June 10, 1941. W. A. CHAMBERS 2,245,125

MAGNETIC SWITCH

Filed Nov. 29, 1939

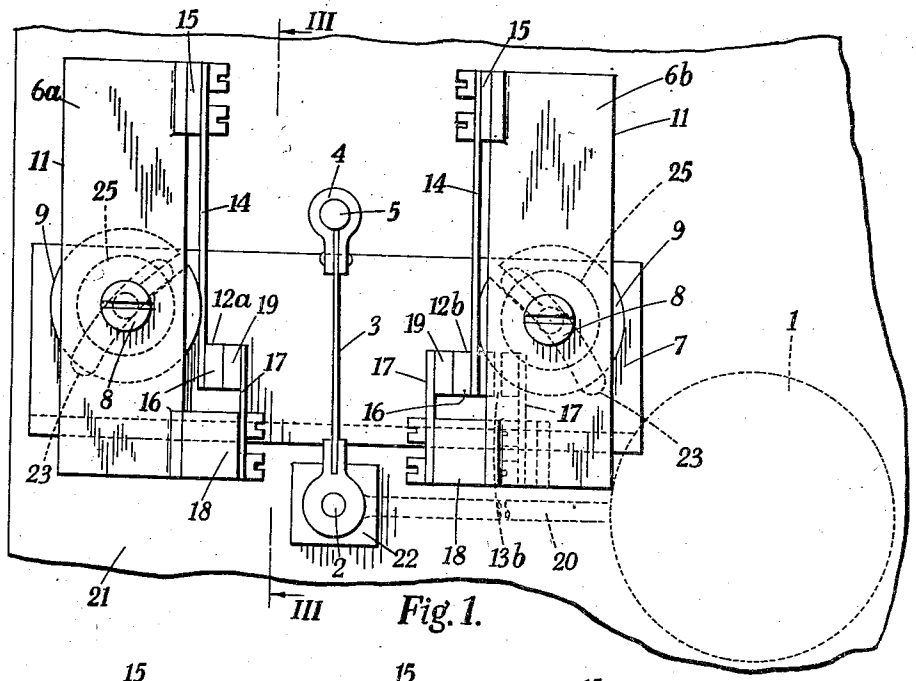


Fig. 1.

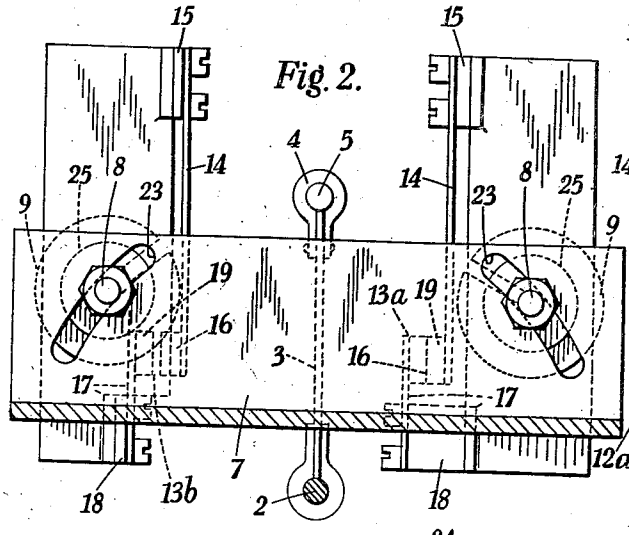


Fig. 2.

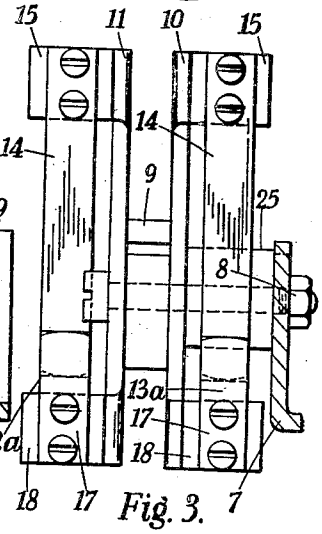


Fig. 3.

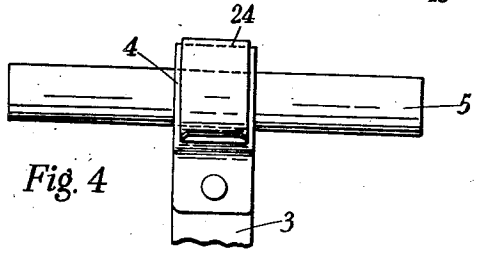


Fig. 4

Inventor
W. A. CHAMBERS
by
Blain & Kilcoyne
Attorney

Patented June 10, 1941

2,245,125

UNITED STATES PATENT OFFICE

2,245,125

MAGNETIC SWITCH

William Arnold Chambers, Ewell, England, assignor to Ronald Trist & Co. Limited, Slough, England, a British company

Application November 29, 1939, Serial No. 306,749
In Great Britain December 7, 1938

8 Claims. (Cl. 200—84)

This invention relates to magnetic snap-action switches of the kind in which contacts are opened or closed with a sudden rapid movement as a result of the action of a fixed magnet on an armature which moves in its field. When the armature reaches a critical point the force exerted on it by the magnet becomes sufficient to take charge and move it with a snap action.

An important object of the invention is to provide an improved switch for operation by a member moving in response to a variable condition of large amplitude.

Another object is to provide a construction in which there is a minimum of constraint on the actuating member of the switch.

Yet another object is to provide a construction of switch in which no electrical connections need be made to parts which move with the actuating member.

A further object of the invention is to provide a switch by which a plurality of sets of contacts may be operated to control different electrical circuits.

A still further object is to provide a switch having an actuating member which moves between two critical positions, the switch being actuated at each critical position.

The invention is particularly useful in connection with a float-operated liquid level indicator or alarm, for use, for example, in steam boilers. In this case the actuating member is moved in response to the height of the float and contacts may be arranged at positions corresponding to high and low water-levels. The erratic movement of the float makes it quite unsuitable for the operation of the electrical contacts without the aid of the magnet to give a positive and definite movement when the float reaches a critical position. It is also important that the magnet should not exert an appreciable force on the float before the critical positions are reached, as this would prejudice the correct operation of the float. Moreover, not only has the float a movement of large amplitude, but also it may be desirable from time to time to adjust the switch so that it is operated at different levels from those originally fixed. The invention provides a switch which satisfies all the requirements.

The preferred form of switch according to the invention will now be described with reference to the accompanying drawing, in which—

Figure 1 is a front elevation of the switch;

Figure 2 is a rear elevation of the switch;

Figure 3 is a section on the line III—III in Figure 1; and

Figure 4 is a fragmentary side view of the actuating member.

The switch is operated in accordance with the movement of a float 1 which is mounted in a boiler 21 on an arm 20 and fixed to a shaft 2, which thus rocks with the float. This shaft passes out of the boiler through a stuffing-box diagrammatically indicated at 22 and is secured at its outer end to a blade spring 3. This spring constitutes a driving member and carries at its upper end an armature 4 through which extends an insulated rod or peg 5 which forms an actuating member.

The actuating member moves between contacts mounted in two units 6*a* and 6*b*. Each unit includes a permanent close-gapped magnet 9, in the form of an interrupted annulus, which is held between two metal plates 10 and 11 by a screw 8. This screw also serves to secure the unit to a common supporting plate 7, a spacing block 25 being provided between the supporting plate 7 and the plate 10. The screws 8 pass through arcuate slots 23 which are cut in the plate and are bounded by arcs struck about the centre of the shaft 2, so that the units always remain at the same distance from the shaft 2. In consequence, whatever the position of a unit on the plate, the armature 4 will come into contact with the gap of the magnet when it rocks far enough over towards that unit.

Each unit also includes two sets of spring contacts arranged one on each side of the magnet. The sets in the unit 6*a* are marked 12*a* and 13*a*, and those in the unit 6*b* are marked 12*b* and 13*b*. Each set consists of a blade spring 14 attached to an insulating block 15 and carrying a contact member 16, and a second blade spring 17 attached to an insulating block 18 and carrying a contact member 19 that co-operates with the member 15. The two insulating blocks of the set of contacts 12*a* are secured to the plate 11, and those of the set of contacts 13*a* to the plate 10. Current to the contact members passes through the blade springs 14 and 17 and through electrical leads (not shown) connected to those springs at the insulating blocks.

Each set of contacts is biassed so that it is either normally open or normally closed. In each case, when the armature 4 comes into contact with the gap in the magnet 9, the actuating member 5 engages the blade spring 14 of each set and urges it towards the axis of the magnet. In the construction illustrated, the unit 6*a* may be termed the high-level unit, as the armature moves towards it as the float rises. The setting is such that the actuating member 5 engages the blade springs 14 when the normal water level in the boiler is reached, and thereupon opens both sets of contacts 12*a* (these sets being biassed to close). The set 12*a* forms part of the circuit to the motor that drives the boiler feed-water, so that this pump is stopped when the contacts open. The set 13*a* forms part of a circuit that includes a lamp which, when it is alight, indicates that the pump is running, and which is thus

extinguished at the same time as the pump is stopped.

The unit 6*b* may be called the low-level unit, as it is operated when the water level falls to a dangerously low value. In it, the set of contacts 12*b* is biased to be normally closed and controls an automatic stoker for the boiler. This set is opened, so as to stop the stoker, when the armature 4 makes contact with the magnet 9 in the unit 6*b*. The set of contacts 13*b* is biased to be normally open and controls an alarm circuit that includes a bell, which rings when the circuit is closed and thus calls attention to the fall in the water level.

In operation and assuming that the water level in the boiler is low so that the feed water pump is running, the water in the boiler will gradually rise and as it rises the shaft 2 will rotate in a counterclockwise direction. The spring 3 will thus be bowed more and more until the force on the armature becomes sufficient to overcome the attraction of the magnet. At this moment the armature will be moved quickly to the left as seen in Figure 1. As the water level approaches the normal, the armature 4 will reach a critical position at which force exerted on it by the magnet 9 of the unit 6*a* becomes sufficient to take charge and move the armature quickly to the left until it abuts against and closes the gap in that magnet. During this movement the spring 3 becomes bowed again.

The water level and the angular orientation of the shaft 2 which correspond to the critical position of the armature where the magnetic force takes charge and those which correspond to the force sufficient to detach the armature from the magnet may differ by a small amount. This feature may be very useful, as it prevents the contacts from being alternately operated in opposite directions when the level of the boiler fluctuates through a very small range. For example, the feed water pump may be in operation until the level is high enough to bring the armature to the critical position in which the contacts are operated. When this occurs, the level has to sink to an appreciably lower value before the spring 3 is sufficiently bowed to detach the armature from the magnet so as to bring the pump once more into operation. This is a valuable feature, since it brings the pump into operation for a substantial period and does not allow a state to occur where the pump is made to perform one or two strokes and is then at once cut off.

The difference between the two critical levels associated with each set of contacts may be reduced by preventing the armature from coming into close contact with the magnet after operation of the contacts. This may conveniently be done by providing a sheath of non-magnetic material around the armature. Very conveniently this sheath may take the form of a spring clip of copper 24 which can be quickly applied to the armature when desired.

The arrangement of the armature and magnets described provides a very "steep" field of force in the neighbourhood of the critical position of the armature, so that the force exerted by the magnet on the armature is very small until the latter comes very close to its critical position. This is an important feature, since it enables the float to operate without appreciable mechanical restraint when moving in its normal range.

It will be seen that it is easy to make the switch control in circuits desired and to adjust each of the units independently of the other. For example, if it is decided that the automatic stoker should be stopped at a somewhat higher water level, it is only necessary to move the whole unit 6*b* slightly nearer the unit 6*a* and it is unnecessary to make any other alterations at all. It will further be seen that the armature may move with a large amplitude under a large rise and fall of the water in the boiler without the delicacy of operation of the switch being in any way impaired.

I claim:

1. An apparatus of the character described comprising means adapted to be mechanically driven in response to a variable condition, the actuating member in the form of an armature but free of electrical connections adapted to be moved by said mechanical driving means, a movable abutment in the path of travel of said actuating member and adapted to be engaged and moved by said actuating member when moving in one direction, and a magnet which by its attraction for the actuating member takes charge when the critical position is reached and causes the actuating member to move with a snap action into the position in which it engages said abutment thereby to hold said actuating member in its engaging position until said first-mentioned means by which it is driven reaches a critical return position at which it exerts sufficient force to move said actuating member against the attraction of said magnet.

2. An apparatus according to claim 1, in which two abutments are arranged near the opposite ends of the path of travel of the actuating member.

3. An apparatus of the character described comprising means adapted to be mechanically driven to one side or the other of a normal position in response to variable conditions, an actuating member connected therewith in the form of an armature but free of electrical connections adapted to be moved back and forth by said mechanically driven means, the movement of said mechanically driven means over its central range of movement being controlled solely by the means which drives it, a movable abutment at each end of the path of travel of said actuating member and adapted to be engaged and moved by said actuating member, a magnet adjacent each abutment adapted to attract and hold the armature when within the electrical field of the magnet, thereby to move the actuating member with a snap action.

4. An apparatus according to claim 3, in which each magnet and its associated abutment form a unit, and means for moving the unit to an adjusted position with respect to the movement of the actuating member.

5. In apparatus according to claim 3, in which a resilient connection is interposed between the actuating member and the driving means.

6. In apparatus according to claim 3, in which the actuating member is connected to the mechanically driven means by a radially positioned blade spring.

7. In apparatus according to claim 1, in which the magnet is of the closed gap type and an actuating member in the form of an armature moves to close the circuit of the magnet.

8. In apparatus according to claim 1, in which the means adapted to be mechanically driven is a float.

WILLIAM ARNOLD CHAMBERS.