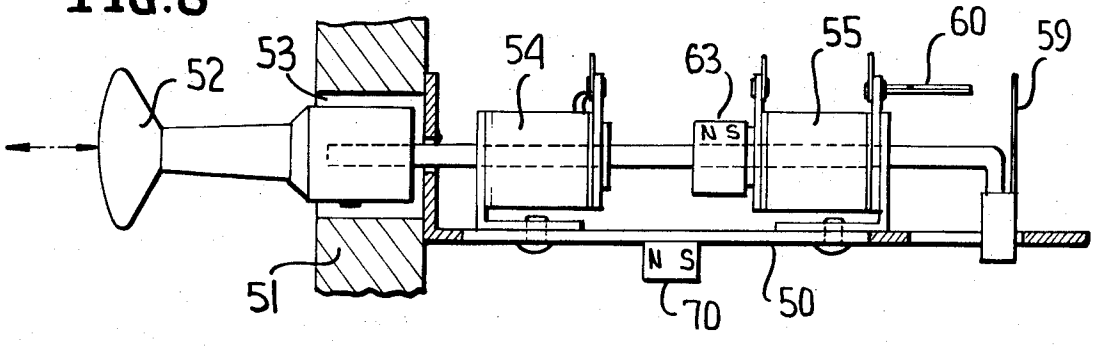
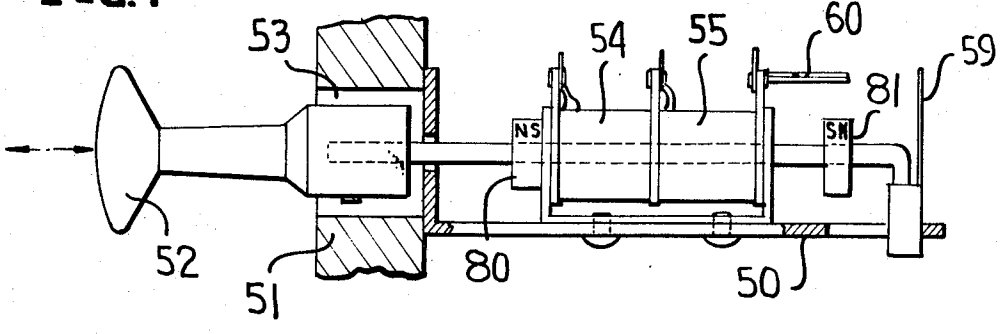



FIG.7




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# COMBINATION STOP ACTION

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Int. Cl. H01h 9/20

U.S. Cl. 335—179 14 Claims

## ABSTRACT OF THE DISCLOSURE

A draw knob for an electronic or pipe organ, in which a pair of actuating electromagnets operate on a permanent magnet means, to actuate a shaft to which the permanent magnet is secured. The electromagnets include armatures which exert a toggle effect on the permanent magnet means. The electromagnets are so poled relative to the permanent magnet means that the latter can be repelled by that electromagnet to which it is most nearly adjacent, and having passed a dead center position becomes self-attached to the armature of the other electromagnet, which is not energized at that time. In a modification, a further permanent magnet is positioned mid-way between the extremes of movement of the first mentioned permanent magnet means, and is so poled as to force the first mentioned permanent magnet means off dead center.

In a further modification of the invention, applied to a stop tab, two permanent magnets are mounted on a pivotable member, and are positioned over electromagnets having parallel axes. The electromagnets are so arranged that each permanent magnet is repelled by the electromagnet to which it is adjacent, when the latter is energized, forcing the remaining permanent magnet to approach the armature of the remaining and then unenergized electromagnet, to effect a toggle action.

## BACKGROUND OF THE INVENTION

Combination stop actions, in electronic or pipe organs, are systems for actuating selected combinations of switches selectively to open and closed condition, in response to operation of single controls. The switches control tone color filters, relays or solenoid-operated valves either connecting these into or disconnecting these from, the organ system, so that they are operative or inoperative to perform their intended function. The musician can operate each one of the switches individually, by means either of a draw knob in some organs, or by means of a pivtable tab in others. It is conventional to provide combination stop actions in which the draw knows, or the tabs, are each hand operated and also operated by an electromagnet pair, i.e., any preselected combination of tabs or draw knobs may be commonly actuated by operation of a single control switch which closes circuits energizing appropriate combinations of electromagnets, to produce motion in or out, for the draw knobs, and up or down for the tabs. The draw bars for tabs may, however, be individually actuated manually independently of the electromagnets.

It is desirable for the individual switch actuators to provide toggle or over-center action; and they must remain in their last position and always go to extreme positions. This toggle action has in the past been provided by mechanical elements, for example, levers and springs, which are costly and require expensive electromagnets



capable of exerting considerable force, and are relatively bulky, and subject to mechanical failure.

It is an object of the present invention to provide a novel combination action system employing permanent magnet devices to provide toggle action, primarily in order to reduce costs of fabrication, but also having in view, reduction of maintenance and reduction of space and power requirements.

## SUMMARY OF THE INVENTION

A bistable draw knob or stop tab for an electronic or pipe organ, which may be operated manually or by means of electromagnets, and which utilizes permanent magnets to confer bistability.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in perspective of a tab operated switch according to one embodiment of the invention;

FIG. 2 is a view inside elevation of the device of FIG. 1;

FIG. 3 is a view in section taken on the line 3—3 of FIG. 2;

FIG. 4 is a view inside elevation of the structure of FIGS. 1–2;

FIG. 5 is a view inside elevation of a draw bar operated switch, according to the invention;

FIG. 6 is a view inside elevation of a modification of the system of FIG. 5;

FIG. 7 is a view inside elevation of a further modification of the system of FIG. 5.

## BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIGS. 1–4 of the accompanying drawings, **10** is a mounting plate having end slots **11** which serve to locate mounting bolts, not illustrated, for securing the device of the invention to the case of an electronic organ. A cut-out **12** is provided centrally of mounting plate **10**, through which extends a tilt rod **13**, pivotally mounted on a pin **14** extending transversely through the mounting plate **10** centrally of cut-out **12**. A stop tab **15**, usually fabricated of decorative resinous material, is secured to that portion of tilt rod **13** which extends forwardly of mounting plate **10**, and externally of the organ case, and has two positions, an up position, illustrated in full lines in FIG. 3, in which a switch **16** is open, and a down position, illustrated in dotted lines in FIG. 3, in which switch **16** is closed. Secured to the ends of electromagnets **20, 21** are thin felt spacer pads **28**, which act as spacers between the permanent magnets **25, 26** and the electromagnets **20, 21**, on engagement of one of the former with one of the latter.

The angles made by the cross-bar **23**, the distance of the cross bar **23** from the pivot **14**, and the heights of the felt spacer pads **28** above the back surface of mounting plate **10**, are adjusted so that in the up position of tab **15** permanent magnet **26** lies flat against pad **28**, while in the down position of tab **15** permanent magnet **25** lies flat against pad **28**.

The material of which the device is fabricated is steel, apart from tab **15**, to provide the requisite low reluctance magnetic circuits, necessary for bistability.

Secured over permanent magnet **25**, by means of a bolt **29**, is a silver switch contact **30** in the form of a

stiff straight rod or wire extending in the direction of the longitudinal dimension of the mounting plate **10**.

Secured to electromagnet **20**, under pad **28**, is an insulated contact mount **31**, on which is mounted a switch contact **32**, which co-acts with switch contact **30**. The contact **32** is composed of two slightly resilient silver wires **35**, **36**, each extending through an opening in contact mount **3** to a terminal **33**. The wires **35**, **36** extend perpendicularly from contact mount **31** for slightly more than half their lengths and then bend inwardly at a 30° angle to beyond a cross-over point **37**. When the tab **15** is moved to its down position, wire **30** moves to the cross-over point **37** and forces that point down, tending to spread the bent arms of wires **35** and **36**. The resultant wedging action assures a firm contact.

The device is stable in either of its operated positions, achieved in response to operation of tab **15**, because the operated position represents a minimum reluctance magnetic circuit for one of the permanent magnets, but not for the other. Use of permanent magnets provides the requisite detent action, necessary to achieve bi-stability in absence of current in electromagnets **20**, **21**. Detent action has heretofore been achieved by means of an over-center or detent spring. The electromagnets are provided with iron core coils **34**, to enhance effectiveness and efficiency.

In order to operate the switch electrically, a pulse of current is applied to that electromagnet which is serving to detain cross bar **23**. In FIG. 3, this is electromagnet **21**. The direction of the current is such, having regard for winding sense and polarity of permanent magnet **26**, that the latter is repelled. Maximum force is thereby applied to permanent magnet **26** at the start of its motion, where it is needed to overcome detent action. As the permanent magnet **26** moves away from core **34**, its attraction toward the core reduces, although the force driving it away from the core, due to electromagnet action, is also reduced. At the same time, the attraction between electromagnet **25** and core **34** is increasing. If the impulse provided by electromagnet **21** is sufficiently great, the tilt bar **13** will, due to the resultant of all the force acting, move over center, and thereafter continue its motion until again latched in its new position.

Pulse sources for the electromagnets **20**, **21**, respectively, may be transistor switches, and any predetermined number of devices according to the invention may be simultaneously and selectively actuated to desired positions, thereby selectively actuating preselected combinations of tone color filters. The details of the switching circuits are outside the scope of the present invention, since they are considered conventional.

While many electronic organs employ stop tabs for selecting tone color filters, others employ draw bars. In FIGS. 5–7 of the invention is illustrated three diverse embodiments of the present invention as applied to draw bars.

In FIGS. 5–7, is illustrated a mounting plate **50**, secured to a wall **51** of an electronic organ. A draw bar knob **52** extends through an opening **53** in wall **51**.

In FIG. 5, a pair of electromagnets **54**, **55** is mounted in spaced apart relation on bracket **50**. Each of electromagnets **54**, **55** is provided with iron core **56**. The cores **56** are provided with aligned passages **57**, through which extends a pull rod **58**, secured at one end to knob **52**, and supporting a switch contact **59** at its other end. A further stationary switch contact **60** is secured to an insulating plate **61**, which in turn is supported by electromagnet **55**. The switch may be the same as that utilized in the embodiment of our invention illustrated in FIGS. 1–3.

Secured to rod **58** and located between the electromagnets **54**, **55** is a permanent magnet **63** arranged to have its South pole facing electromagnet **55** and its North pole facing electromagnet **54**. The electromagnets are secured to bracket **50** by means of L-shaped mounts



**61**, **62** and the mounts and brackets are fabricated of steel. The rod **58** is thus bi-stable in its extreme positions, i.e., with the permanent magnet in contact with either core **56**, and it may be actuated to these extreme positions by force applied to knob **52**. The rod **58** may also be actuated by energizing the appropriate one of electromagnets **54**, **55** to provide a repulsive impulse applied to the permanent magnet, of sufficient magnitude to drive the permanent magnet beyond dead center.

In the system of FIG. 5, it is possible, if the actuating coil is under energized, either in respect to amplitude of current or duration of current, or both, to have the bar **58** arrive and remain at dead center. This possibility is removed in FIG. 6 by providing a second permanent magnet **70**, so poled as to oppose movement of magnet **63**, and thereby to contribute to stability, while the magnet is in an extreme position, because, in the illustration, its south pole face is nearly aligned with the north pole face of magnet **63**, while the north pole of permanent magnet **70** is to the left. The presence of the auxiliary magnet **70** renders the position of the magnet **63** unstable in its central position, i.e., when located midway between the armatures of electromagnets **54**, **55**, because in that position two north poles are superposed and two south poles are superposed. Once the magnet **63**, traveling to the left in FIG. 6, has passed its central position, magnet **70** applies further force to the left, causing magnet **63** to complete its traverse. The magnets **63**, **70** may preferably have the same lengths, parallel to bar **58**, for maximum effect.

Another arrangement is illustrated in FIG. 7. The distinction over the systems of FIGS. 5 and 6 is that in FIG. 7, the electromagnets **54**, **55** are immediately adjacent each other, and two permanent magnets **80**, **81** are employed, one outside electromagnet **54** and the other outside electromagnet **55**. Operation is essentially unchanged over that of FIG. 5, but the mechanical assembly is simplified.

We claim:

**1**. An organ switch actuator, comprising

a movable element having two alternative positions,

a manually operable device for moving said movable element selectively between said alternative positions,

first and second electromagnets operatively associated with said movable element and having armatures, respectively,

at least one permanent magnet secured to said movable element in position to be responsive to selective energization of said electromagnets,

means mounting said at least one permanent magnet to be normally selectively in immediate proximity to only one of said electromagnets, while remote from the other, and to have poles respectively facing said armatures, respectively, and

means for applying current selectively to one of said electromagnets of such character as to generate repulsive forces between said at least one permanent magnet and said one of said electromagnets while said permanent magnet is immediately adjacent said one of said electromagnets and selectively to the other of said electromagnets to generate repulsive force between said at least one permanent magnet and the other of said electromagnets while said at least one permanent magnet is immediately adjacent said other of said electromagnets,

a first switch contact secured to said movable element,

a second stationary switch contact, said switch contacts being relatively located to be closed when said movable element is in one of said alternative positions and to be open when said movable element is in the other of said alternative positions,

said at least one permanent magnet being positioned to contact at least one of said armatures to operate as a stop means for at least one of said alternative positions.

2. The combination according to claim 1, wherein said switch actuator is a draw bar, and said manually operable device is a draw knob, and wherein said movable element is coaxial with and extends through said armatures.

3. The combination according to claim 2, wherein said at least one permanent magnet is a single permanent magnet located on said draw bar between said electromagnets.

4. The combination according to claim 2, wherein said at least one permanent magnet is a pair of permanent magnets secured to said draw bar, said electromagnets being located between said permanent magnets and having like poles facing said armatures.

5. The combination according to claim 2, wherein is provided a further permanent magnet located to co-act with said at least one permanent magnet to provide force tending to move said at least one magnet off a dead center position.

6. The combination according to claim 1, wherein is provided a bracket,

a pivot pin secured to said bracket,

wherein said movable element is a tilt bar pivoting on said pivot pin, and

said manually operable device is a pivotable tab secured to said movable element, a cross bar supported by said movable element and movable therewith, and wherein said at least one permanent magnet is two permanent magnets located on opposite ends of said cross bar with like poles proximate said armatures and respectively movable into and out of immediate proximity with said electromagnets, respectively, on pivoting of said tilt bar between limiting positions, said magnets coacting with said armatures to limit pivotal movement of said cross bar.

7. The combination according to claim 8, wherein is provided a bracket,

a pivot pin secured to said bracket,

wherein said movable element is a tilt bar pivoting on said pivot pin,

said manually operable device is a pivotable tab secured to said movable element, a cross bar supported by said movable element and movable therewith, said movable element and said cross bar being dimensioned such that said armatures lie in the paths of movement of opposite ends of said cross bar, and

wherein said at least one permanent magnet is two permanent magnets located on opposite ends of said cross bar with like poles proximate said armatures and respectively movable into and out of immediate proximity with said electromagnets, respectively, on pivoting of said tilt bar between limiting positions, said magnets coacting with said armatures to limit pivotal movement of said cross bar.

8. A motor, comprising

a movable element having two alternative positions,

a manually operable device for moving said movable element selectively between said alternative positions,

first and second electromagnets operatively associated with said movable element and having armatures, respectively,

at least one permanent magnet secured to said movable element in position to be responsive to selective energization of said electromagnets,

means mounting said at least one permanent magnet to be normally selectively in immediate proximity to only one of said electromagnets, while remote from the other, and to have poles respectively facing said armatures, respectively, and

means for applying current selectively to one of said electromagnets of such character as to generate repulsive force between said at least one permanent magnet and said one of said electromagnets while said permanent magnet is immediately adjacent said one of said electromagnets and selectively to the other of said electromagnets to generate repulsive force between said at least one permanent magnet and the other of said electromagnets while said at least one permanent magnet is immediately adjacent said other of said electromagnets,

said at least one permanent magnet being positioned to contact at least one of said armatures to operate as a stop means for at least one of said alternative positions, and

a load device connected to said movable member for actuation thereby.

9. The combination according to claim 8, wherein said movable element is a draw bar, and said manually operable device is a draw knob, and wherein said movable element is coaxial with and extends through said armatures.

10. The combination according to claim 9, wherein said at least one permanent magnet is a single permanent magnet located on said draw bar between said electromagnets.

11. The combination according to claim 9, wherein said at least one permanent magnet is a pair of permanent magnets secured to said draw bar, said electromagnets being located between said permanent magnets and having like poles facing said armatures.

12. The combination according to claim 8, wherein is provided a further permanent magnet located to co-act with said at least one permanent magnet to provide force tending to move said at least one magnet off a dead center position.

13. A motor comprising

a movable element,

electromagnetic means having armature means,

means mounting said movable element for translation parallel to said armature means between two alternative positions,

a manually operable device for moving said movable element selectively between said alternative positions,

a pair of permanent magnets,

means mounting said permanent magnets on said movable element so that said magnets have poles of the same polarity facing said armature means and so that when said movable element is in one of its positions one of said permanent magnets is normally selectively in immediate proximity to one end of said armature means the other of said permanent magnets is remote from the other end of said armature means, and

means for applying current selectively to said electromagnetic means of such character to generate repulsive forces between said electromagnetic means and one of said permanent magnets proximate said armature means and repulsive forces between said electromagnetic means and the other of said permanent magnets when said other permanent magnet is proximate said armature means.

14. A motor comprising

a movable element,

electromagnetic means having armature means,

means mounting said movable element for translation parallel to said armature means between two alternative positions,

a manually operable device for moving said movable element selectively between said alternative positions,

a pair of permanent magnets,

means mounting said permanent magnets on said movable element so that said magnets have poles of the same polarity facing said armature means and so that when said movable element is in one of its positions one of said permanent magnets is normally selectively in immediate proximity to one end of said armature means the other of said permanent magnets is remote from the other end of said armature means,

means for applying current selectively to said electro-

magnetic means of such character to generate repulsive forces between said electromagnetic means and one of said permanent magnets proximate said armature means and repulsive forces between said electromagnetic means and the other of said permanent magnets when said other permanent magnet is proximate said armature means, and

wherein said armature means are arranged such as to lie in the path of travel of said permanent magnets.



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