Sept. 25, 1962 J. RABINOW 3,056,003

FLUID OPERATED SWITCH

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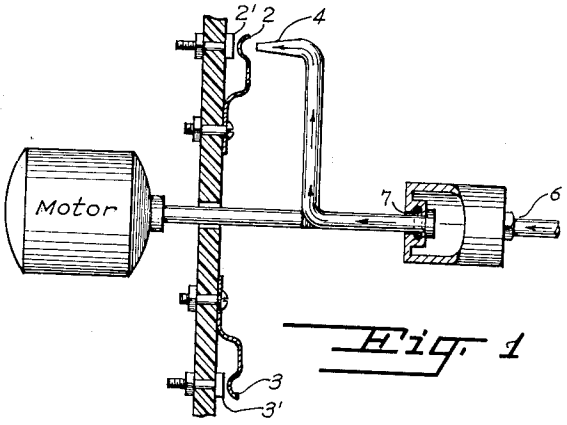


Fig. 1

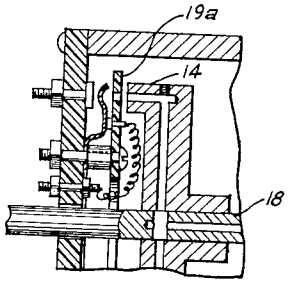


Fig. 2A

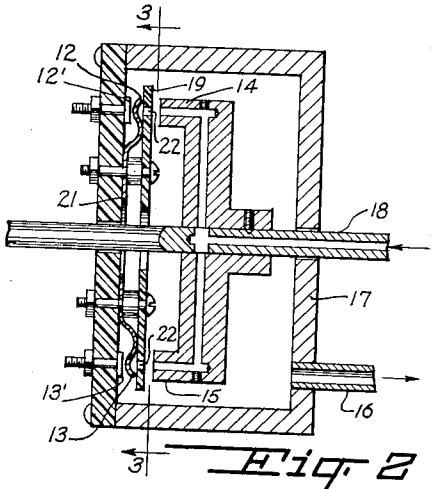


Fig. 2

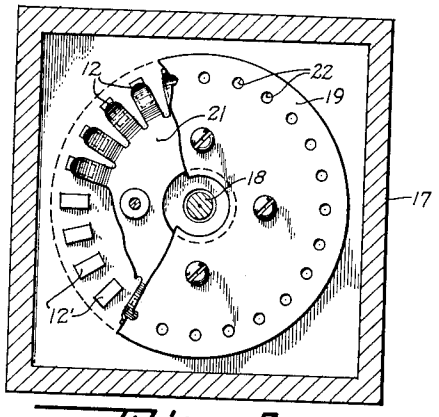


Fig. 3

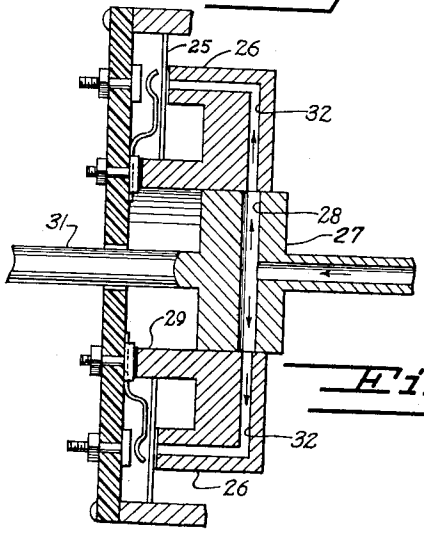


Fig. 5

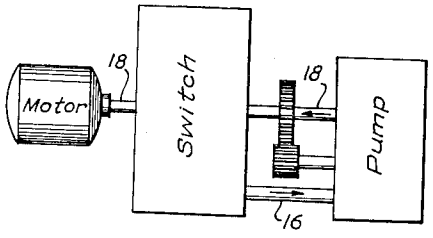


Fig. 4

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3,056,003
FLUID OPERATED SWITCH

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Original application Dec. 9, 1955, Ser. No. 552,184, now Patent No. 2,855,473, dated Oct. 7, 1958. Divided and this application Oct. 2, 1958, Ser. No. 764,790
3 Claims. (Cl. 200—81.9)

This invention relates to multi-contact electrical switches in which a moving fluid is used to operate the contacting members. The present application is a division of my co-pending application Serial No. 552,184 filed December 9, 1955, now Patent No. 2,855,473.

There are many fields in the electrical arts where high speed, multi-contact switches are of great importance. Among these are: the art of analog-to-digital converters, telemetering commutators, telephone switches, computer switches, and so on.

As is well known, most switches suitable for high speed operation have limited life and there exists a need for switches that can make-and-break a multiplicity of circuits for thousands, millions, and even billions of cycles.

In the switch described in this specification I shall describe a simple device capable of very long life and foolproof operation. The switch uses a gas or a liquid as the actuating means for the contacts, resulting in a minimum of mechanical shock and wear in the mechanism.

The main object of my invention is to produce an electrical switch capable of operating for a great number of cycles.

Another object of my invention is to produce a switch capable of operating at a very high rate of speed.

Another object of my invention is to produce a switch of relatively simple and inexpensive construction.

Still another object is the provision of high-speed switch means having a plurality of adjacent contacts operable by direct fluid pressure at very high speed and in very rapid succession. A further object is the provision of a series of adjacent switches and means for delivering a jet of high-velocity fluid in rapid succession to different ones of said switches to actuate them.

According to the invention, a series of switches is provided, each switch having at least one resilient switch blade adapted to be acted on directly by a jet of fluid, which may be gas or liquid, to move said resilient blade into contact with an opposite contact element of the switch while the jet is acting on the blade, the blade disengaging itself from said contact by its own resilience or by an oppositely-directed force on said blade as soon as the jet pressure is removed. The jet may be applied to the blades in rapid succession by a moving nozzle. If the blades are arranged in a circle or on an arc, the nozzle may be a rotating one, in which case the operation may be cyclic.

The specific nature of the invention, as well as other objects and advantages thereof, will clearly appear from a description of a preferred embodiment as shown in the accompanying drawings, in which:

FIG. 1 is a schematic diagram showing the principle of the invention;

FIG. 2 is a schematic sectional view of an improved form of the invention;

FIG. 2*a* is a detail view of the arrangement of FIG. 2 provided with back contacts;

FIG. 3 is a sectional view, partly broken away, taken on line 3—3 of FIG. 2;

FIG. 4 is a schematic diagram of a complete switch assembly including motor and pump; and

FIG. 5 is a schematic diagram of a modified form of the invention.

FIG. 1 shows a schematic view of my invention. A jet of air (or other gas) is moved across a plurality of switch contacts 2, 2', and 3, 3', etc., so that it causes the various contacts to close, one after the other. This jet may be delivered by a rotating nozzle 4, supplied with air under pressure from pipe 6 through coupling 7. Because the air can be given a very high velocity as it leaves the nozzle, the operation of the switch can be made very rapid.

It will be noted that there is relatively little motion between the mating contacts 2, 2', etc. Depending on the design of the spring contact 2, a suitable amount of "wipe" can be designed into the mating contacts, if desired.

For many types of use, very little or no wiping action is required, and an open-circuit contact separation of only a few thousands or $\frac{1}{1000}$ of an inch is required, so that very little force or pressure is required even for high speed operation. Under these conditions, by using suitable known long-wearing contact materials, the switch can be made capable of extremely long life, in the order of millions or even billions of cycles.

FIG. 2 shows a more practical design of an air operated switch. Here two contacts, 12 and 13, are operated simultaneously by the two jets 14 and 15. This is shown by way of example only, as more than two jets may be used. Very many different arrangements of contacts may be used. The air, being non-conductive, permits isolation of each switch element, if desired.

Any suitable source of compressed air can be used, except that for long-time operation the air should be suitably cleaned. Means for doing this are now well known. An inert gas can be used instead of air and, under some circumstances, leads to improved performance of the contacts and longer life. Instead of air under pressure to operate these contacts, vacuum applied to the exhaust pipe 16 of the case 17, as shown in FIG. 2, will also produce the desired result. Finally, of course, the gas can be recirculated by a suitable pump as shown in FIG. 4. The pump is shown as a separate unit driven by the same shaft 18 that operates the switch, but normally it would be made an integral part of the switch mechanism, and the whole assembly can be totally enclosed to keep out dirt, moisture, etc.

The details of the actual contacts are shown in FIG. 3. An insulating plate which may be the back of casing 17 carries a large number of the stationary contacts 12', 13' which may be of the "printed circuit" variety, if desired. A multi-fingered spring member 21 is located immediately adjacent to these contact 12', so that one finger 12 of the spring member 21 is located over each of the stationary contacts. Still further ahead of the spring is a back-stop plate 19 which can be made of any suitable material and which serves a triple purpose.

This plate 19 preloads the spring fingers, so that in the "open" position they press lightly against the face of this plate. This prevents their oscillating freely in air and prevents accidental contact closure due to resonant vibrations.

The plate also serves to accurately position the spring contacts 12 and thus control the gap spacing between the stationary and moving contacts.

And, thirdly, the plate can be provided with holes 22 so that the air jet is interrupted between contacts, making possible a definite "break before make" of the contacts, if desired, even though the contacts are very close together.

All of the switches illustrated can be operated by liquid as well as gas, but the totally enclosed switch of FIG. 2 is perhaps best suited for this purpose. If the switch is operated by a liquid, such as for instance, a light machine oil, the whole case 17 can be filled with the liquid. If desired, the case can be kept substantially empty of liquid by having the oil continuously pumped out of the case and back into the nozzles.

I found in my experiments with a switch of this type, that submerging the contacts reduced contact bounce because of the damping property of the liquid. The use of a suitable liquid will enable the switch to handle higher voltages without breakdown and will require a smaller pump to achieve satisfactory operation.

FIG. 5 shows a slightly different arrangement of my switch wherein the nozzles **26** are stationary, but an "air-commutator" is used to feed the air (or other fluid) to the nozzles in succession. The revolving cylinder **27** is provided with at least one hole **28**. The cylinder is closely fitted into the bored hole in the nozzle casing **29**. As the shaft **31** revolves, the cylinder revolves with it. Thus the hole **28** lines up successively with passages **32** connecting the air to the nozzles in sequence.

While I show the contacts arrayed radially and the jets acting along a line parallel to the axis of rotation of the central shaft, it should be understood that radial jets can be employed with the contacts arranged at right angle to the jet axis.

In the figures of this specification, I show simple single pole-single throw switch elements for the sake of clarity. It should be obvious to the users of such switches that other contact combinations are possible as well. By using an insulating plate **19***a* as shown in FIG. 2*a* and mounting an additional set of stationary contacts **20** on this plate, single pole-double throw action can be achieved. In general, the contact arrangements so well known in the relay art can be used in the switches of this invention. As in the case of the relays, the "stationary" contacts need not be truly rigidly mounted. They can be mounted on relatively springy supports so as to provide more "wipe" as the contacts close and to enable the switch design to use stacks of contacts behind each other.

In FIGS. 1 and 2, the fluid is shown as acting directly against the movable contacts. If desired, a flexible diaphragm **25** can be introduced between the movable contacts and the nozzles **26**, as shown in FIG. 5. The fluid would then impinge on this diaphragm, and through it operate the contacts, without coming into contact with the switch elements.

In FIG. 3 the spring contact members **12** are all shown conductively connected to plate **21**; however, it will be understood that these contact members, or some of them, may also be insulated from each other to provide independent control of separate circuits, where desired.

It will be apparent that the embodiments shown are only exemplary and that various modifications can be made in construction and arrangement within the scope of my invention as defined in the appended claims.

What is claimed is:

1. An electrical switch comprising, a plurality of arcuately arranged substantially coplanar insulatedly separated stationary contacts, a like plurality of substantially coplanar conductive resilient radial finger-like contact members each extending over and in closely spaced relationship with a respective one of said stationary contacts, a like plurality of stationary nozzles in arcuate arrangement, each said nozzle being directed toward a respective one of said contact members, a source of fluid under pressure, and distributing means for successively coupling said fluid source to each of said nozzles, whereby said finger-like contact members are successively engaged and separated from the respective stationary contacts.

2. An electrical switch in accordance with claim 1 wherein said distributing means includes a like plurality of first ducts respectively extending from each of said nozzles, a rotatable hollow shaft disposed centrally of said stationary contacts and coupled at one end to said fluid source, and a second duct extending radially from said hollow shaft, said second duct being rotatable with said hollow shaft and arranged to couple said fluid source successively to each of the ends of said first ducts opposite said nozzles.

3. An electrical switch in accordance with claim 1 and including a flexible diaphragm spaced between said nozzles and said radial finger-like contact members, said diaphragm being sufficiently flexible to transmit actuating forces to said contacts in succession.

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