Nov. 10, 1970 G. A. H. HEMDAL ETAL 3,539,746

RELAY SWITCH WITH DIAPHRAGM OPERATED BY EXPLOSIVE GAS MIXTURE

Filed April 17, 1968 2 Sheets-Sheet 1

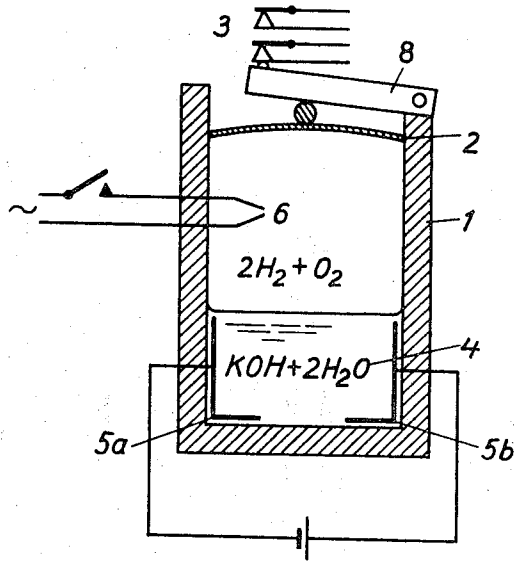

Fig. 1

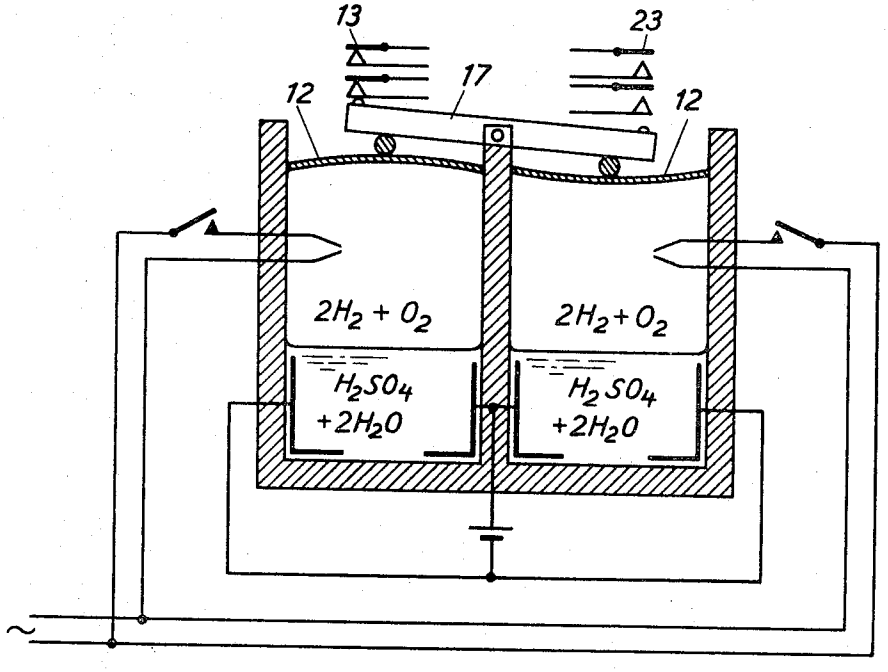

Fig. 4

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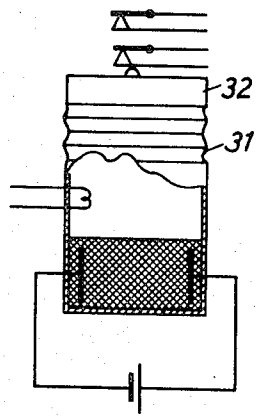

Fig. 2

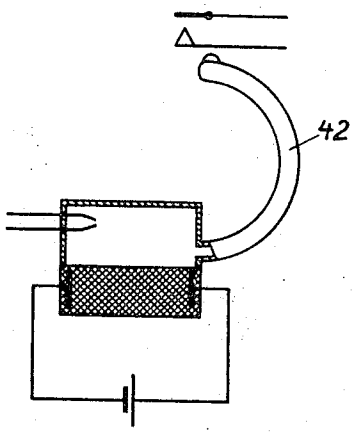

Fig. 3

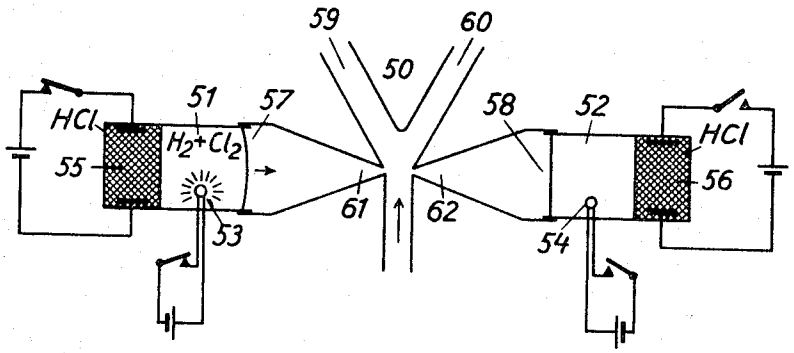

Fig. 5

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RELAY SWITCH WITH DIAPHRAGM OPERATED BY EXPLOSIVE GAS MIXTURE

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U.S. Cl. 200—83 7 Claims

ABSTRACT OF THE DISCLOSURE

A relay includes a container with at least a portion of one wall being deformably outward to actuate an electrical or mechanical device. Within the container is an electrolyte in contact with a pair of electrodes connected to a direct current source. By electrolysis an explosive gas mixture is generated. Switch-operator ignition means within the container controllably explode the gas mixture to cause the deformably portion of the wall to actuate the device.

The technical development, for example in new telecommunication plants, has led to increased demands on the speed of relays and of devices influenced by electromagnets.

By means of electromagnetic solutions it might be difficult to increase considerably the speed of the devices in an economic manner.

This invention recommends a new way to produce a rapid and simple operation of devices, in which up to now electromagnets have been used, for example a relay, by using a very rapid expansion of a gas carrying out useful work. By "relay" is here meant in general terms a device that, when operated, in its turn controls secondary functions. This is effected by means of the invention in accordance with the characterizing part of the main claim.

The invention will be further described by means of some embodiments with reference to the attached drawing on which

FIG. 1 illustrates the principle of the invention,

FIG. 2 shows one embodiment of the container,

FIG. 3 shows another embodiment of the container,

FIG. 4 shows a further embodiment of a relay according to the invention, and

FIG. 5 shows the object of the invention used for controlling a fluidistor.

FIG. 1 shows the principle of a relay according to the invention. By **1** is designated a container having rigid walls except on one side where it is closed by an elastic diaphragm **2**. Above the diaphragm, electric contacts **3** are located opposite a lever **8**. The contacts **3** are actuated in the convex state of the diaphragm whereas they are not actuated in the concave state of the diaphragm. The container is partly filled with an electrolyte **4**, for example $KOH+2H_2O$, in which electrodes **5***a* and **5***b* are immersed. By supplying an electric current to the electrolyte a mixture of hydrogen gas and oxygen gas, $2H_2+O_2$, will be generated, which compound can be ignited if an ignition voltage is supplied to a pair of electrodes **6** positioned in the space of the container above the electrolyte. By igniting the gas mixture an explosive occurs with the effect that the diaphragm bulges convexly actuates the contacts **3**. Considering that the process is reversible there is no loss of material in the container if it is completely sealed.

The current intensity of the electrolysis is controlled in such a way that, after one ignition, a sufficient quantity

of gas will be generated to allow the next ingition to take place within a short time determined by the working conditions, for example, by a counter electromotive force being generated in the container when the explosive necessary quantity of gas has been obtained.

By means of a relay of the above mentioned type an operation speed that is much greater than that of conventional relays can be achieved. The essential thing is, however, that the combustion process can be ignited by means of a very short signal. Thus the relay is suited, for example, for cooperation with a computer because the ignition can be carried out by means of the very short electrical pulses obtained from the computer.

The container may, instead of the container shown in FIG. 1, which has rigid walls and an elastic diaphragm, consist of a pair of bellows **31** containing the electrolyte and the end wall **32** of which is displaced parallelly to itself during the explosive combustion (FIG. 2). The container can also work according to the pressure gauge principle, FIG. 3, a hollow body **42** being straightened when the pressure increases and being in such a way able to actuate means, for example, electric contact means. The container can also be completely elastic in the form of a cylinder or a ball whose whole surface expands, and furthermore it can be designed as a cylinder having a movable piston.

The embodiment of the relay shown according to FIG. 1 can be used to control a contact device which, for example, is closed at one actuation and is opened at the other, of the type push-button switch. The diaphragm of said embodiment can, for example, consist of rubber which after a pressure action returns to its rest position. If holding following release of a common contact is desired, the device according to FIG. 4 may be used.

The device according to FIG. 4 is different from the device according to FIG. 1 in that the container **1** is provided with two closed chambers, each having a diphragm **12** consisting of, for example, elastic sheet-metal. The diaphragm can take up two alternative stable positions, concave or convex respectively. Half-way between the two containers, a lever **17** is arranged which dependant on which of the diaphragms is convex can take two alternative positions. If the gas mixture of the container on the left side on the figure is ignited, the contacts **13** will be brought to a working condition and are retained in that position by the elastic force of the diaphragm. If it is desired to bring the contacts **13** to a rest position, the gas mixture of the container on the right side on the figure will be ignited and the lever is swung back and actuates the diaphragm, so that it takes the opposite stable position. The device according to FIG. 4 can also be used as a bistable flip-flop if one places a further contact means **23** straight in front of the container to the right on FIG. 4. In this way the contact means **13** and **23** can be operated alternately and either contact means be held in actuated position until the other is operated.

In the above mentioned embodiments the electrolyte has been described as a fluid with a limited surface with the pairs of electrodes **5***a* and **5***b* immersed in this fluid. For practical application another form of preserving the electrolyte might be preferred, for example absorbed in a carrier in which the electrodes are inserted.

In the examples described the purpose of the electrolytes has been to provide a decomposing of water into hydrogen gas and oxygen gas in order to generate oxyhydrogen gas. If instead electrolytes consisting of a hydrogen compound of some halogen, for example HCl, are chosen, it will be possible to produce a gas mixture which, when influenced by beams of light, can be brought to explosion.

Thus, the ignition of the gas mixture can occur in different ways. The oxyhydrogen gas, for example, can be ignited by means of a spark generated between two electrodes inserted in the chamber of the container as is described in the above examples, or by allowing a sufficiently strong current to pass through a filament located in the chamber across the electrolyte. As has been mentioned the ignition can also be carried out by, for example, the light effect. Then a source of light can be arranged inside the chamber of the container or if the container is made translucent, a light source can be arranged outside the container but in its neighbourhood.

In the above mentioned examples the control means were described as contact means for activating electric circuits. The relay according to the invention is, however, as well fit for control of for example hydrodynamic or aerodynamic processes by affecting valves in tube systems or fluid- or gas flows in fluidistors. FIG. 5 shows a fluidistor **50** whose flow of which can be controlled alternatively to the left branch **59** or to the right branch **60**. The fluidistor is controlled by means of two relays **51** and **52**, according to the invention through control channels **61** and **62**. In the container of each relay is arranged a source of light **53** and **54**, respectively, with associated current circuits. The electrolyte, in the example chosen, HCl, is adsorbed in a carrier **55** or **56**. Each of the containers is provided with a diaphragm **57** and **58**, respectively, which bulges when the pressure increases. Assuming that the fluid- or gas flow of the fluidistor at a certain time flows through the left branch **59** and that the gas mixture in the container of the relay **51** be ignited, the bulging of the diaphragm **57** will cause an increase of pressure in the left control channel **61** of the fluidistor and the fluid- or gas flow will be deflected into the right branch **60**. To govern the flow back to the left branch the relay **52** must be operated.

We claim:

1. Relay for actuating electrical or mechanical devices, said relay comprising a movable control means for actuating said electric or mechanical devices, a closed container having a wall which has at least a portion that is displaceable in an outward direction to a working position for actuating said control means, said container containing a pair of electrodes, a direct current source connected to said electrodes, an electrolyte in said container and in contact with said electrodes, said electrolyte when supplied by an electric current generates a gas mixture having a pressure which is low enough to allow said movable portion to remain substantially in a rest position different from the working position, an ignition means for igniting said gas mixture to cause an explosion so as to considerably increase the pressure in said container to a value able to move the outwardly displaceable portion of said wall to said working position, and switch means for actuating said ignition means.

2. A relay according to claim **1** in which the container by means of a partition wall is divided into two separate chambers each containing an electrolyte, an ignition means and a movable wall portion, and said switch means comprises separate switches for selectively actuating the ignition means in each chamber so that by igniting alternately the gas mixture of said chambers the control means is brought to two alternative positions.

3. A relay according to claim **1**, in which the electrolyte is absorbed in a carrier.

4. A relay according to claim **1**, in which the ignition means consists of an electric sparking device.

5. A relay according to claim **1**, in which the ignition means consists of a source of light.

6. A relay according to claim **5**, in which the source of light consists of a glow discharge lamp.

7. A relay according to claim **5**, in which the source of light consists of a cathode-ray tube.

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