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MAGNETIC-PNEUMATIC PROXIMITY SWITCH

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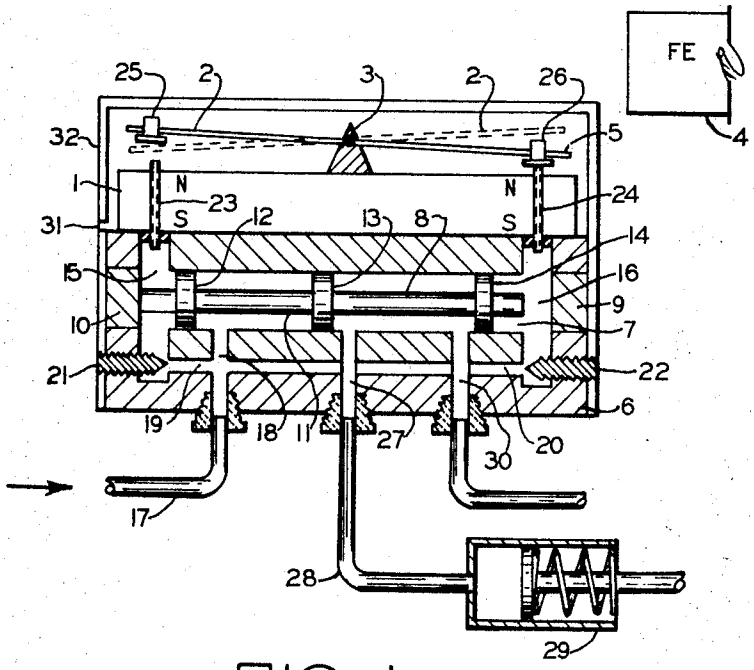

FIG. 1

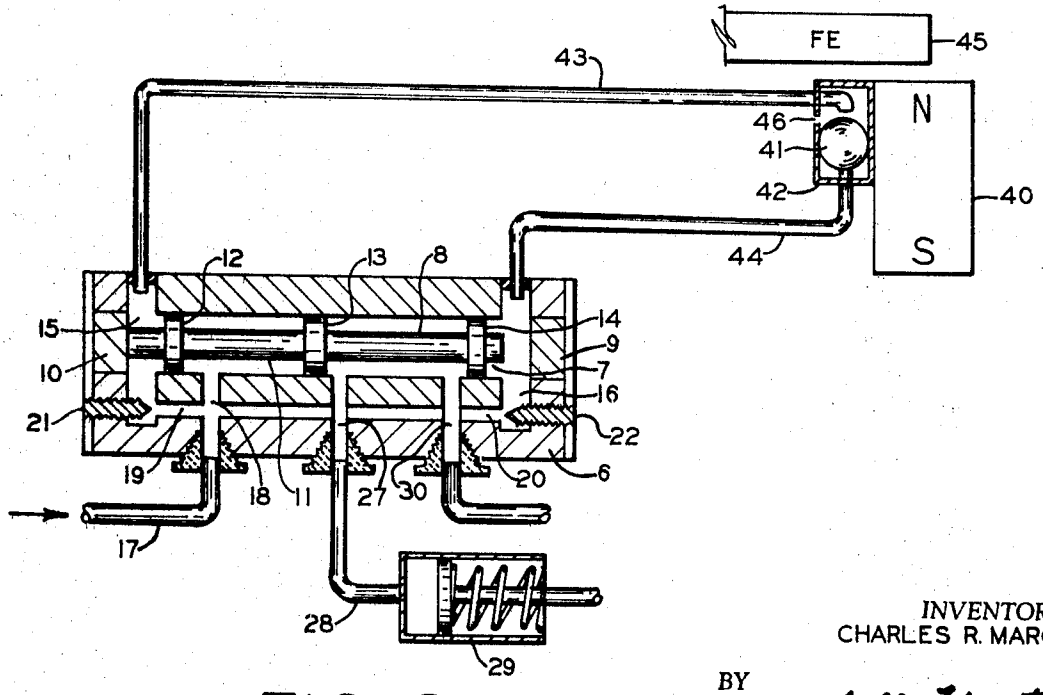

FIG. 2

INVENTOR.
CHARLES R. MARCUM

BY Marshall & Yeasting

ATTORNEYS

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MAGNETIC-PNEUMATIC PROXIMITY SWITCH

Charles R. Marcum, Louisville, Ky., assignor to General Equipment and Manufacturing Company, Inc., Louisville, Ky., a corporation of Kentucky

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ABSTRACT OF THE DISCLOSURE

The magnetic-pneumatic proximity switch comprises a magnetizable member mounted for movement in the field of a permanent magnet as that field is shifted by the approach or retreat of a magnetizable object to be detected, the member being arranged in a pneumatic circuit to open or close passages as an object is detected. Preferably the switch also includes a spool pilot valve in the assembly arranged to control a fluid operated work cylinder.

BACKGROUND OF THE INVENTION

Magnetically operated sensors in which an armature of magnetizable material is moved in response to the approach of a magnetizable object to open or close electrical contacts have been used extensively. However, in many instances, an air cylinder or equivalent device, is required to obtain a sufficiently long or powerful stroke. This required one or more solenoid operated valves responsive to the electrical signals from the sensor or proximity switch to control the air cylinder. Electrical circuits and switches are undesirable in many hazardous areas and expensive enclosures are required to reduce the hazard.

OBJECTS AND SUMMARY OF THE INVENTION

The object of the invention is to provide a sensitive proximity switch devoid of electrical circuits and capable with a pilot valve of directly controlling a working air cylinder or similar device.

Acording to the invention a small valve adapted to control a small air flow is constructed employing a magnetizable member of a magnetic proximity switch. The small valve which operates as the magnetizable member of the sensor moves, opens or closes a restriction in a pneumatic circuit to control a spool valve which, in turn, controls the flow of operating fluid to or from a working piston and cylinder device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a section through the magnetic-pneumatic proximity switch, and a controlled work cylinder.

FIG. 2 is a similar section through a switch employing an alternative form of magnetizable member and magnetically actuated valve.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A magnetic-pneumatic proximity switch comprises, in effect, two cooperating assemblies. The first assembly includes a permanent magnet **1** magnetized to have its upper surface of one polarity and its lower surface of another polarity. A magnetizable member or armature **2** is mounted on a pivot pin **3** supported above or on the magnet **1** with the armature **2** extending generally parallel to and spaced from the upper face of the magnet **1**. The armature **2** is generally equal in length to the magnet **1**.

The armature **2** and magnet **1** are arranged, as by weakening one side of the magnet, so that the armature normally assumes the position shown in solid lines. When a magnetizable object **4** to be detected approaches a position indicated by the fragment of such object the magnetic flux at the adjacent end of the magnet **1** shifts to include the object **4**. This reduces the attractive effort between the adjacent end **5** of the armature **2** and the magnet **1** so that the armature rocks to other end of its travel as shown by the dotted lines.

The second assembly of the two cooperating assemblies includes a valve body **6** having a bore **7** in which a valve spool **8** is slidably fitted. The ends of the bore **7** are closed by plugs **9** and **10**. The valve spool **8**, as shown, comprises a longitudinal stem **11** and three lands **12**, **13**, **14**. The stem **11** extends axially beyond the lands **12** and **14** and cooperates with the plugs **9** and **10** to limit the travel of the spool **8**.

The body **6** also, as shown, has a pair of drilled passages **15**, **16**, transverse to and intersecting the ends of the bore **7**. Air under pressure is supplied through a pipe or tube **17** and passages **18** and **19** or **20** leading to the passages **15** or **16**. The rate at which air may be admitted is controlled by needle valves **21**, **22**. Air escapes from the passages **15** or **16**, which include the chambers formed in the ends of the bore **7**, by way of tubes **23**, **24**, sealed into the ends of the passages and extending through or past the magnet **1** and terminating adjacent rubber or plastic pads **25–26** attached to the armature **2**. One or the other of the pads **25**, **26** closes the end of the adjacent tube **23**, **24** depending upon the presence or absence of a magnetizable object to be detected.

The valve body **6** also includes an outlet passage **27** leading through a pipe or tube **28** to a working cylinder **29**. As shown, the working cylinder **29** is single acting and includes a spring to return its piston when the air pressure is released. An exhaust passage **30** is also provided in the valve body **6**, as well as a vent **31** in a cover **32** to allow escape of air from the tubes **23** or **24**.

As shown in FIG. 1, the valve spool **8** is at the left end of its range of travel as a result of a high control pressure in the chamber at the right end of the bore **7**. In this position the outlet passage **27** and exhaust passage **30** are in communication through the space between the lands **13** and **14**. When the armature **2** is rocked to its other position the tube **23** is closed and tube **24** is opened. The resulting changes in control pressures shifts the spool to the right so that land **13** moves to the other side of passage **27**. This connects passages **18** and **27** to apply pressure to the working cylinder.

While it is preferable to simultaneously and oppositely vary the control pressure at the ends of the valve spool, as described, the valve may be operated with one control pressure by providing a fixed biasing force urging the valve toward one end of its travel. This could be provided by a small coil spring, for example. In this variation the air supply to the spring end of the valve is omitted and the corresponding tube **23** or **24** opened to atmosphere. The bias force should be about half the force exerted when the chamber at the other end of the bore **7** is pressurized.

For simplicity the bore **7** is shown formed directly in the body **6**. In actual construction an arrangement of an inserted sleeve between the spool and valve body may be used. Examples of such constructions are shown in U.S. Pat. 2,767,689 to Moog and in U.S. Pat. 2,781,782 to Gerwig.

An alternative form of magnetic-pneumatic proximity switch is shown in FIG. 2. Since the spool valve and valve body arrangement is the same as in FIG. 1 no specific description of this portion is needed.

The magnetic sensor valve portion of this embodiment includes a magnet **40** magnetized to have poles in its upper and lower faces as shown. A magnetizable member in the form of a ball **41** is loosely guided in a ball track **42** mounted alongside the magnet **40** with the ball adjacent a corner of the magnet. The ball track **42** is in the form of a

cylindrical capsule and has tubes 43 and 44 inserted therein. These tubes 43, 44 correspond to the tubes 23, 24 of FIG. 1 and form an air switch to control the flow of air to or from the chambers at the ends of the valve spool. The tubes 43, 44 terminate in the capsule ball track 42 with their open ends facing the ball so that the ball serves as a stopper for one or the other of the tubes.

The ball 41 is moved along the track by the approach or retreat of a magnetizable object 45 to be detected. In the arrangement shown the ball moves toward the corner in response to the approach of the object 45.

The capsule ball track 42 is vented to the atmosphere through an opening 46.

In each of the foregoing examples the first assembly, i.e. the magnetically actuated pneumatic switch, may be used separately to control a pneumatic circuit or small working cylinder. The direction of air flow through the switch may be reversed with no change in operating principles. Thus air may be supplied to the vent opening 46 of the capsule track 42 and the output taken from the tubes 43 or 44. Furthermore, either example may be used as a single pneumatic valve by eliminating one of the tubes 23, 24 or 43, 44.

I claim:

1. In a magnetic-pneumatic proximity switch adapted to operate in response to the approach or retreat of a magnetizable body, in combination, a stationary permanent magnet; a magnetizable member; means mounting the magnetizable member adjacent the magnet for movement through a limited path in response to the approach of the magnetizable body; and a fluidic circuit having a port in position to be opened or closed by movement of said magnetizable member.

2. A magnetic-pneumatic proximity switch according to claim 1 in which the fluidic circuit includes a pair of ports in position to be alternatively opened or closed by movement of the magnetizable member to the limits of its path of movement.

3. A magnetic-pneumatic proximity switch according to claim 1 including a pneumatically actuated valve the actuating chamber of which is included in said pneumatic circuit.

4. A magnetic-pneumatic proximity switch according to claim 2 including a pneumatically actuated valve having opposed actuating chambers connected one to each of said pair of ports.

5. A magnetic-pneumatic proximity switch according to claim 1 in which the magnetizable member is a ball retained in a ball track positioned adjacent the magnet.

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HENRY T. KLINKSIEK, Primary Examiner

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137—83; 235—207; 251—65; 335—205, 229