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ACTUATING MECHANISM

Filed Aug. 31, 1964

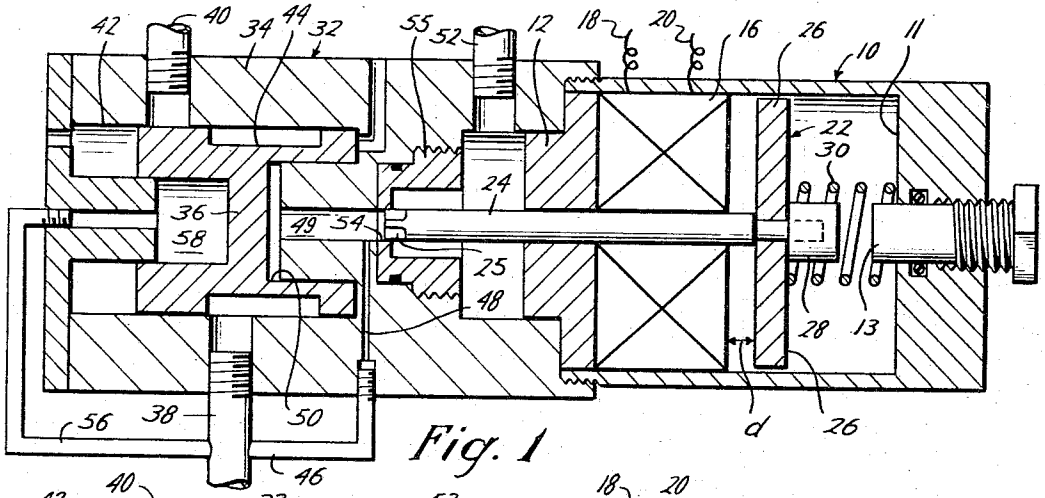


Fig. 1

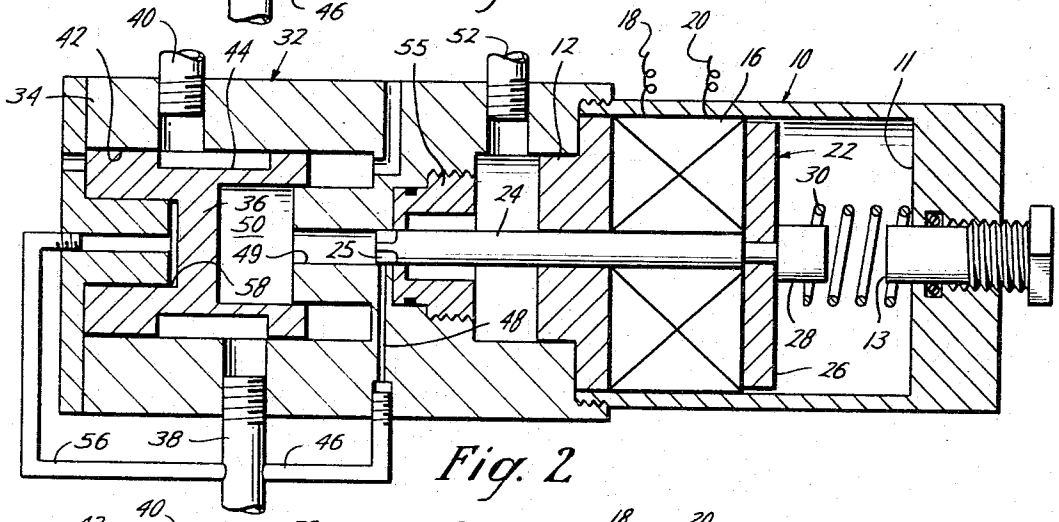


Fig. 2

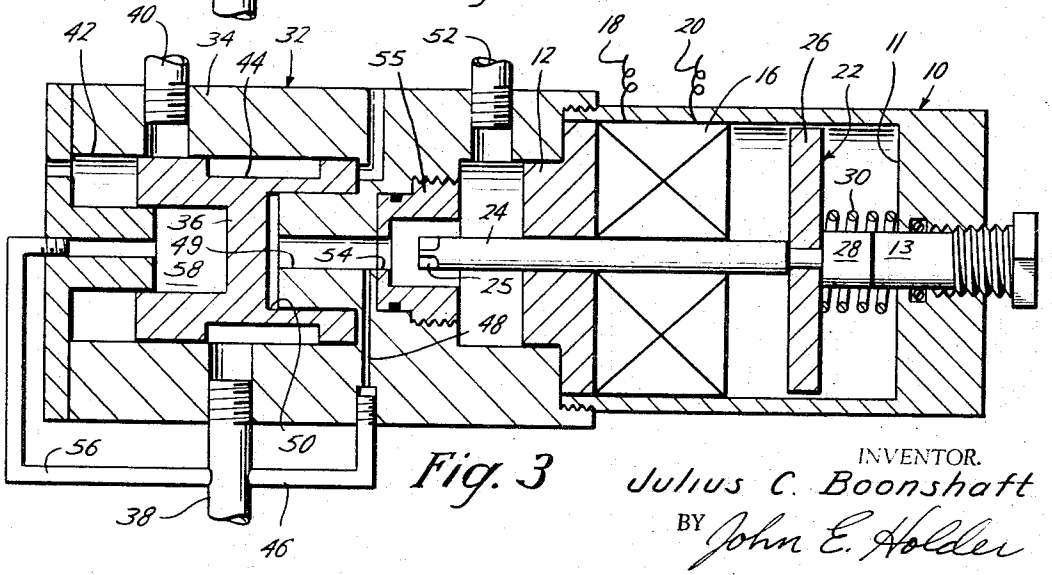


Fig. 3

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ACTUATING MECHANISM

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This invention relates to a very high speed actuating device and, more particularly, to a very high speed electromagnetic actuating device.

It is a broad object of this invention to provide a new and improved very high speed electromagnetic actuating device which requires a minimum of energizing power, can be economically manufactured, occupies a minimum of space, and can be adapted to perform a variety of functions.

It is another object of this invention to provide a new and improved high speed valve actuating mechanism.

These and other apparent objects are accomplished, in accordance with this invention, by providing an actuating device comprising: a movable member coupled to an armature of an electromagnet and a resilient means urging said armature toward said electromagnet. The force to be exerted by said resilient means is determined by the force to be applied against the movable member and armature in a direction away from said electromagnet, the force of the spring being sufficient to bring said armature within the field of action of said electromagnet, so that when said electromagnet becomes energized, said armature becomes attracted to said electromagnet. The electromagnet of this device is characterized by a high holding capability and very rapid demagnetization.

A complete understanding of this invention may be had by reference to the following detailed description when read in conjunction with the accompanying drawings in which:

FIGURES 1–3 are sectional views of a preferred form of an actuating device incorporating the principles of this invention with the device being shown in various stages of operation.

Referring to FIGURE 1, there is shown a housing **10** defining an end portion **12** to which is secured, by suitable means such as glue, an electromagnet **16** having input terminals **18** and **20**.

A movable armature generally designated as **22** is positioned inside the electromagnet **16**. The armature defines a shaft portion **24** and an enlarged head portion **26** which carries an abutment shoulder **28**. The end of the shaft **24** has cut away slot portions **25** thereon. A resilient member **30** is positioned between a side wall **11** of housing **10** and head portion **26** for positioning the head **26** within the field of action of the electromagnet **16** as hereinafter described. The resilient member **30** may take the form of a coiled type spring as shown on the drawing. A stop plug **13** is adjustably positioned in the wall **11** of the housing and projects inwardly into the interior of the housing **10**.

It will be appreciated that if the head **26** is spaced beyond a distance *d* from the electromagnet for any given size of electromagnet, the head will not be rapidly attracted to the electromagnet when energized. Consequently, the separation between the head and the electromagnet when it is deenergized must be established in order for the device to be operated. This is the purpose of resilient member **30**.

A valve mechanism generally designated as **32** is shown threadedly connected to housing **10**. The valve mechanism is generally comprised of a housing **34** and a shuttle piston **36** operating within the housing. Inlet and outlet ports **38** and **40** respectively are provided in

the wall of housing **34** and communicate with a cylinder or bore **42** within which the piston **36** is movably positioned. A recessed portion **44** formed on piston **36** provides fluid communication between the ports **38** and **40** when the piston **36** assumes the position shown in FIGURE 2.

A first inlet passageway **46** connects the inlet port **38** with a restricted passageway **48**. Passageway **48** in turn connects with an intermediate bore **49** and a large interior bore **50** formed in one end of piston **36**. Thus, fluid flow may be established between the inlet port **38** and bore **50**. This large bore **50** is also fluidly connected with an auxiliary outlet **52** by way of intermediate bore **49** and a valve opening **54** in one end of valve housing **34**. The valve opening is formed within a threaded plug member **55** which permits precise longitudinal adjustment of the valve opening.

A second inlet passageway **56** connects the inlet port **38** with a small interior bore **58** formed in the piston **36**. The cross-sectional area of piston **36** exposed to the small interior bore **58** is less than that exposed to the large interior bore **50**.

As shown in each of the figures, the housing **10** enclosing the electromagnet and armature is connected to the valve housing **34**. The shaft **24** extending from the housing **10** through end plate **12** is arranged so that the end of shaft **24** is positioned within valve opening **54** thus closing the valve opening when the electromagnet is energized to move the armature to the left as shown in FIGURE 2.

The operation of the above device is as follows: when the electromagnet **16** is energized, the armature head **26** will be attracted to the electromagnet thereby moving the armature and shaft **24** to the left as viewed in FIGURE 2. The end of shaft **24** of the armature will be moved into a position within valve opening **54** thereby blocking fluid flow between the bore **49** and auxiliary outlet **52**. Fluid under high pressure entering the inlet port **38** is in communication with the large interior bore **50** by way of first inlet passageway **46**, restricted passageway **48**, and intermediate bore **49**. The fluid inlet port **38** is also in communication with the small interior bore **58** by way of the second inlet passageway **56**. Since the cross-sectional area exposed to the fluid pressure is greater in bore **50** than in bore **58**, the piston **36** will move to the left to the position shown in FIGURE 2. This position of piston **36** provides a fluid connection between inlet and outlet ports **38** and **40** through the recessed portion **44** in the piston.

When energization of electromagnet **16** is discontinued, high fluid pressure, which has built up in bores **49** and **50**, rapidly forces the end of shaft **24** to the right and out of the opening **54**. This movement of the shaft permits rapid dumping of fluid from the bores **49** and **50** into the large auxiliary outlet **52**. Since the electromagnet **16** has a characteristic of rapid demagnetization, the movement of armature **22** and shaft **24** under the force of fluid pressure is very rapid. This force of the fluid under pressure in bores **49** and **50** is sufficiently great to overcome the effect of spring **30** which tends to bias the armature toward a closed or energized position. The armature moves to the right until the abutment shoulder **28** engages the stop plug **13** positioned in housing wall **11** (FIGURE 3). After this sudden release of fluid pressure from bores **49** and **50**, the high fluid pressure in bore **58**, although acting on the smaller cross-sectional area, is now great enough to move the piston **36** to the right. This movement of the piston places the recess **44** out of communication with inlet and outlet ports **38** and **40** to close the valve.

With this depletion of pressure in bore **50** due to the sudden escape of fluid through outlet **52**, the resilient

member or spring **30** is then effective to move the armature **22** back to the left toward the electromagnet until the inside face of head portion **26** is positioned from the electromagnet at a distance *d* as shown in FIGURE 1. This precise positioning of the head **26** is determined by the strength of spring **30** and the distance *d* may be on the order of .010 inch.

The distance *d* should be small enough to insure fast movement of the armature in response to energization of the electromagnet and large enough to provide a spacing between the slotted end **25** of shaft **24** and the opening **54** sufficient to permit fluid flow through the opening **54** into outlet **52** and thereby prevent build-up of fluid pressure in bores **49** and **50**.

Upon subsequent energization of electromagnet **16**, the armature is rapidly moved the distance *d* to the left to again close the opening **54** and cause a pressure build-up in bores **49** and **50**. This in turn will cause the piston **36** to move to the left as shown in FIGURE 2 to thereby open the inlet and outlet ports **38**, **40** to fluid communication.

Although the actuating mechanism has been shown for use in conjunction with a valve mechanism, it is readily appreciated that it could be used with any system requiring a fast actuating mechanism.

In addition, while a particular embodiment of the present invention has been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. A mechanism for selective high speed opening and closing of a fluid passage having high-pressure fluid therein, comprising:

a passageway having a source of high-pressure fluid connected to one side thereof, and a large dumping port connected to the other side thereof,

a shaft mounted for longitudinal movement between three mutually adjustably spaced positions,

an enlarged head portion at one end of said shaft,

an electromagnet adjacent to said enlarged head portion, said electromagnet having a characteristic of rapid demagnetization,

said mechanism having a first position wherein said electromagnet is energized and said enlarged head portion is pulled into contact with said electromagnet, said shaft having a length so that in said first position, the other end of said shaft is within and closes said passageway against said high-pressure fluid,

said mechanism having a second position wherein said electromagnet is unenergized, and said shaft is forced completely clear of said passageway by said high-pressure fluid and said enlarged head portion is so far removed from said electromagnet that the field of said electromagnet when energized is incapable of pulling said enlarged head portion into contact with said electromagnet against the force of said high-pressure fluid, the extreme distance of said enlarged head portion from said electromagnet in said third position being determined by adjustable stop means,

a third position wherein said electromagnet is unenergized and said enlarged head is out of contact with said electromagnet but close enough so that the field of said electromagnet can pull said enlarged head into contact with said electromagnet when energized against the force of said high-pressure fluid, said shaft and said passageway being so spaced so that said shaft just clears said passageway,

adjustable spring means bearing against said enlarged head and biased to force said enlarged head and shaft into said third position from said second position.

2. A valve mechanism comprising:

a valve housing having an inlet and outlet port, and high-pressure fluid always present at said inlet port,

a shuttle piston slidably mounted within said valve housing for movement to respectively open and close said ports to fluid communication therebetween, one side of said shuttle piston having a small bore connected to said high-pressure fluid and the other side of said shuttle piston having a large bore connected to said high-pressure through a restricted passage,

a passageway having one side thereof communicating with said restricted passage, and a large dumping port connected to the other side thereof,

a shaft mounted for longitudinal movement between three mutually adjustably spaced positions,

an enlarged head portion at one end of said shaft,

an electromagnet adjacent to said enlarged head portion, said electromagnet having a characteristic of rapid demagnetization,

said mechanism having a first position wherein said electromagnet is energized and said enlarged head portion is pulled into contact with said electromagnet, said shaft having a length so that in said first position, the other end of said shaft is within and closes said passageway against said high-pressure fluid, to maintain said large bore under full high-pressure and drive said shuttle piston in the direction of said small bore

said mechanism having a second position wherein said electromagnet is unenergized, and said shaft is forced completely clear of said passageway by said high-pressure fluid to permit said large bore to dump and said high-pressure fluid in said small bore to drive said shuttle piston in the direction of said large bore, and said enlarged head portion is so far removed from said electromagnet that the field of said electromagnet when energized is incapable of pulling said enlarged head portion into contact with said electromagnet against the force of said high-pressure fluid, the extreme distance of said enlarged head portion from said electromagnet in said third position being determined by adjustable stop means,

a third position wherein said electromagnet is unenergized and said enlarged head is out of contact with said electromagnet but close enough so that the field of said electromagnet can pull said enlarged head into contact with said electromagnet when energized against the force of said high-pressure fluid, said shaft and said passageway being so spaced so that said shaft just clears said passageway, to permit said large bore to continue to dump and said shuttle piston to remain driven in the direction of said large bore,

adjustable spring means bearing against said enlarged head and biased to force said enlarged head and shaft into said third position from said second position.

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Disclaimer and Dedication

3,357,676.—*Julius C. Boonshaft*, Huntingdon Valley, Pa. ACTUATING MECHANISM. Patent dated Dec. 12, 1967. Disclaimer and dedication filed Feb. 4, 1970, by the assignee, *Weston Instruments, Inc.*

Hereby enters this disclaimer to the entire remaining term of said patent and dedicates the patent to the Public.

[*Official Gazette May 26, 1970.*]