June 2, 1970 B. B. BEEKEN 3,515,827

FLUID TO ELECTRIC TRANSDUCER

Filed March 20, 1968

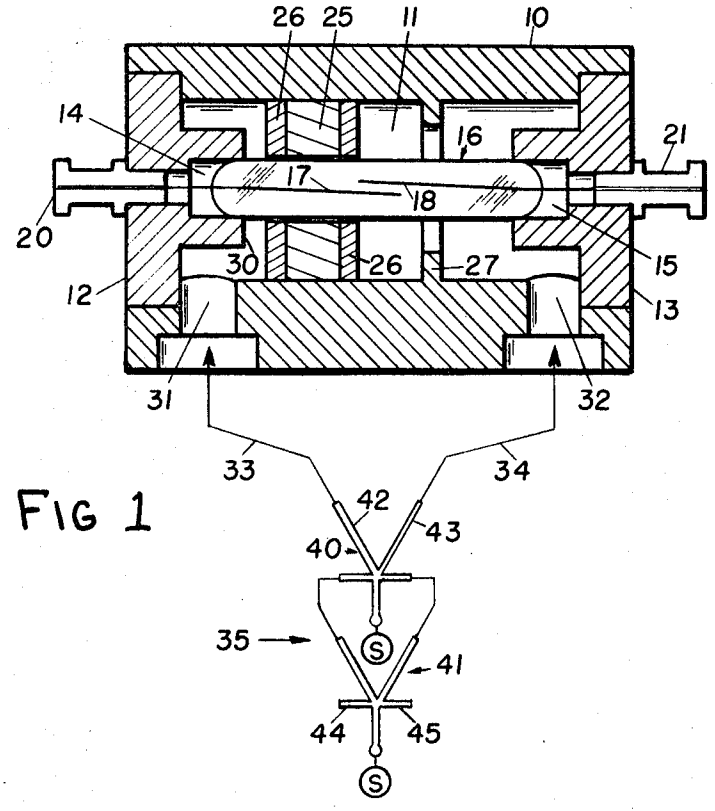

FIG 1

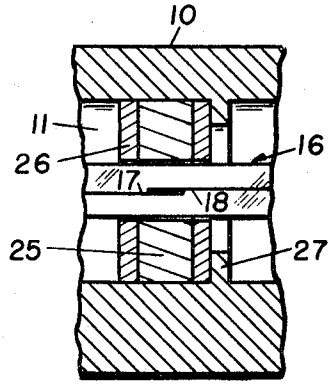

FIG 2

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FLUID TO ELECTRIC TRANSDUCER

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U.S. Cl. 200—81.9 4 Claims

ABSTRACT OF THE DISCLOSURE

A fluid to electric transducer including a glass-enclosed reed-type switch that has a pair of magnetically sensitive contacts. An annular permanent magnet is mounted for sliding movement over a cylindrical outer surface of the glass enclosure and is arranged so as to be displaced in one axial direction by a first fluid-operated means, and to be displaced in the other axial direction by a second fluid-operated means.

This invention relates to an improved fluid to electric transducer. More particularly the invention relates to an improved fluid to electric transducer wherein a magnetic element is shifted in each of two directions by fluid means so as to operate a reed-type electrical switch.

In the practical application of fluidics there are many occasions where it is desirable to be able to convert fluid pressure signals into corresponding electric signals. Several proposals have been made here however these proposals have not always been satisfactory from the standpoint of reliability, durability, cost or the ease with which such may be incorporated with other fluid control elements.

The primary object of the instant invention is to provide a novel fluid to electric transducer that is durable, reliable and relatively inexpensive.

Another object of the invention is to provide an improved fluid to electric transducer which, in being very rugged and compact, can be used in very hostile environments.

Another object of the invention is to provide a novel fluid to electric transducer which may be readily incorporated in a fluidic control system.

A further object of the invention is to provide an improved fluid to electric transducer whereby a reed-type electrical switch is operated by a movable magnet that is driven in each of two operative directions by two fluid-operating means.

Other objects of the invention will become apparent as the disclosure progresses.

In the drawings:

FIG. 1 is an axial sectional view of the instant transducer.

FIG. 2 is a fragmentary axial sectional view illustrating an active condition of some of the elements shown in FIG. 1.

Referring to FIG. 1 there is shown a main body member **10** having a cylindrical bore **11** axially formed therethrough. Two end covers or caps **12** and **13** are sealingly secured by any suitable means to the opposite ends of said main body **10** so as to form two fluid chambers at the ends of said bore **11**. The inner ends of the end caps are formed with central recesses **14** and **15** respectively which are adapted to receive and retain the end portions of an elongated glass-enclosed reed-type switch **16** that extends coaxially through said bore **11**. The switch **16** is of a well-known type and thus all the structural details thereof need not be discussed here. In general however this switch includes a pair of magnetically sensitive reed contacts **17** and **18** that respectively

extend out through the ends of the glass enclosure and through appropriate central holes formed in a pair of fittings **20** and **21**. The fittings **20**, **21** are centrally secured by any suitable means to and at the outer ends of the said end caps **11** and **12** and are made of any suitable electrical insulating material such as nylon, Delrin or the like.

An annular shaped permanent magnet **25** is mounted in the bore **11** and around the body portion of reed switch **16**, and is arranged for axial movement along a portion of the length of said switch **16**. To each radial face of said magnet **25** there is secured a disc-like washer **26** made of any suitable plastic material or the like. Washers **26** effectively afford smooth runnings seals first between the magnet **25** and the adjacent outer cylindrical surface of the reed switch **16**, and secondly between the magnet **25** and the adjacent inner cylindrical walls of said bore **11**. The axial right-hand limit of travel of the magnet **25** (as viewed in FIG. 1) is determined by engagement of the latter with a radially inwardly extending shoulder **27**, while the axial left-hand limit of travel of the said magnet is determined by the engagement of the magnet with the inner end **30** of the end cap **12**. When magnet **25** is in its first or left-hand position the remote and thus weak action of the magnetic field thereof allows the normally open switch contacts **17** and **18** to remain open. When magnet **25** is in its second or right-hand limit position the now stronger action of the magnetic field thereof causes the switch contacts **17**, **18** to close, as illustrated in FIG. 2, due to induce magnetism in the reed contacts.

In order to permit magnet **25** to be shifted between its said right- and left-hand operative positions the main body **10** is formed with two fluid conduit apertures **31**, **32** that are located adjacent the ends of bore **11** respectively. The apertures **31**, **32** are connected through suitable fittings to the output lines **33** and **34** respectively of the two-stage fluidic power unit **35**. The unit **35** comprises a pair of bistable wall attachment type fluid amplifiers **40** and **41**, the output of amplifier **41** controlling the operation of amplifier **40**. The construction and operation of each of the amplifiers **40** and **41** are well-known and need not be discussed in detail here. The output leg **42** of amplifier **40** is connected to said conduit line **33** while the other output leg **43** thereof is connected to said conduit line **34**. Each of the amplifiers **40**, **41** is operatively connected to a suitable source of fluid pressure S.

In the operation of the instant transducer when the fluidic control unit **35** is in a state wherein the output leg **43** is conducting the working fluid (such as air) the fluid pressure generated in the right end of bore **11** causes the magnet **25** to move to the left (as viewed in FIG. 1) and into its said first operative position whereby the electrical contacts **17** and **18** of switch **16** remain in their open condition shown in FIG. 1. When a control fluid pressure pulse or signal is received through the signal control line **44** of amplifier **41** the amplifier **40** will be operatively switched so that said output leg **42** is conducting and thus directs pressure through line **33** and into the left-hand end of bore **11**. At this time pressure fluid in the right end of bore **11** may exhaust through line **34** and said amplifier leg **43**. Under these conditions said magnet **25** will be axially shifted to its second or right-hand operative position as is illustrated in FIG. 2 and in this displaced condition the magnetic field of the magnet **25** will cause the contact **17** and **18** to close and remain closed as shown in FIG. 2. This actuated condition of the parts will persist until a fluid pressure reset signal is applied through control line **45** of amplifier **41** at which time amplifier **40** will be restored to its other operative condition wherein output leg **43** is conducting. Here with fluid pres-

sure applied to the right-hand end of bore **11** and with the fluid pressure in the left-hand end of bore **11** now able to exhaust through line **33** the said magnet **25** will be displaced back to its said first or left-hand operative position so that the contacts **17** and **18** of switch may again assume an open condition. As will be apparent the successive alternate application of fluid pressure signals to the control lines **44** and **45** of amplifier **41** will cause the switch **16** to successively open and close; these fluid pressure signals thus being effectively converted into corresponding electrical signals at the contacts **17** and **18** of switch **16**.

The instant apparatus has been found to operate reliably over long periods of use and is capable of operating at cyclic speeds well above 10 cycles per second.

Since many changes could be made in the embodiment of the invention as particularly described and shown herein without departing from the scope of the invention, it is intended that this embodiment be considered as exemplary and that the invention not be limited except as warranted by the following claims.

What I claim is:

1. A fluid to electric transducer comprising:

a main body having a cylindrical bore formed therethrough;

a glass-enclosed reed-type electrical switch disposed in said bore and having a non-conductive outer cylindrical surface and a pair of magnetically sensitive contacts;

an annular permanent magnet mounted for axial sliding movement in said bore and on said outer cylindrical surface of said reed-type switch, the two opposite limits of said axial movement of said magnet defining first and second operative positions of said magnet, the magnetic field of said magnet causing said switch contacts to close when said magnet is in its first operative position;

end caps connected to the ends of said main body so that a fluid chamber is formed at each end of said bore; and

fluid control means for admitting fluid pressure to one of said chambers and exhausting fluid pressure from the other of said chambers, and then for exhausting fluid pressure from said one chamber and supplying fluid pressure to said other chamber whereby said permanent magnet is alternately shifted to said first and second operative positions and said switch contacts are thereby alternately closed and opened.

2. Apparatus as defined by claim **1** wherein said fluid control means includes a first bistable fluid amplifier and a second fluid amplifier that is adapted to control the operation of said first fluid amplifier.

3. A fluid to electric transducer comprising:

a main body having a bore formed therethrough;

a reed switch disposed in said bore, said reed switch having a pair of magnetically sensitive electrical contacts;

means for retaining said reed switch in said bore;

an annular permanent magnet disposed in said bore and surrounding said switch, said magnet being movable along said switch between first and second operative positions for respectively opening and closing said switch contacts;

means defining a first fluid chamber at one end of said bore so that upon application of fluid pressure to said first fluid chamber said magnet may be displaced from said first to said second operative position;

means defining a second fluid chamber at the other end of said bore so that upon application of fluid pressure to said second chamber said magnet may be displaced from said second to said first operative position; and

fluid control means for alternately applying fluid pressure to said first and second fluid chambers, said fluid control means including a first fluid amplifier that is operatively coupled to control the fluid pressures for displacing said magnet, and a second fluid amplifier that is operatively coupled so as to control the operation of said first fluid amplifier.

4. Apparatus as defined by claim **10** wherein said first and second fluid amplifiers are bistable-type fluidic devices.

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ROBERT K. SCHAEFER, Primary Examiner

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U.S. Cl. X.R.

200—82

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,515,827 Dated June 2, 1970

Inventor(s) Basil B. Beeken

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 4, line 1:

"10" should be 3.

SIGNED AND
SEALED
NOV 17 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents

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