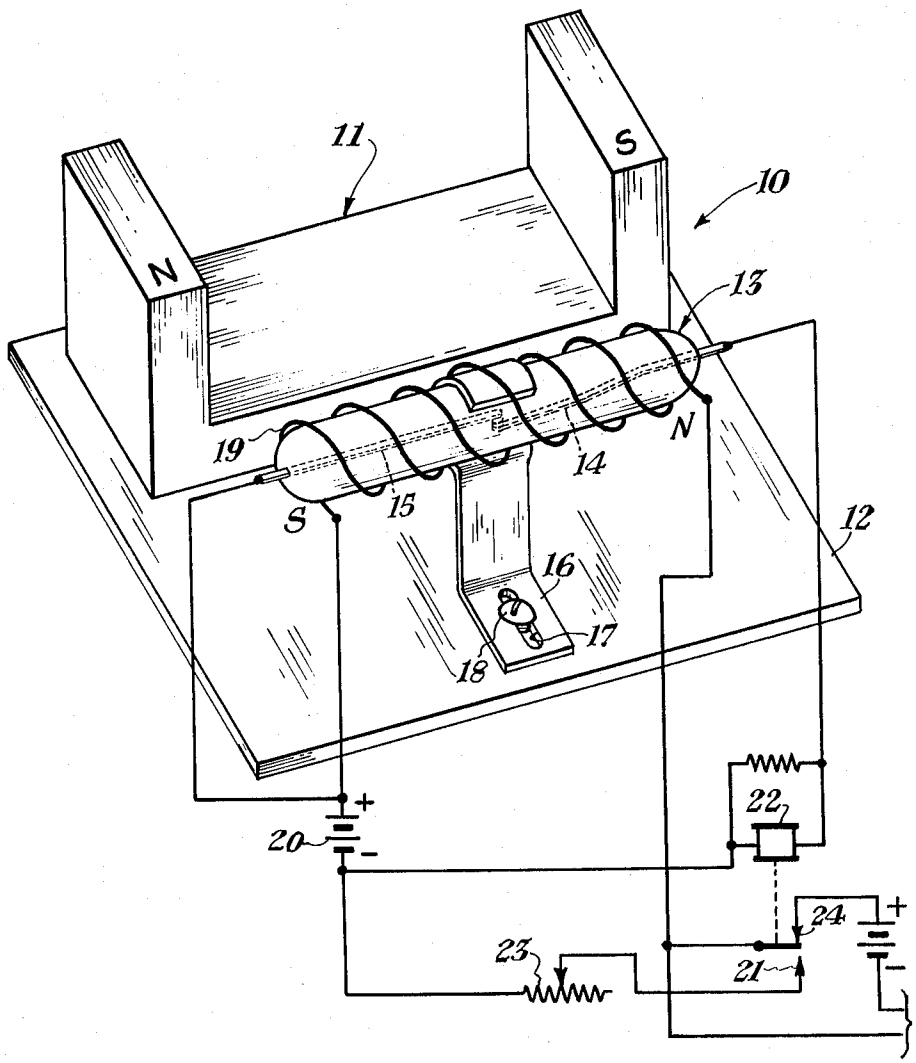
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MAGNETIC PROXIMITY DETECTOR

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MAGNETIC PROXIMITY DETECTOR

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This invention relates to a new and improved magnetic proximity detector for detecting magnetically permeable objects moving past a point within a predetermined distance from the location of the detector.

The invention can be used to count wheels on cars of a train moving on a rail past a given point but is not limited to such use.

Generally, the type of detector embodied in this invention comprises a magnetic circuit including magnetically operable switching means normally held under the influence of a permanent magnet in either an open or closed condition against an opposing spring bias. Introduction of a magnetically permeable object in the proximity of the magnetic circuit causes a change in the magnetic circuit and permits operation of the switching means from their open or closed condition to their alternate closed or open condition to which they are biased. The magnetic circuit and switching means are restored to their normal condition when the permeable object passes out of the area where it affects the circuit. The opening and closing of the switch can be used to control counting or recording apparatus. Proximity detectors of the type embodied in this invention have been used before to count wheels of a train. An example of such a detector for the purpose of counting railway car wheels is shown in my copending application for Letters Patent of the United States, Serial No. 165,144, filed January 9, 1962, for Proximity Detectors.

One of the inadequacies of prior art detectors of this type is that after a magnetically permeable object has caused operation of the switching means the switching means may not reset until the object has moved away a distance appreciably greater than the distance at which it was first detected. This is especially true if the object being detected or other structures near the detector have become residually magnetized. This condition can be partially corrected by using switching means which open or close in response to a very slight change in the strength of the magnetic field affecting them. However, a switch with this type characteristic, that is, with a high release to pickup ratio, is subject to spurious operation in applications where it is subjected to mechanical shock or vibration, as, for example, when it is mounted on or adjacent a railway track for counting railway car wheels.

This invention solves these problems by retaining the use of a magnetically operable switch with a relatively low release to pickup ratio, thus avoiding susceptibility to spurious operation under mechanical shock, and employing an electromagnetic coil effective only during the time the switch is in its operated condition due to the presence of a magnetically permeable object to generate a magnetic field tending to reenforce the action of the magnetic circuit and help restore the switch to its unoperated condition.

Among the objects of this invention are the following:

To construct an efficient and dependable magnetic proximity detector of relatively small size and simple structure with superior reset characteristics that permit separate detection of closely spaced objects.

To provide a magnetic proximity detector with unusually good reset characteristics but without sacrificing resistance to spurious operation due to mechanical shock or vibration.

To teach the construction of magnetic proximity detectors whose reset characteristics are substantially unaffected by magnetic fields caused by residual magnetism of surrounding structures or of the object being detected.

These and other objects will become readily apparent as the invention becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing which is a perspective view of a magnetic proximity detector of the type encompassed by this invention showing electrical components in schematic form.

In the drawing numeral **10** indicates a magnetic proximity detector comprising a permanent magnet **11** secured to a base **12** to which is also adjustably secured an enclosed magnetically operable reed type switch **13** having reed contacts **14** and **15** biased toward an open position. Switch **13** is mounted to base **12** by means of a bracket **16** of non-magnetic material. Bracket **16** is provided with an elongated aperture **17** through which aperture passes a screw **18** or other fastener for adjustably securing the bracket to base **12**. Switch **13** is of a well-known type in which the reeds are of magnetic material and the contacts are biased to an open position as by spring means. The contacts can be caused to close and complete an electrical circuit when the switch is placed in a magnetic field of sufficient strength to overcome the force biasing them to an open position. Such a magnetic field is provided by the lateral portion of the magnetic field of magnet **11**. As is well known, when a permeable object enters the area of the main magnetic field extending between the north pole and south pole of magnet **11** the portion of the magnetic field of magnet **11** extending in the direction of switch **13** is weakened. Switch **13** can be so placed with respect to magnet **11** that the weakened field is of insufficient strength to hold reeds **14** and **15** in their closed position and the switch opens. When the permeable object starts to move out of the main magnetic field of magnet **11** its shunting effect on the lateral portion of the field becomes less until the switch contacts are again closed under the influence of the lateral field. Bracket **16** and switch **13** are adjustable toward or away from magnet **11** so that the proper operating characteristics can be provided.

The contacts of switch **13** can be connected to control an external circuit including a recording, counting or indicating device, not shown, which is appropriate for the purposes for which the detector is used. As shown in the drawing, the contacts of switch **13** are in series with a relay **22**. When switch **13** is closed, relay **22** is energized and the external circuit completed through front contact **24** of relay **22**. When switch **13** is opened, relay **22** is deenergized and the external circuit is interrupted. Since switch **13** opens and closes in response to the approach and departure of a magnetically permeable object, the opening and closing cycle of switch **13** will be the basis for an accurate record or count of such objects moving past the detector.

Once the contacts of this type of magnetically operable switch are closed the strength of the magnetic field may decrease considerably before contacts will open and the field strength must increase considerably from the level at which the contacts open to cause them to close again. The relation of the field strength at which the contacts of a biased open switch will return to an open position after being closed and the field strength necessary to close the contacts from an open position may be expressed as a ratio called a release to pickup ratio. Usually the release to pickup ratio for this type of switch will be about 40–70%.

Since the strength of the field available to close the contacts at switch **13** with a given magnet **11** while a magnetically permeable object is in the proximity of the de-

tector depends on the shunting effect of the object on the field of magnet **11** and this shunting effect, in turn, is inversely proportional to the distance from the magnet to the object, it is obvious that the distance to which the object must move before the detector can reset after having operated is considerably greater than the distance between the object and the magnet at which the object is first detected and the switch caused to operate. This is especially true if the residual magnetism of structures near the detector changes after the detector has been installed and adjusted or if the object being detected is magnetized. It is possible under these conditions that another of the objects being detected could enter the detector area before the preceding object has moved far enough away to permit switch **13** to close. Under these conditions the second object would not be detected and the indication or counting would be inaccurate.

To partially offset this condition, it would be possible to use a reed switch with characteristics such that only a very slight reduction in the strength of the field necessary to hold the contacts closed would permit the contacts to again open. That is, a switch could be chosen with a very high release to pickup ratio. However, this would be unsatisfactory because the contacts of a switch having a high release to pickup ratio would also be extremely susceptible to spurious opening under the influence of mechanical shock or vibration. Such spurious opening would result in inaccurate detection or counting. Therefore, this invention utilizes a different solution.

This invention retains a switch having a relatively low release to pickup ratio so that it can be used on or adjacent to a railway or other location where it is subject to mechanical shock without spurious operation and employs an electromagnetic coil around switch **13** to assist in reclosing the contacts after they have been opened. As shown in the drawing, coil winding **19** is connected to a source of power **20** through a back contact **21** of relay **22**. When the winding **19** is energized it creates a magnetic field which urges contacts **14** and **15** toward each other assisting the action of the magnetic field of magnet **11**. As described above relay **22** is connected in a circuit controlled by contacts **14** and **15** so that when these contacts are opened in response to the shunting effect of a permeable object entering the magnetic field of magnet **11** relay **22** is deenergized and the circuit for electromagnetic winding **19** is completed through back contact **21**. Variable resistor **23** in the electrical circuit for winding **19** can be adjusted to control the electrical current through winding **19** and consequently the magnetic field created by it. Preferably, resistor **23** is adjusted so that switch **13** will reset when the distance between magnet **11** and an object being detected is only slightly greater than the distance at which the presence of the object was first sensed and switch **13** operated.

Bracket **16** and resistor **23** can be adjusted so that the reset distance can be selectively set from a distance approximately equal and only slightly greater than the sensing distance to a distance many times greater than the sensing distance.

Although the invention has been described in connection with a detector employing a switch biased to an open position and magnetically closed in the absence of a permeable object in the vicinity of the detector, it is obvious from this description to one skilled in the art how this invention can be used in a detector such as the one disclosed in FIGURE 3 of my copending application, Serial No. 165,144, employing a switch biased to a closed position and magnetically opened in the absence of a permeable object in the vicinity of the detector.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. Therefore, it is to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

Having thus described my invention, what I claim is:

1. A magnetic proximity detector for indicating the presence of a magnetically permeable object within a predetermined area, said detector comprising an electrical circuit means normally in one condition, means coupled to said circuit means and effective while a magnetically permeable object is within said predetermined area to cause said electrical circuit means to change to another condition, and electromagnetic means electrically coupled to said circuit means and effective only while said electrical circuit means in said other condition to tend to restore said circuit means to its one condition.

2. A magnetic proximity detector for indicating the presence of a permeable magnetically object within a predetermined area, said detector comprising an electrical circuit means operable from one condition to another and biased toward said other condition, magnetic means magnetically coupled to said circuit means and effective in the absence of a magnetically permeable object within said predetermined area to maintain said electrical circuit in said one condition but permitting said electrical circuit means to return to said other condition when a magnetically permeable object enters said predetermined area, and electromagnetic means electrically coupled to said circuit means and effective only when said electrical circuit means is in said other condition to tend to restore said circuit means to its one condition.

3. A magnetic proximity detector for indicating the presence of a magnetically permeable object within a predetermined area, said detector comprising an electrical circuit means operable from one condition to another and biased toward said other condition, magnetic means magnetically coupled to said circuit means and effective in the absence of a magnetically permeable object in proximity to said magnet means to maintain said electrical circuit means in said one condition but permitting said electrical circuit means to return to said other condition when a magnetically permeable object approaches within a predetermined distance of said magnet means, and electromagnetic means electrically coupled to said circuit means and effective only when said electrical circuit means is in said other condition to tend to restore said circuit means to its one condition and thereby effective to limit said predetermined area so that said area extends approximately equal distances from a dimensional center of said magnet means.

4. A magnetic proximity detector for indicating the presence of a magnetically permeable object within a predetermined area, said detector comprising a magnetically operable switch biased to an open position, magnet means for closing such switch and normally holding it in a closed position, said magnet means being ineffective to hold said switch in a closed position and permitting said switch to open when a magnetically permeable object enters said predetermined area, and means electromagnetically coupled to said switch and effective only while the switch is in its open position tending to close said switch.

5. A magnetic proximity detector for indicating the presence of a magnetically permeable object within a predetermined area, said detector comprising a magnetically operable switch biased to an open position, magnet means magnetically coupled to said switch for closing said switch and normally holding said switch in a closed position, said magnet means being ineffective to hold said switch in a closed position and permitting said switch to open when a magnetically permeable object enters said predetermined area, and electromagnetic means electromagnetically coupled to said switch and effective only when the switch is in its open position tending to close the switch.

6. A magnetic proximity detector for indicating the presence of a magnetically permeable object within a predetermined area, said detector comprising a magnetically operable switch biased to an open position, magnet means

magnetically coupled to said switch for closing said switch and normally holding it in a closed position, said magnet means being ineffective to hold said switch in a closed position and permitting said switch to open when a magnetically permeable object enters said predetermined area, and means intermittently magnetically coupled to said switch and magnetically coupled to said switch only while said switch is in its open position tending to close the switch and thereby being effective to condition said detector for detecting another permeable object closely following an object already detected.

7. A magnetic proximity detector for indicating the presence of a magnetically permeable object, said detector comprising a switch biased to one position and magnetically operable to another position, magnet means magnetically coupled to said switch for operating and holding said switch in its other position, said magnetic means being ineffective when a magnetically permeable object approaches within a predetermined distance from the location of said magnet to hold said switch in its other position and permitting said switch to return to its one position thereby indicating the presence of said object, and means electromagnetically coupled to said switch and effective only while said switch is in said one position tending to urge said switch to said other position in cooperation with said magnet means whereby the distance between said magnetically permeable object and said magnet means at which said magnet means will again be effective to operate said switch to its other position is approximately equal to the distance between said object and said magnet means at which the said switch first returned to said one position.

8. A magnetic proximity detector for indicating the presence of a magnetically permeable object, said detector comprising a switch biased to one position and magnetically operable to another position, magnet means magnetically coupled to said switch for operating and holding said switch in its other position, said magnetic means being ineffective when a magnetically permeable object approaches within a predetermined distance from the location of said magnet to hold said switch in said other position and permitting said switch to return to said one position thereby indicating the presence of said object, and means intermittently magnetically coupled to said switch and magnetically coupled to said switch only while said switch is in said one position tending to urge the switch to said other position in cooperation with said magnet means, the effectiveness of said means being adjustable whereby the distance between said magnetically permeable object and said magnet means at which said magnet means in cooperation with said means will again be effective to operate said switch to its other position may be selectively set from a distance approximately equal to the distance between said object and said magnet means at which said switch first returned to said one position to greater distances up to the distance at which said magnet means is effective alone to again operate said switch to said other position.

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