May 9, 1933. W. H. STANNARD 1,908,193

AUTOMATIC CONTROL MECHANISM

Filed Feb. 27, 1931 2 Sheets-Sheet 1

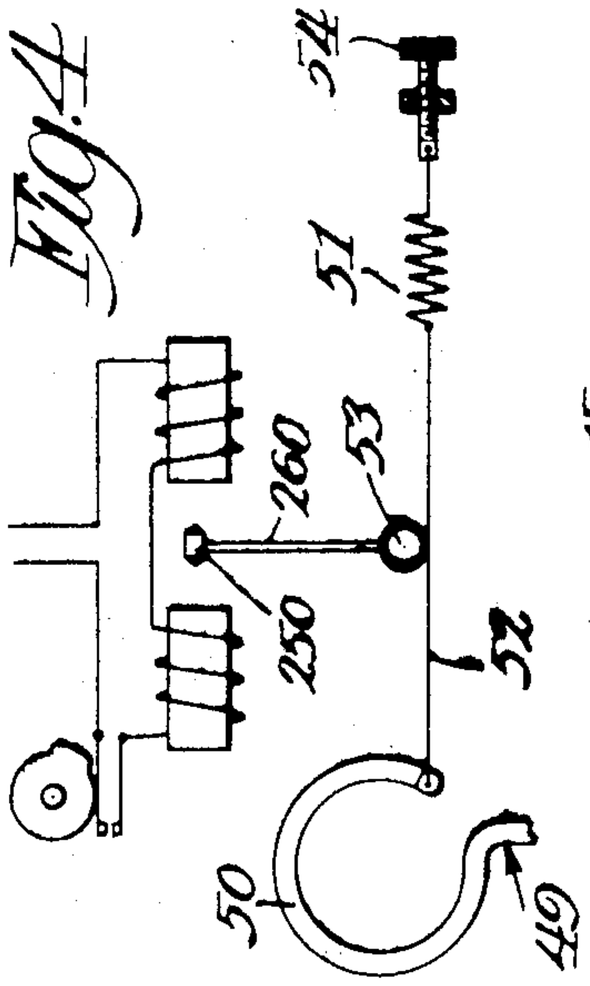

Fig. 4

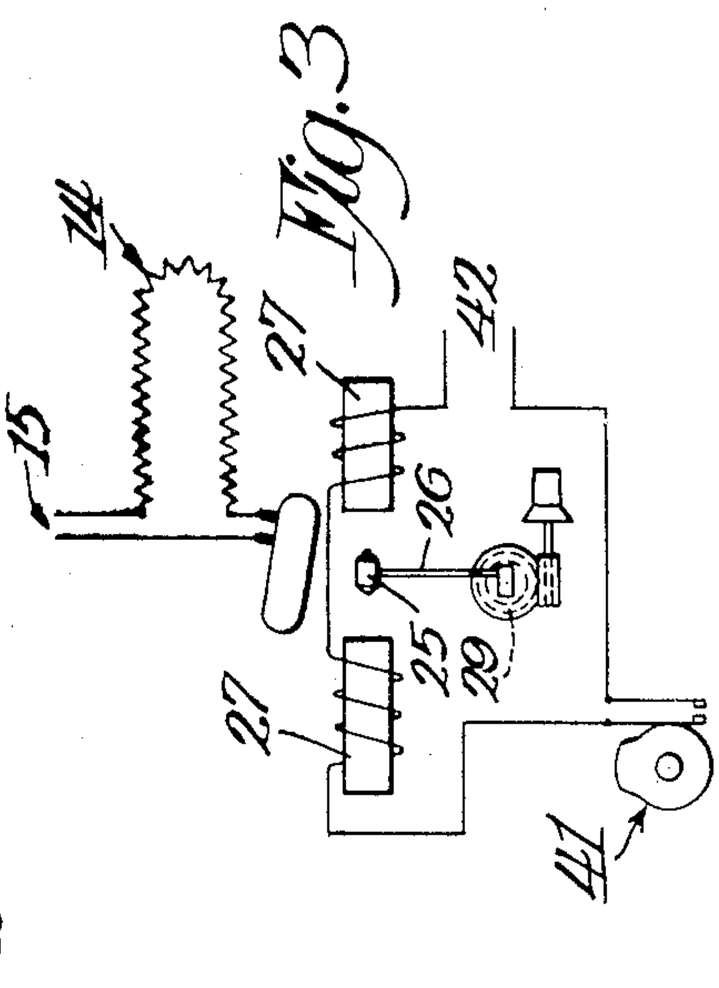

Fig. 3

Fig. 2

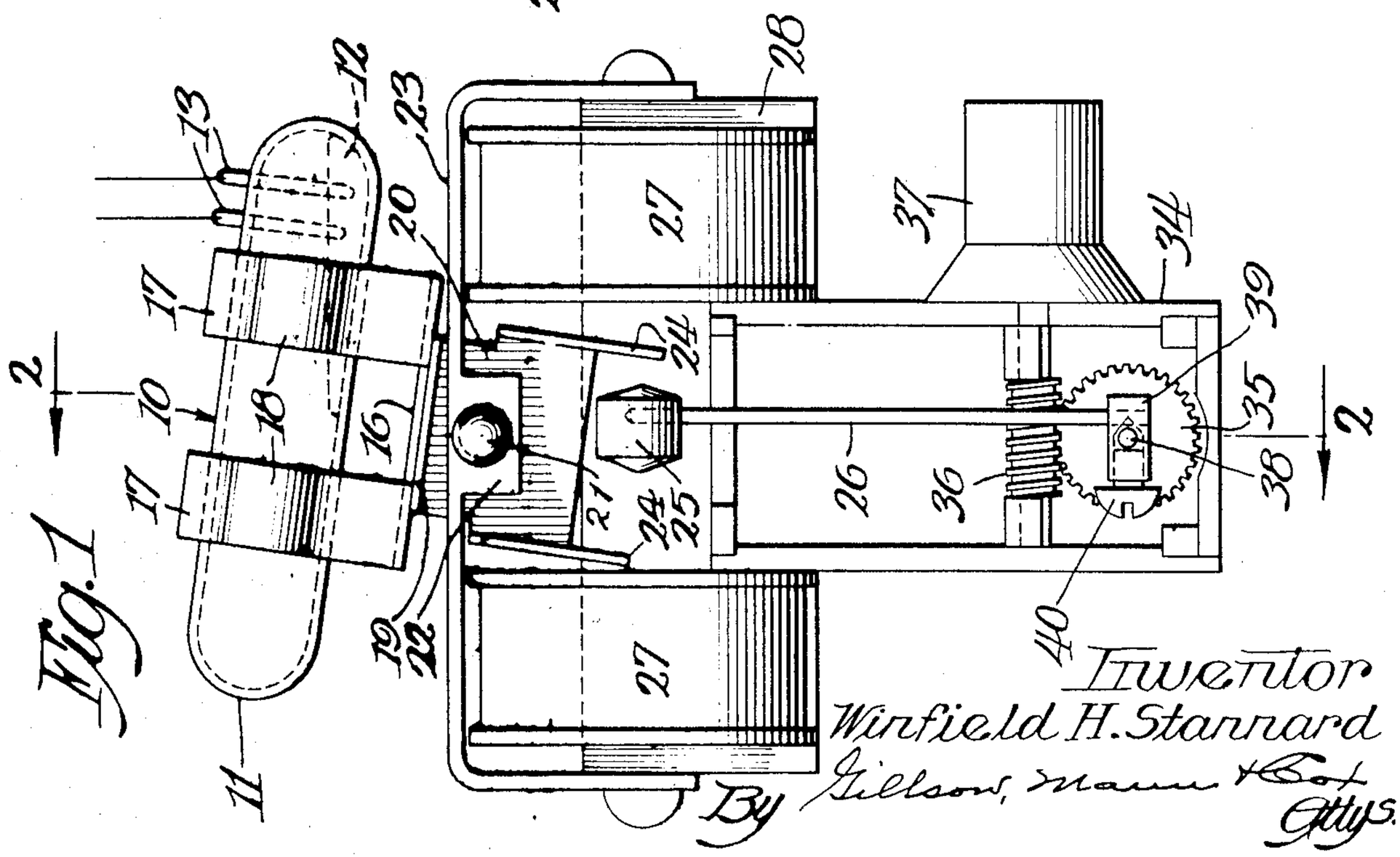

Fig. 1

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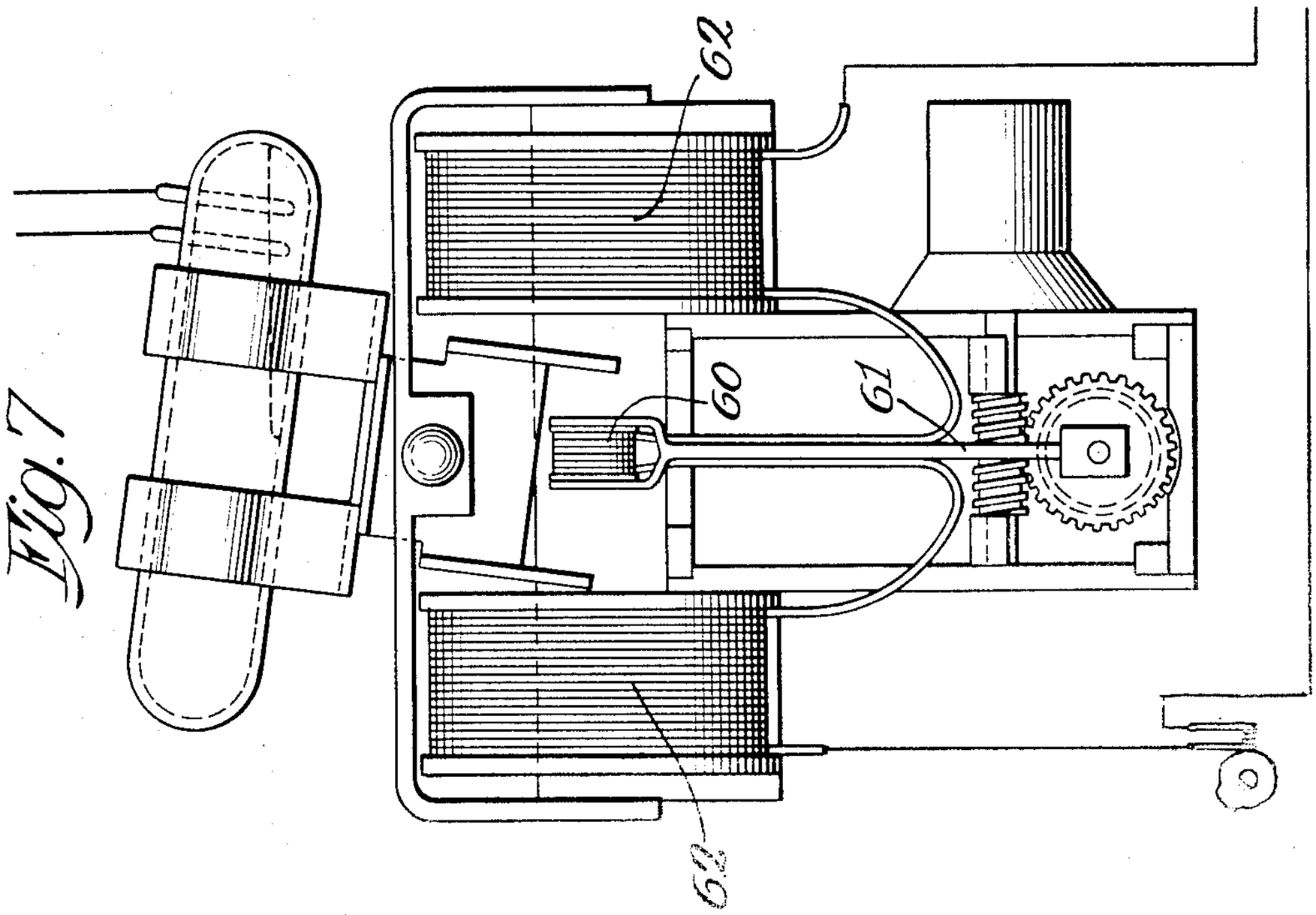

Fig. 7

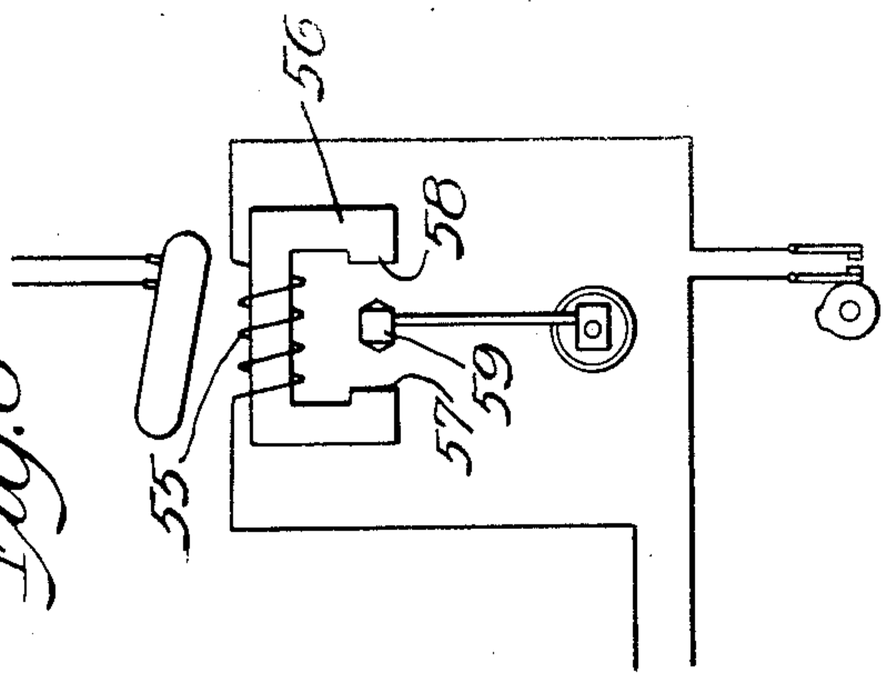

Fig. 6

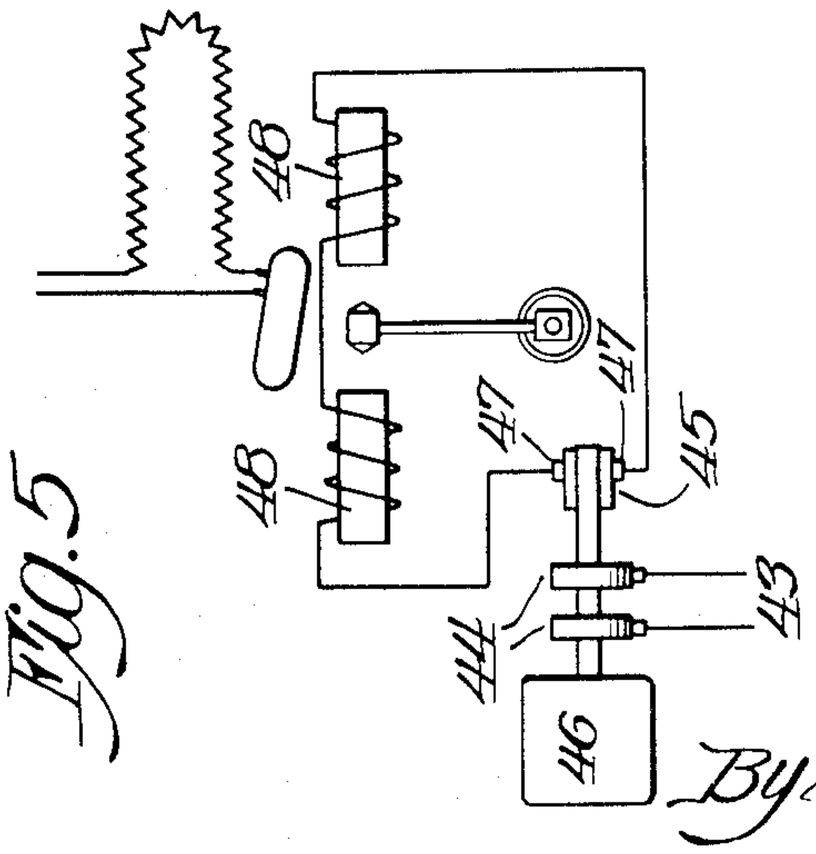

Fig. 5

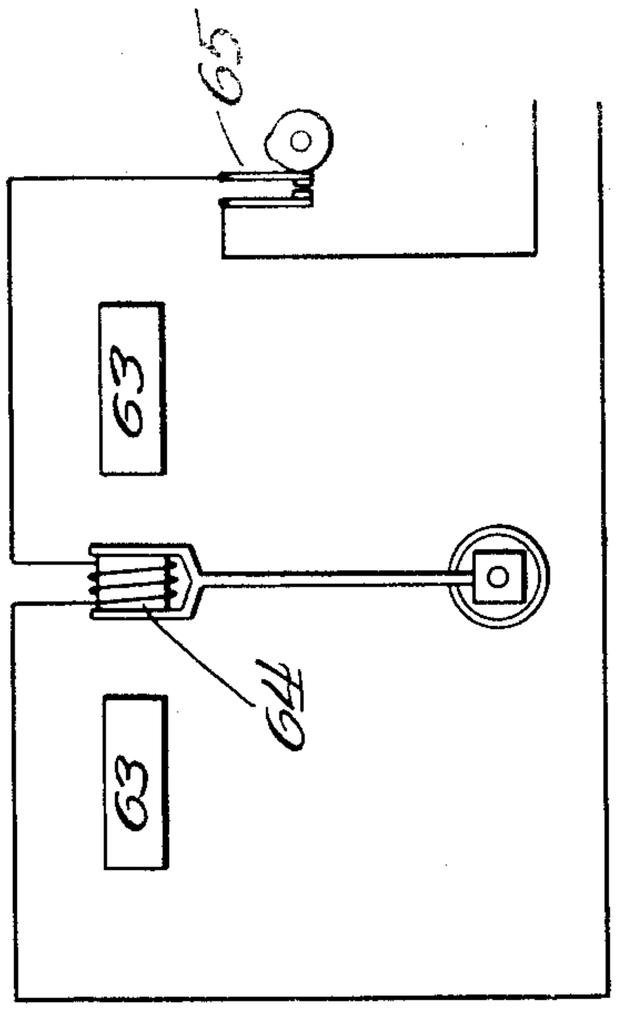

Fig. 8

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Patented May 9, 1933 1,908,193

UNITED STATES PATENT OFFICE

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AUTOMATIC CONTROL MECHANISM

Application filed February 27, 1931. Serial No. 518,715.

This invention relates to automatic control mechanism for operating switches, valves and the like power controls in response to changes in temperature, pressure and other energy conditions. Reference is made to applicant's copending application, Serial No. 303,093 of which the present application is a continuation in part.

Further objects and advantages of the invention will be revealed as the disclosure proceeds and the description is read in connection with the accompanying drawings, in which—

Fig. 1 is a side elevation of the mechanism for operating an electric switch in response to changes in temperature;

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a diagram showing the thermo-sensitive unit exposed to the action of a heating coil which is controlled by an electric switch;

Fig. 4 is a similar diagram showing a like mechanism operated by pressure responsive means;

Fig. 5 is a diagrammatic indication of means to prevent residual magnetism from existing in the armature;

Fig. 6 diagrammatically indicates a modified form of the device in which the armature moves between the opposed pole pieces of a single electromagnet.

Fig. 7 is a side elevation of the mechanism analogous to that shown in Fig. 1, but in which an energized solenoid replaces the armature shown in Fig. 1; and

Fig. 8 is a diagrammatic indication of a further modification of the device showing an energized solenoid between two opposed permanent magnets.

These specific illustrations and the correspondingly specific descriptions are used solely for the purpose of disclosure, and are not intended to indicate limitations on the use of the device or the scope of the claims.

The power controller depends for its operation upon the fact that when two magnetic poles are geometrically opposed, there is some point between them at which the attraction or pull toward one pole will just balance the pull of the opposite pole. Consequently, a magnetic body at such a position in such a field will not be drawn toward either pole, but whenever the body is displaced from this neutral position, it will be drawn rapidly toward the pole toward which it was originally displaced.

In accordance with this invention, the energy-sensitive device is called upon only to position an armature, or an effective substitute therefor, in some intermediate position in a magnetic field.

The operativeness of the instrument is unaffected whether the opposed magnets present like or unlike poles to each other, but the preferable arrangement is to cause like poles to be presented. In this case the armature is much less likely to remain permanently magnetized in a given direction.

The power controller is illustrated in the drawings by a mercury switch, generally indicated by 10. Its specific arrangement is not a part of the invention and it is obvious that it may be replaced by any suitable electric switching device. As shown, the switch includes a sealed tube 11 containing a quantity of mercury 12, and fitted with contacts 13 adapted to be connected with a circuit to be controlled, as for example, between one side of a heating coil 14 (Fig. 3) and one side of the line 15.

The tube is carried by a clip comprising a base 16 and two pairs of arms 17, bent at 18 to receive and clasp the tube. As is usual, the tube is mounted to tilt and thereby permit the mercury to run toward or away from the contacts 13, as the case may be. For that purpose, the clip 16 is fixed to one arm 19 of a bracket, the other arm 20 of which is made fast to a pivot pin 21, mounted on a block 22, carried by a yoke 23 forming part of the frame of the device. The arm 20 is also provided with wings 24 by means of which the bracket, clip and tube are rotated about the pivot 21.

This movement is caused by a magnetic body 25, represented by a block of Norway iron, rotatably supported by a rod 26 between two magnets 27 carried by a yoke 28. The rod or arm 26 is controlled by an energy re-

sponsive device, as, for example, a thermo-sensitive unit generally indicated by 29. The base of this device is a bi-metallic helix 30, one part being of brass and the other of non-expansible alloy such as Invar. One end of the helix is fixed to a block 31 by the screw 32, and the block in turn is fixed to a hollow shaft 33, journaled in the box frame 34 and fitted at its left end (Fig. 2) with a worm gear 35 meshing with a worm 36 journaled in bearings in the frame 34, and rotatable by a knob 37 to adjust the position of the shaft 33 and consequently to determine the temperature range in which the instrument will work.

The other end of the helix 30 is fixed to the right end of the shaft 38, which extends through the tubular shaft 33 and the worm gear 35, and into a block 39 to which it is adjustably secured by a screw 40. The lower end of the arm 26 is fixed to the block 39.

The thermo-sensitive unit above described is of the type shown in the DeKhotinsky Patent No. 1,375,780 and reference is made to that patent for a more detailed description of the unit and its operation.

The magnets 27 are energized electrically and intermittently. This may be accomplished, as illustrated in Fig. 3, by inserting the interrupter 41 between the line 42 and the magnets. When the magnetic element 25 is a ferrous body, it is advantageous to reverse the current flowing through the electro-magnets at each establishment of the circuit.

This effectively kills residual magnetism in the armature. In Fig. 5 current is led from the line 43 to the slip rings 44, to the commutating switch 45 which is driven around by the motor 46. The switch brushes 47, 47 are connected to the electro magnet 48, 48. Intermittent energization of the device may be secured by making one point only on the slip ring 44 conductive. The circuit of Fig. 5 is accordingly used when the armature 25 is ferrous.

Assuming that the parts are in position shown in Figs. 1, 2 and 3, and the temperature rises, the operation is as follows: The bi-metallic helix 30 will rotate the shaft 38 clockwise in Fig. 1, moving the block 25 from a neutral position with respect to the magnets 27. When the magnets are energized, the armature now being in a position where the pull of the magnet on the right dominates, will be pulled rapidly toward the pole against the torsion of the bi-metallic helix 30.

The right wing 24 is in its path, and is pushed along ahead of the armature. This movement rotates the bracket with the clip 16 and the switch 10 in a counterclockwise direction, which causes the mercury 12 to flow away from the contacts 13, 13 and open the circuit including the heating coil 14.

The interrupter 41 (or the commutator switch) will then deenergize the magnets 27, and the helix 30 acting now purely as a restoring spring will return the block 25 to the left. Possibly because of the heating, the thermostatic distortion of the helix will not allow the block to reach the exact neutral position and when the magnets are energized again, it will be drawn to the right once more, but the switch, being already tilted to the open position, will not be changed.

As the temperature drops, the helix 30 will move the block further and further to the left in Fig. 1 until at length it will be placed in such a position that the pull of the left magnet dominates and the switch will be thrown again to the position shown in Fig. 1, closing the circuit of the heating element 14.

It is desirable to have the speed of the circuit interrupter bear some relation to the temperature cycle. When the control mechanism is used in combination with a thermo-sensitive unit for controlling the operation of a heating coil within a closed space, as indicated for example in Fig. 3, it will be found that peak temperatures will occur in the enclosure at approximately equal intervals of time. The time interval between successive temperature peaks corresponds to the temperature cycle, and experience has shown that current interruptions occurring at quarter intervals of the temperature cycle are satisfactory, although more frequent or fewer interruptions may be used as conditions warrant. The interval of time between interruptions, however, must be sufficient to permit the armature to come to rest before the magnetic field is once more set up.

By way of example, if the automatic control mechanism of the invention is used in conjunction with an electrical furnace having a temperature cycle of two minutes, it would be appropriate to interrupt the circuit through the electro-magnets at intervals of thirty seconds. On the other hand, if the control mechanism is associated with apparatus, in which the temperature cycle might run as high as twenty minutes, circuit interruptions at five minute intervals would be appropriate.

It will be obvious that the operation of the switch is quick and positive, and that there is an absence of arcing, sticking and lagging, which are characteristics of automatic control mechanism now in common use.

In Fig. 4, the thermo-sensitive unit is replaced by a pressure sensitive unit 49, consisting of a Bourdon tube 50, opposed to a spring 51, both of which are connected with a cord 52 wound about a shaft 53 which carries the arm 260 equipped with the magnetic body 250.

As the pressure rises, the tube 50 will uncoil, allowing the spring 51 to move the cord 52 to the right, rotating the shaft 53 counterclockwise and shifting the magnetic body 250 accordingly. A drop in pressure has the opposite result.

The device is adjusted by means of a screw

54 which permits the tension on the spring 51 to be increased or diminished.

It will be understood that the circuit interruptions for the pressure sensitive device will preferably occur at quarter intervals of the pressure cycle.

In the modification shown in Fig. 6, a single electromagnet only is used. The magnet may be built up from a coil 55 surrounding a core of yoke-shaped laminations 56 having opposed pole faces 57 and 58 between which the armature 59 is free to move.

Instead of using a magnetic body such as a block of iron, a small solenoid may be used as shown in Fig. 7. The apparatus and its arrangement is identical with that described in Fig. 1 with the exception that a small solenoid 60 is carried by the rod 61. The magnetizing coils 62 and the solenoid 60 may be connected in series and they are so wound that the poles of their magnetic fields are all in the same sequence. For instance, reading from left to right, the poles of the large magnet are N. S. of the solenoid N. S. and of the large magnet on the right N. S.

They should be energized by the same current (i. e. D. C. or A. C. of the same frequency). It is not necessary that the current energizing the magnet 62, 62 be interrupted if the current flowing through the solenoid 60 be intermittent.

A further modification incorporating this idea is shown in Fig. 8 where the field is developed by two strong, opposed permanent magnets 63, 63. A solenoid 64 is mounted to move freely between them. As is indicated, the current through the solenoid is intermittently established by the switch 65.

The energy used to tilt the mercury switch is derived from an external electric circuit. The energy sensitive device is called upon to perform very little work, and consequently, I am able to utilize very small pressure, heat or energy changes to control considerable currents.

I claim as my invention—

1. In a device of the class described, a pair of spaced magnets, a magnetic body movably mounted between the magnets and subject to the attraction of both, a power controlling device adapted to be operated by the magnetic body while moving under the attraction of and toward one of the magnets, and an energy sensitive device for initially positioning the magnetic body at or near a neutral magnetic position between the magnets, means for setting up a magnetic field which, if the body is at other than neutral position, will draw the body to one magnet or the other, depending upon which side of neutral position the body is initially positioned by the energy sensitive device, and means to restore the body to an intermediate position upon the collapse of the field.

2. In a device of the class described, a pair of spaced magnets, a magnetic body movably mounted between the magnets and subject to the attraction of both, a power controlling device adapted to be operated by the magnetic body while moving under the attraction of and toward one of the magnets, an energy sensitive device for initially positioning the magnetic body at or near a neutral magnetic position between the magnets, means for adjusting the magnetic body with respect to the energy sensitive device, means for setting up a magnetic field which, if the body is at other than neutral position, will draw the body to one magnet or the other, depending upon which side of neutral position the body is initially positioned by the energy sensitive device, and means to restore the body to an intermediate position upon the collapse of the field.

3. In a device of the class described, a pair of spaced magnets, a magnetic body movably mounted between the magnets and subject to the attraction of both, a power-controlling device adapted to be operated by the magnetic body while moving under the attraction of and toward one of the magnets, and a thermo-sensitive device for initially positioning the magnetic body at or near a neutral magnetic position between the magnets, means for setting up a magnetic field which, if the body is at other than neutral position, will draw the body to one magnet or the other, depending upon which side of neutral position the body is initially positioned by the thermo-sensitive device, and means to restore the body to an intermediate position upon the collapse of the field.

4. In a device of the class described, a pair of spaced electromagnets, means for intermittently energizing both magnets simultaneously, a magnetic body movably mounted between the magnets and subject to the attraction of both, a power-controlling device adapted to be operated by the magnetic body while moving under the attraction of and toward one of the magnets, and a bi-metallic thermo-sensitive unit for giving the magnetic body an initial movement toward one magnet.

5. In a device of the class described, a movably mounted solenoid, means intermittently establishing a magnetic field adapted to react upon the field of the solenoid and to move it therein, a power control device adapted to be operated by the solenoid when moving in the magnetic field, energy sensitive means for giving the solenoid an initial movement, and means to restore the solenoid to the position determined by the energy sensitive device upon collapse of the intermittently produced magnetic field.

6. In a device of the class described, a movably mounted solenoid, means establishing a magnetic field adapted to react upon the field of the solenoid and to move it, a

power control device adapted to be operated by the solenoid when moving in the magnetic field, means to open intermittently the circuit through the solenoid, energy sensitive means for giving the solenoid an initial movement and means to restore the solenoid to the position determined by the energy sensitive means upon the cessation of current flow without operating the power control device.

7. In a circuit control device, a freely movable element having a magnetic field, means for establishing a preponderating magnetic field to react upon the field of the element, energy sensitive means initially positioning the element at or near a neutral magnetic position in the strong magnetic field, means to cause the collapse of either or both magnetic fields and means to restore the element to the position determined by the energy sensitive device upon the collapse of the field.

8. In a circuit control device, a magnetic element, means for establishing a magnetic field to react upon and to displace the element, means to cause the intermittent collapse of the magnetic field, energy sensitive means initially positioning the element in the magnetic field and means to restore the element to the position determined by the energy sensitive device upon the collapse of the field.

9. In a device of the class described, a pair of spaced electro-magnets, means for intermittently energizing both magnets simultaneously, a magnetic body operating between the magnets, a power control device adapted to be operated by movement of the magnetic body toward one magnet, and an energy sensitive device for giving the magnetic body an initial movement toward that magnet.

10. In a device of the class described, a movably mounted magnetic body, means for subjecting the magnetic body to intermittent, but simultaneously acting, opposed magnetic attraction, a power control device adapted to be operated by said magnetic body when moved in one direction by the magnetic attraction, energy sensitive means for giving the magnetic member an initial movement, and means to restore the body to an intermediate position.

11. In an electric circuit control device, means intermittently establishing two magnetic fields, a magnetic body adapted to move in both magnetic fields, energy sensitive means determining which of the two fields shall be traversed by the magnetic body, circuit control means operated by said body, and restoring means for positioning said body at an intermediate position upon the collapse of said magnetic fields.

12. In an electric circuit control device in combination, intermittent electric circuit closing means, two electromagnets energized by said electric circuit, producing thereby two magnetic fields, a magnetic body adapted to move in both magnetic fields, energy sensitive means determining which of the two fields shall be traversed by the magnetic body, circuit control means operated by said body when traversing either of said magnetic fields, and flexible restoring means for positioning said body at an intermediate position upon the collapse of said magnetic fields.

13. In an electric circuit control device, two electromagnets having opposed poles, a ferrous body freely movable in the space between the poles, energy sensitive means for initially positioning the ferrous body in the space, circuit control means operated by the ferrous body while moving under the attraction of an electromagnet, an electric circuit including a polarized source of energy, commutating means, interrupting means and the said electromagnets, and means to restore the ferrous body to an intermediate position between the poles upon the interruption of the circuit, whereby residual magnetism is minimized in the ferrous body.

14. In a device of the class described, a pair of intermittently energized spaced electromagnets, a magnetic body movably mounted between the magnets and subject to the attraction of both, a power controlling device adapted to be operated by the magnetic body while moving under the attraction of and toward one of the magnets, an energy sensitive device for giving the magnetic body an initial movement from a neutral position between the magnets, and means to restore the magnetic body to an intermediate position when the magnets are de-energized.

15. In a device of the class described, a pair of intermittently energized spaced electromagnets, means for intermittently energizing both magnets simultaneously, a magnetic body movably mounted between the magnets and subject to the attraction of both, a power-controlling device adapted to be operated by the magnetic body while moving under the attraction of and toward one of the magnets, an energy sensitive device for giving the magnetic body an initial movement from a neutral position between the magnets, and means for adjusting the magnetic body with respect to the energy sensitive device.

16. In a device of the class described, a pair of intermittently energized spaced electromagnets, a magnetic body movably mounted between the magnets and subject to the attraction of both, a power-controlling device adapted to be operated by the magnetic body while moving under the attraction of and toward one of the magnets, a thermo-sensitive device for giving the magnetic body an initial movement toward one magnet, and means to restore the magnetic body to an intermediate position when the magnets are de-energized.

17. In a device of the class described, a movably mounted magnetic body, means intermittently subjecting the magnetic body to opposed magnetic attraction, a power control device adapted to be operated by said magnetic body when moved by the magnetic attraction, energy sensitive means for giving the magnetic member an initial movement, and restoring means operative upon the collapse of a magnetic field to place the magnetic body in an intermediate position.

18. In a device of the class described, a movable magnetic member, a fixed magnetic member, means for intermittently subjecting the movable member to a magnetic field, and means associated with said members for causing the movable member to be magnetically moved toward or away from the fixed member depending upon the initial position of the movable member with respect to the fixed member upon establishment of the magnetic field, and energy sensitive means determining said initial position.

19. In a device of the class described, a pair of spaced electromagnets, a source of current for energizing the magnets, an interrupter interposed between the source and the magnets for intermittently breaking the circuit through the magnets, a magnetic body movably mounted between the magnets, a power control device adapted to be operated by movement of the magnetic body, and energy sensitive means for shifting the body.

20. In an electric circuit control device, a magnet, an armature movable toward the magnet by the attraction of the latter, circuit controlling means adapted to be operated by the armature as it approaches the pole of said magnet, and means for restoring the armature to a position away from the magnet when the magnet is deenergized.

21. In an electric circuit control device, a pair of magnets, means for intermittently but simultaneously energizing the magnets, an element acted upon by the fields of the magnets and adapted to move in said fields, circuit controlling means actuated by the element as it approaches one or the other of the magnets, and means to restore the element to some intermediate position upon the collapse of the magnetic fields, the restoration of the element to said position having no effect upon the circuit controlling means.

22. In an electric circuit control device, a pair of spaced magnets, a solenoid acted upon by the field of both magnets and adapted to move in said fields, circuit controlling means adapted to be operated by the solenoid as it approaches either of the magnets, and means to restore the solenoid to some intermediate position upon the collapse of the magnetic fields, the restoration of the solenoid to said position having no effect upon the circuit controlling means.

23. In an electric circuit control device, a pair of spaced magnets, a solenoid acted upon by the fields of both magnets and adapted to move in said fields, circuit controlling means adapted to be operated by the solenoid as it approaches the pole of either of the magnets, and means operative upon the cessation of current flow through the solenoid to restore it to some intermediate position, the restoration of the solenoid to said position having no effect upon the circuit controlling means.

In testimony whereof I affix my signature.

WINFIELD H. STANNARD.