

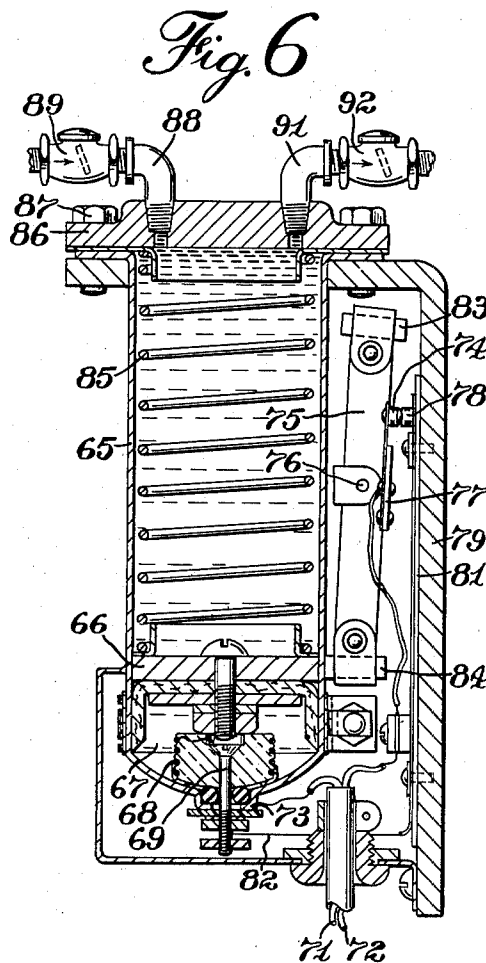
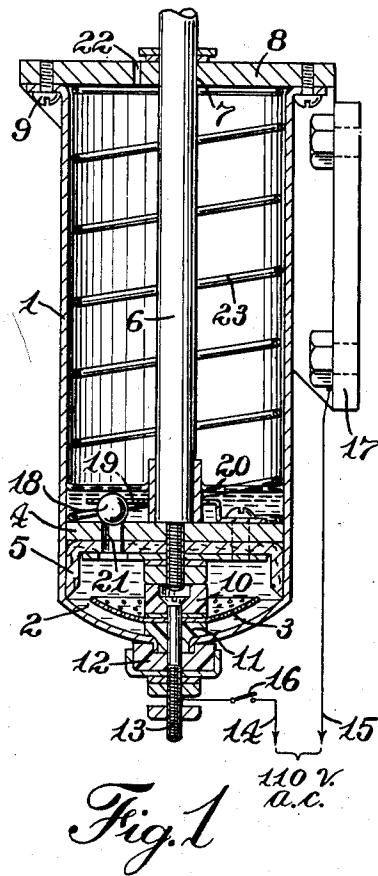
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J. W. DICKEY
ELECTROSTEAM ACTUATOR

2,578,992

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3 Sheets-Sheet 1



WITNESS:

Esther M. Stockton

INVENTOR.
John W. Dickey
BY
Clinton S. Jones
ATTORNEY

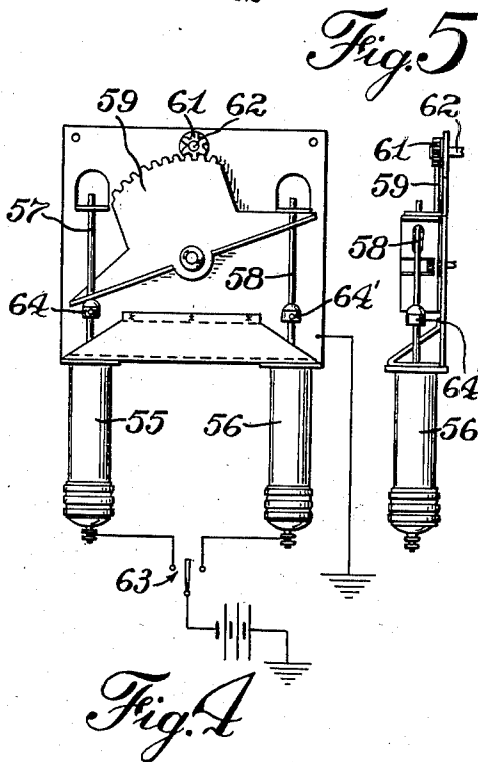
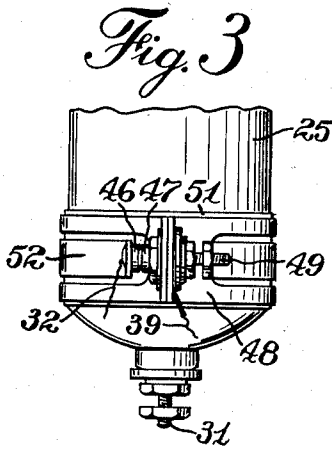
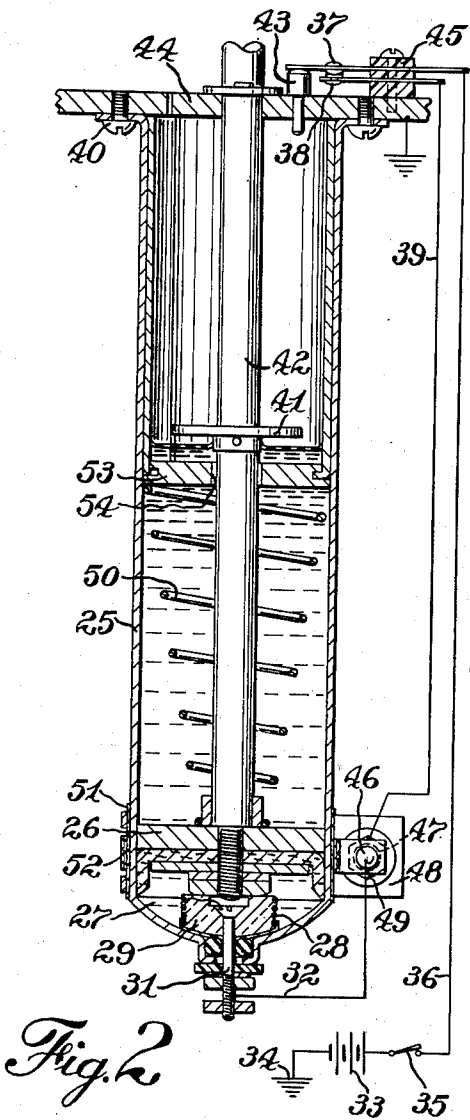
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3 Sheets-Sheet 2



WITNESS:

Esther M. Stockton

INVENTOR.
John W. Dickey
BY
Clinton S. James
ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTROSTEAM ACTUATOR

John W. Dickey, Newfield, N. Y., assignor to
Bendix Aviation Corporation, a corporation of
Delaware

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1 Claim. (Cl. 60—25)

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The present invention relates to an electro-steam actuator and more particularly to a rectilinearly actuated jack or ram energized by internally generated steam. The present disclosure is in the nature of an improvement over the structure shown in applicant's prior application, Serial No. 608,539, filed August 2, 1945, now Patent No. 2,548,708, and incorporates novel and desirable features for controlling and utilizing the steam actuator, and for preventing it from generating excessive pressures or temperatures.

It is an object of the present invention to provide a novel electro-steam actuator incorporating devices for controlling and cushioning its operation.

It is another object to provide such a device incorporating means for storing up energy in the actuator and using it as an impulse driver or impeller.

It is another object to provide such a device having pressure and temperature actuated elements for protecting the actuator from excessive stresses.

Further objects and advantages will be apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a vertical substantially mid-sectional view of one preferred embodiment of the invention, the electrical connections being shown diagrammatically;

Fig. 2 is a similar view of an embodiment of the invention incorporating means for cushioning and controlling the stroke of the actuator;

Fig. 3 is a detail in side elevation showing the thermostatic control for the electrical heating element shown in Fig. 2;

Fig. 4 is a further elevation on a reduced scale showing a pair of actuators such as illustrated in Fig. 2 used to operate a rotary shaft such as a window adjusting shaft;

Fig. 5 is a side view of the structure shown in Fig. 4;

Fig. 6 is a vertical substantially mid-sectional view of an embodiment of the invention in which the piston of the actuator is automatically caused to reciprocate continuously in order to perform the function of a pump;

Fig. 7 is a similar view of an embodiment of the invention adapted to be used as an impulse drive such as a starting device for internal combustion engines; and

Fig. 8 is a section taken substantially on the line 8—8 of Fig. 7.

In Fig. 1 of the drawing, there is illustrated a cylinder 1 having a puddle 2 of vaporizable conductive liquid at its lower end with a heating

element in the form of a perforated metallic disc 3 immersed in the liquid to supply electrical energy for vaporizing the liquid. A piston 4 having a packing member 5 is slidably mounted in the cylinder and has a rod 6 suitably fixed thereon, which passes through an opening 7 in a closure plate 8 fixed as indicated at 9 to the upper end of the cylinder 1.

The disc 3 is fixed in the lower end of the cylinder 1 by means of suitable insulating mounting members 10, 11 and 12 and a clamping bolt 13 which serves as a binding post for the attachment of an electrical conductor.

Means for supplying electrical energy to the disc 3 is provided comprising power lines 14 and 15, the line 14 being connected to the binding post 13 through a manual switch 16 while the line 15 is grounded on a mounting bracket 17 for the cylinder 1. The power lines are preferably connected to a source of alternating current as indicated in order to prevent electrolytic action in the liquid.

Means for limiting the vapor pressure beneath the piston 4 within the cylinder 1 is provided in the form of a safety valve comprising a spherical member 18 which is held seated by a spring 19 in the upper end of a passage 21 through the piston 4, whereby said passage is normally closed, but escape of steam through said passage is permitted when sufficient pressure is built up to overcome the force of the spring 19. Vent 22 in the closure plate 8 permits passage of fluid above the piston 4 into and out of the upper end of the cylinder 1.

The liquid 2 may be an aqueous solution of a suitable salt such as sodium sulphate, and the level of the liquid in the cylinder is preferably maintained above the piston 4 as shown, in order to provide a reserve to replace evaporation, and to condense any steam which escapes by the safety valve 18. A layer of oil 20 on the surface of the liquid 2 may be used to retard evaporation.

In the operation of this embodiment of the invention, closure of the manual switch 16 completes the circuit from the power line 14 through the disc 3 and the vaporizable liquid 2 to the body of the cylinder 1 and back through the lead 15. The heat generated by the resistance of the liquid to the passage of the current therethrough causes violent ebullition, and the pressure of the steam so generated raises the piston 4 in cylinder 1, whereby the piston rod 6 may be caused to actuate any load connected thereto.

If the load to be actuated by the piston rod 6 should stick or should exceed a predetermined

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value, the pressure in the lower end of the cylinder builds up until the spring 19 is overcome by the pressure on the valve member 18, whereupon said valve member rises and permits the excess pressure to be released. The steam which escapes by the safety valve 18 is condensed as it enters the cool body of liquid above the piston 4, and when the switch 16 is opened to allow the parts to return to idle position, this liquid can return to the bottom of the cylinder 1 by passing around the cup-shaped piston packing 5. The return of the piston to idle position is preferably assisted by a spring 23.

In Fig. 2 of the drawing, there is illustrated a cylinder 25 in which is slidably mounted a piston 26 similar to that shown in Fig. 1. The lower end of the cylinder contains a vaporizing liquid 27, and an electrical heating device 28 for vaporizing the liquid is mounted in the lower end of the cylinder, insulated therefrom as illustrated at 29 and held in position by a clamping bolt 31 which provides an attachment for an electrical feed wire 32.

In this embodiment of the invention, the heater 28 comprises a resistance wire of suitable material adapted to be heated by the passage of current and means for heating the wire is provided comprising a battery 33 grounded at 34 and connected through a manual switch 35 to a feed wire 36. Wire 36 is connected to a movable contact 37 which normally engages a fixed contact 38 to which a lead 39 is connected.

Means for opening contacts 37, 38 as the piston 26 approaches the end of its stroke are provided comprising a flange member 41 fixed on a rod 42 attached to the piston, and a plunger 43 slidably mounted in a closure plate 44 in position to open contacts 37, 38 when actuated by engagement of flange member 41. The closure plate 44 is fixed as indicated at 40 to the cylinder 25, and serves as mounting means for contacts 37, 38 which are supported thereon while being insulated therefrom as indicated at 45. The closure plate also serves as a guide for the piston rod 42.

Means for deenergizing the electrical heating element 28 when the temperature of the cylinder 25 rises above a predetermined value is provided in the form of thermostatically controlled contacts 46, 47 best shown in Fig. 3. These contacts are mounted on a ring 48 clamped around the lower end of the cylinder 25 by a bolt 49 and insulated from the cylinder by a sleeve 51. Contact 47, which is mounted on the clamping bolt 49, is connected to the electrical conductor 39, while contact 46 is mounted on a strip of bimetal 52, which is connected to the heater lead 32, and is so tensioned as to maintain the contacts in engagement until a predetermined temperature is exceeded, upon which event the contacts are separated and the heater is thus deenergized.

In this embodiment of the invention, means are provided for preventing sudden motion of the piston 26 such as might be caused if the load should stick and should then be suddenly released. As here shown, this is accomplished by filling the cylinder 25 with liquid, preferably of the same type as in the bottom of the cylinder, up to a partition 53 which is fixedly mounted in any suitable manner at an intermediate point in the cylinder. The partition 53 has a central opening 54 providing a restricted passage around the piston rod 42 which allows the liquid below the partition to flow into the upper part of the cylinder 25 as the piston 26 rises, but which controls the speed of the piston by dash-pot action,

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thereby effectively preventing sudden or rapid movement of the piston. A spring 50 is provided for urging the piston toward its idle position.

In the operation of this embodiment of the invention, closure of manual switch 35 energizes the heater 28 since contacts 37, 38 and contacts 46, 47 are normally closed. The consequent heating and vaporization of the liquid 27 in the bottom of the cylinder generates steam pressure which causes the piston 26 to move upward, actuating the rod 42 until the flange member 41 engages the plunger 43 whereupon the heating circuit is broken by the opening of contacts 37, 38, and the generation of steam is interrupted. If for any reason the liquid in the lower end of the cylinder should run low, or pressure therein become excessive so as to raise the temperature of the lower end of the cylinder above a predetermined value, the thermostatic contacts 46, 47 open and break the heating circuit.

In Figs. 4 and 5, there is illustrated an application of the actuator shown in Figs. 2 and 3 to operate a rotary shaft such as an adjusting shaft for automobile windows and the like. As there shown, two such units 55 and 56 operate piston rods 57, 58 having a lost-motion connection to an arcuate rack member 59 which meshes with a pinion 61 on a window adjusting shaft 62. A two-throw switch 63 is arranged to alternatively energize the units 55, 56, one such unit 55 serving to move the rack 59 in the direction to raise the window as by means of an abutment 64 mounted on the piston rod 57 while the other unit 56 serves to move the window toward closed position, as by means of an abutment 64' on the piston rod 58.

In Fig. 6 of the drawing, there is illustrated an electrosteam actuator having means to cause continuous reciprocation of the piston so that the device may be used as a pump. As there shown, a cylinder 65 has a piston 66 slidably mounted therein and arranged to be actuated by steam generated by an electrical heater 68 from a vaporizable fluid 67 in the lower end of the cylinder. Heater 68 is clamped in the lower end of the cylinder 65 by a binding post bolt 69 connected to one end of the heater coil, the opposite end of which is grounded to the cylinder. Means for energizing the heater are provided comprising power leads 71, 72, the lead 71 being grounded on the cylinder as indicated at 73 while the lead 72 is connected to a contact 74 mounted on a lever 75 which is pivoted at 76 so as to rock about a horizontal axis. Contact 74 is insulated from the lever as shown at 77 and is arranged to engage a contact 78 mounted on a bracket 79 but insulated therefrom as indicated at 81, and connected by a lead 82 to the binding post 69.

A pair of permanent magnets 83 and 84 are mounted at the ends of lever 75 so that the rocking movement of the lever conveys them alternately into and out of engagement with the exterior of cylinder 65. Cylinder 65 is formed of non-magnetic material while the piston 66 is composed of magnetic material, such as soft iron. Consequently, as the piston approaches the ends of its stroke, the mutual attraction of the magnets and piston actuates the lever 75 to open the contacts at the upper end of the piston stroke, and close them at the lower end of the stroke.

A spring 85 is provided for urging the piston toward its lower or idle position, the spring being confined in the cylinder by a closure plate 86 fixed as indicated at 87 to the upper end of

the cylinder. An inlet fitting 88 having an intake check valve 89 and an outlet fitting 91 having an outlet check valve 92 are mounted on the closure plate 86 and connected to the pipe system through which liquid is to be circulated by the pump.

In the operation of this structure, upon the application of the electrical energy to the leads 71, 72 by and suitable manual control, since the contacts 74, 78 are closed when the piston is in its idle position, the heater 68 will be energized so as to vaporize the liquid 67 beneath the piston 66 and cause the piston to move upward and eject the liquid above the piston through the outlet fitting 91.

When the piston reaches the upper end of its stroke, it comes into proximity to the fixed magnet 83 which is accordingly attracted thereby so as to open contacts 74, 78. The heater 68 is thus deenergized and the piston is permitted to return to its lower position under the action of spring 85, drawing after it a new charge of liquid through the inlet fitting 88. As soon as the piston 66 comes opposite the permanent magnet 84, the latter is attracted by the piston so as to rock the lever 75 in a clockwise direction and close contacts 74, 78 whereupon the operation is repeated.

In Figs. 7 and 8 of the drawing, there is illustrated an embodiment of the invention which is arranged as an impulse actuator for purposes such as the starting of internal combustion engines. As there shown, a cylinder 93 has a piston 94 slidably mounted therein for actuation by steam generated from a liquid 95 in the bottom of the cylinder under the action of a heater 96 fixed therein by means of a binding post 97. Means for energizing the heater are provided comprising battery 98 grounded at 99 and connected by a manual switch 101 and lead 102 to a movable contact 103 on an elastic blade 100 mounted on a closure plate 104 on the cylinder but insulated therefrom as indicated at 105. A cooperating fixed contact 106 is also mounted on the closure plate 104 and connected by a lead 107 to the binding post 97 which latter is connected to one end of the heater 96. The opposite end of the heater is grounded on the cylinder as indicated at 108, and the frame of the device is grounded as indicated at 109 to complete the heater circuit.

A piston rod 111 in the form of a rack bar is fixed to the piston 94 and is guided for reciprocating movement in an opening 112 in the closure plate 104 which conforms closely to said rack. The rack 111 is formed with teeth 113 arranged to engage and rotate a pinion 114 journaled in a plate 115 (Fig. 8) mounted on the closure plate 104. The spaces between the teeth 113 of the rack bar 111 permit the escape of air from the upper end of the cylinder through the opening 112 without substantial obstruction. The teeth 113, however, terminate a substantial distance above the piston 94, leaving a solid portion of the rack bar 111 as indicated at 110. This portion of the rack bar substantially fits the opening 112 whereby the escape of air from the cylinder is restricted as the piston 94 approaches the upper end of its stroke, thereby forming an elastic cushion for the reciprocating parts. A driving clutch member 116 is splined within the pinion 114 and provided with inclined teeth 117 arranged to cooperate with similar teeth 118 formed in a driven clutch member 119 which may be formed on or attached to the ex-

tended crank shaft of the engine to be started. The clutch teeth 117, 118 are yieldably held in engagement by a compression spring 120 mounted within the pinion 114 acting on clutch member 116.

Means are provided for yieldably obstructing the movement of the piston 94 and rack 111 away from its idle position in order to build up considerable pressure in the lower end of the cylinder prior to the engagement of the rack with the pinion 114 so as to cause said pinion to be actuated energetically as an impulse starter. For this purpose, the upper end of the rack bar 111 is beveled as shown at 121, and a roller detent member 122 which is slidably mounted in brackets 123 and 124 is yieldably maintained in the path of the rack bar and in engagement with the beveled surface 121 by springs 125, 126. The brackets 123, 124 are arranged to permit the roller 122 to move out of the path of the rack bar 111 after the rack bar has exerted sufficient force thereon to cam the roller backward against the action of the springs 125, 126, after which the roller presents substantially no resistance to the further movement of the rack.

The contact-carrying blade 100 is positioned in the path of movement of the detent member 122 whereby contacts 103, 106 are opened when the detent roller is cammed out of the path of the rack bar 111, and are held open until the rack bar and detent return to their idle positions.

In operation, starting with the parts in the positions illustrated, closure of the manual switch 101 causes energization of the heater 96 whereupon the liquid 95 is vaporized and steam pressure built up beneath the piston 94. When this pressure becomes sufficient to cause the inclined surface 121 of the rack bar to cam the detent roller 122 out of the path of the rack bar, the rack is projected forcibly into engagement with the pinion 114, and the latter caused to transmit its rotation through the clutch 117, 118 to the engine shaft 119. When the piston approaches the end of its upward stroke, the solid portion 110 of the rack bar enters the opening 112, thus nearly closing said opening. The air trapped in the upper end of the cylinder consequently forms a cushion which yieldingly retards the movement of the piston rod and piston.

When the rack bar 111 cams the detent 122 out of its path, the contacts 103, 106 are opened, thus deenergizing the heater 96 and permitting the piston 94 to return to idle position under the influence of the spring 130. If the engine has not started, and the operator keeps the starting switch 101 closed, the heater 96 is immediately reenergized and the actuation of the starter repeated.

When the engine starts, the engine shaft 119 overruns the clutch member 116 until such time as the rack member 111 is returned to idle position, whereupon the pinion 114 is permitted to rotate freely with the engine crank shaft.

Although certain embodiments of the invention have been shown and described in detail, it will be understood that other embodiments are possible and various changes may be made in the construction and arrangement of the parts without departing from the spirit of the invention.

I claim:

In an electro-steam actuator, a cylinder and a piston slidably mounted therein, a puddle of vaporizable liquid in one end of the cylinder, yielding means urging the piston toward said end of the cylinder, an electrical heater adapted when

energized to form a flash boiler for said puddle of liquid and thereby generate steam pressure between the piston and said end of the cylinder, and means actuated by the consequent movement of the piston for deenergizing the electrical heater, including further means for arresting the movement of the piston by said steam pressure comprising a fluid trapped in the cylinder back of the piston, and a vent for said fluid; in which said trapped fluid is a liquid, and including further a storage chamber for the liquid ejected by the piston through said vent.

JOHN W. DICKEY.

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