

June 19, 1951

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2,557,902

PNEUMATICALLY-OPERATED ELECTRICAL SWITCHING DEVICE

Filed Nov. 22, 1948

2 Sheets-Sheet 1

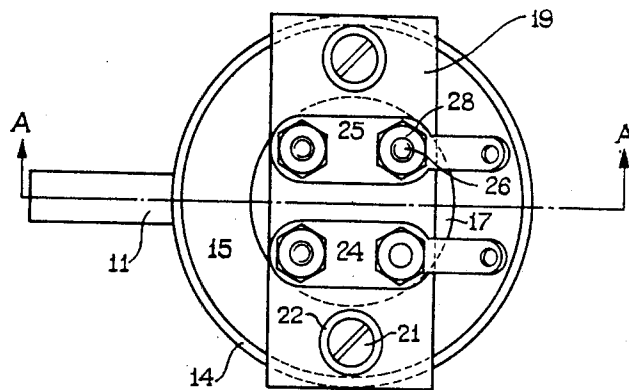


Fig. 1

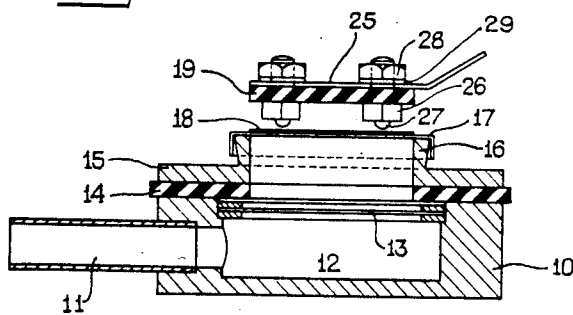


Fig. 2

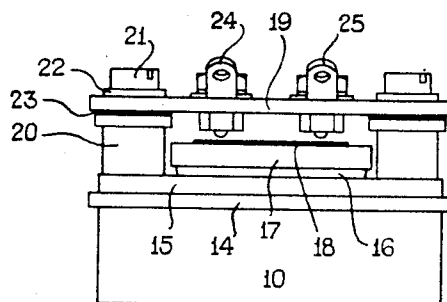


Fig. 3

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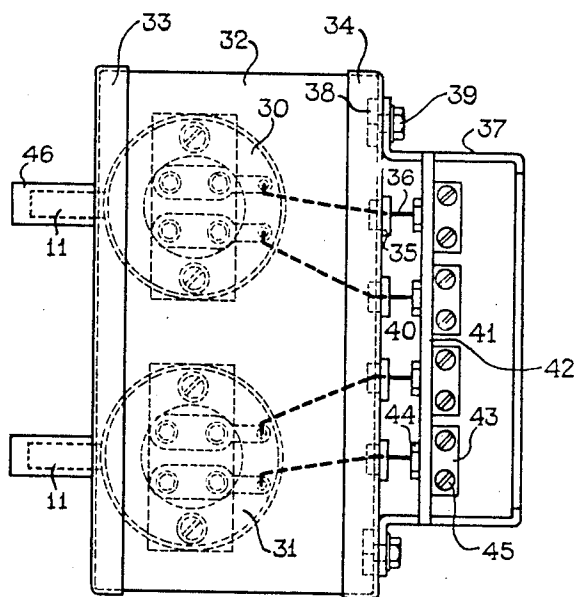


Fig 4

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UNITED STATES PATENT OFFICE

2,557,902

PNEUMATICALLY OPERATED ELECTRICAL SWITCHING DEVICE

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Application November 22, 1948, Serial No. 61,428
In Great Britain December 12, 1947

6 Claims. (Cl. 200—86)

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The present invention relates to electric switching devices suitable for operation by changes in fluid pressure and finds particularly advantageous application to switching devices operated pneumatically by vehicles passing over a tread member located in the road surface. Arrangements of this type are already known and are widely employed as vehicle detectors for use in vehicle-actuated traffic control systems.

Usually in such arrangements the tread member which is composed of rubber or similar resilient material includes a cavity the volume of which is varied as the vehicle passes over the detector so as to produce a momentary increase of pressure which operates the switching device. Such vehicle detectors are called upon to meet very stringent operating conditions since they must be sufficiently robust to withstand damage by heavy vehicles passing at high speed while still being sufficiently sensitive to produce correct operation when traversed by a light vehicle such as a bicycle. Moreover they require careful protection to ensure that their efficiency shall not be impaired by extremes of temperature and the effects of moisture and accumulations of foreign matter on the road. The general object of the invention is to produce a switching device which will meet these requirements more satisfactorily than those hitherto employed and which will be cheap to manufacture, easy to maintain and reliable in operation.

According to the invention, in an electric switching device suitable for operation by changes in fluid pressure, a flanged diaphragm supported on and covering the end of a circular pipe communicating with a control chamber is arranged to be moved bodily by increase in the pressure of the fluid within the chamber to cause it to effect a switching operation.

The invention will be better understood from the following description of one method of carrying it into effect, reference being had to the accompanying drawings comprising Figs. 1 to 4. Fig. 1 shows a plan view of one form of fluid operated switch according to the invention, Fig. 2 shows a cross sectional view on the line A—A in Fig. 1 in the direction of the arrows, while Fig. 3 is an elevation viewed from the right of Fig. 1. Fig. 4 is a plan view of a pair of switches of the type shown in Figs. 1-3 mounted within a container to provide a unit which is particularly suitable for giving unidirectional working in a vehicle-actuated traffic control system.

Considering now Figs. 1, 2 and 3, the cylindrical body 10 of the switching device which is prefer-

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ably of brass has secured to it the inlet pipe 11, which is assumed to be coupled to a flexible tube extending to a cavity in the pneumatic tread member set in the road surface so that the tread cavity is connected with the chamber 12. A filter comprising a fine wire mesh disc 13 fitted in a circular frame accommodated in a recess of the chamber serves to prevent the passage into the upper chamber of unwanted particles which might interfere with the proper functioning of the switch. A ring 14 of electrically insulating material such as phenol fibre board separates the diaphragm support member 15 from the body 10. Sealing compound may be applied to the upper and lower surfaces of the insulating ring 14 to secure an air-tight joint. The member 15 is provided with a circular projecting portion or pipe 16 which is undercut on its outside circumferential surface and loosely supports the diaphragm 17 which is flanged so as to form a circular inverted shallow dish. The diaphragm which is lightly constructed is preferably of nickel silver but may be of other material having the requisite properties. It has a thin ring or disk 18 of platinum or other suitable contact material secured to its upper face and so positioned as to co-operate with four dome-like contacts such as 27 when the diaphragm is lifted bodily off its seating. The inside diameter of the diaphragm is a few thousandths of an inch greater than the greatest outside diameter of the undercut portion 16 so as to permit free movement and provide a slight air leak as will be described later.

The bridge member 19 of phenol fibre board or like insulating material is mounted on two pillars 20 and packing shims 23 and is secured by screws 21 which are threaded into the body 10 and carry washers 22. The member 15 and the pillars 20 remain electrically insulated from the body 10 by the inclusion of insulating sleeves (not shown) over a portion of each screw in known manner.

The bridge 19 serves to support four similar contact members each comprising a dome-shaped precious metal contact 27 welded to the head of a bolt 26. The members are electrically linked in pairs by the soldering tags 25 and 24 to which they are clamped by nuts 28 and locking washers 29.

The contacts 27 are arranged to be equidistant from the ring 18 and according to a preferred adjustment the airgap is of the order of .005" when the diaphragm is at rest. It will be apparent that the open construction of the switch enables the contacts to be viewed easily during

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the assembly and adjustment stages, and the airgap, which is determined by inserting shims 23 of suitable thickness, can be measured by inserting a feeler gauge.

When the switch is included in a vehicle-actuated traffic control system, it is sealed against atmosphere by enclosing it in a suitably dimensioned and hermetically sealed metal container. The pipe 11, which protrudes through a wall of the container, is coupled to a flexible tube which extends to the cavity formed within a tread of resilient material which is inserted in the surface of the road and over which vehicles pass. In this manner the air within the container, the tread cavity and the connecting tubing is isolated from the external atmosphere to prevent the ingress of moisture and other foreign matter into those parts of the system.

The cavity within the tread member is compressed upon the passage of a vehicle and the pressure of air within it and the tube is increased relative to that within the switch container. Thereupon the diaphragm 17 is lifted bodily off its seating after the manner of a piston and the ring 18 is caused to engage with the contacts 27 so that an electrical path is extended from one pair of linked contacts to the other pair to transmit a signal to the controller equipment. The diaphragm aided by gravity will subsequently fall back on to its seating when the vehicle passes clear and the air pressures on both sides of the diaphragm are again substantially equal. Due to the loose fit of the diaphragm on the member 15 air is enabled to flow from the cavity beneath the diaphragm into the switch container. Thus if a vehicle were to come to rest on the tread member the diaphragm would be lifted initially but would not remain in the operated position. Even if this should happen other vehicles passing over the pad will produce pulses of increased pressure which will cause normal operation of the diaphragm. This will not apply of course if the stationary vehicle closes the tread cavity completely and the further vehicles pass over the detector on the side remote from the equipment of Figs. 1-3.

The volume of the switch container is preferably appreciably greater than the volume of the tread cavity, the connecting pipe and the cavity 13 and the leakage round the edge of the diaphragm is such that the back pressure within the container does not equalise the forward pressure in the tread cavity until the aforesaid electrical path has been closed for a useful period. The leakage effect may be increased if found necessary by slotting the portion 16 of the diaphragm support member 15. The slight air leak just mentioned will tend to accentuate the effect that when a vehicle passes clear of the detector there will be a sucking action which positively restores the diaphragm to its seating.

The mounting of the diaphragm 17 freely on the member 16 provides an electrical advantage in that it has been found that as the diaphragm is lifted and restored it tends to rotate slightly and in consequence differing positions of the contact ring 18 are continually being presented to the contacts 27. This arrangement together with the use of two pairs of contacts, appreciably reduces the electrical fault liability of the switch.

It will be apparent to those skilled in the art that alternative constructions of the switch might be employed, for example a single contact member could be mounted centrally upon the bridge 19 and a co-operating contact welded to the dia-

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phragm to which a light flexible conductor could be connected. In this case a single make contact combination is provided and one conductor terminating on the controller equipment would be connected to the contact member on the bridge and the other conductor connected to the flexible lead.

Reference will now be made to Fig. 4 which is a plan view of two pneumatic switches 30 and 31 mounted within a container 32 which is finally hermetically sealed from atmosphere to provide a unit suitable for uni-directional working in a vehicle-actuated traffic control system. The switches are secured to the container 32 by screws (not shown) passing through the base and the end plates 33 and 34 to fit snugly and are retained by airtight soldered joints. The inlet pipes 11, shown temporarily sealed by rubber caps 46, protrude through holes in plate 33. End plate 34 to which the terminal block housing is secured has four holes fitted with insulating bushes 35 which provide paths for the bare conductors connecting appropriate switch soldering tags and terminals. It may be mentioned that all possible air leakage paths in the container created by the jointing of metal members are sealed by a liberal application of solder.

The terminal block housing 37, shown with the cover removed, is secured to the end plate 34 by the nuts and bolts 38 and 39 and is divided into two compartments 40 and 41 by the terminal strip 42 which is of insulating material such as phenol fibre board. The said strip interlocks with the housing and carries four terminals 43 which are secured by the hollow screws 44 threaded into the terminals. The conductors 36 are each passed through a hollow screw and connect with a terminal at a soldered joint. Each terminal is provided with two screws 45 for clamping conductors extending to the controller equipment. Compartment 40 is filled with bitumen before the unit is installed to seal the bushed holes and to act as an electrical insulator and thus the container is completely sealed from atmosphere. The unit may be expected to have to work under arduous conditions, for example below the surface of the road or pavement, and is therefore liberally coated with bitumen on the outside surfaces.

When the unit is being installed, the rubber caps 46 are removed and the appropriate flexible tubes extending from the cavities in the pneumatic treads are securely coupled and sealed to the inlet pipes. The appropriate insulated conductors terminating at the controller equipment are stripped of insulation at the ends, passed through holes in the right-hand wall of housing 37 and secured to the relevant terminals 43 by screws 45. The whole of the stripped portion of the conductors is arranged to be within the compartment 41 which is then filled with bitumen for electrical insulation purposes before the cover is attached to the terminal block housing.

I claim:

1. A pneumatically operated electric switching device comprising, in combination, a vertical tubular element, a diaphragm of a diameter slightly in excess of that of the tubular element positioned normally to rest upon the tubular element, said diaphragm being provided with a downwardly extending flange arranged to surround the upper portion of the vertical tubular element, a pair of contact points supported in fixed position relative to the tubular element, a contact member carried by said diaphragm, ter-

terminal points for connecting an external electrical circuit to said pair of contact points, and a conduit connecting said tubular element with a control chamber element so that at periods of increases in fluid pressure within the control chamber the diaphragm is caused to move bodily upward to engage the pair of contact points and the contact member to effect an electrical switching operation.

2. The switching device claimed in claim 1, wherein the contact member comprises a ring of contact material supported upon the upper surface of said diaphragm and wherein the pair of contact points fixed in position relative to the tubular member is located to be engaged by said ring when the diaphragm is moved upwardly so that a circuit is completed between the said pair of contact points.

3. The switching device claimed in claim 2 comprising, in addition, a bridge of insulating material fixed relative to said tubular member and spanning the said diaphragm, said contact points being secured to said bridge so that the clearance between said contact points and said diaphragm in its normal position is readily observable and accessible for tests.

4. A pneumatically operated electrical switching device comprising in combination a chamber member having an upwardly extending tubular section, a substantially circular diaphragm of slightly larger diameter than that of the tubular section positioned to rest in normal state upon the upper edge of the tubular section, said diaphragm having a downwardly extending flange surrounding a portion of the tubular section, a contact member carried upon the upper surface of said diaphragm, a pair of contact points supported from the said chamber member in fixed location relative thereto and positioned to be contacted by the contact member carried upon the diaphragm, a filter disk supported within the said chamber member to prevent the passage therein of unwanted particles, said chamber member having an entrance port beneath the filter for connection to a conduit in which fluid pressure is subject to change for influencing the instantaneous pressure within the chamber so that at periods of pressure increase within the control chamber the diaphragm supported upon the tubular member is lifted bodily upward to provide contact between the said contact member and the two said contact points and whereby pressure equalization above and below the diaphragm member is established coincidentally with the unseating of the diaphragm from the tubular section and terminal points for connecting an external circuit to the contact points so that during periods of actual contact thereof an electrical circuit may be brought into operation.

5. A detector for road vehicles including a resilient tread member mounted to be engaged by vehicles passing thereover, a longitudinal air-filled cavity forming a part of said tread member, the volume of said cavity being variable with passage of vehicles thereover, an electrical switching device connected with said tread member for operation in accordance with the changes in pressure in said tread member, said switching device comprising a circular pipe, a circular diaphragm of a diameter slightly larger than that of said pipe arranged to be positioned at the upper edge of said pipe, said diaphragm having a downwardly extending flange arranged to surround the upper section of said pipe, a pair of contact points fixedly positioned relative to said pipe, a contact closing member supported by said diaphragm in location relative to the pair of contact points such that upon movement of the diaphragm the contact points are brought electrically together, terminal points for connecting an electrical circuit to said contact points, and means provided by said diaphragm movement under changes in the volume of fluid within the container for causing the said contact points to meet and for returning the contact points to their normally open state by pressure equalization within and without the chamber due to leakage beneath the diaphragm at time periods of initiation of the contact.

6. A pneumatically-operated electric switching device comprising, in combination, a vertical tubular element, an electrically-conducting diaphragm of a diameter slightly in excess of that of the tubular element positioned normally to rest upon the said tubular element, said diaphragm being provided with a downwardly-extending flange arranged to surround the upper portion of the vertical tubular element, a pair of contact points supported in fixed position relative to the tubular element, terminal points for connecting an external electric circuit to the pair of contact points, and a conduit connecting said tubular element with a control chamber element so that at periods of increases in fluid pressure within the control chamber the diaphragm is caused to move bodily upward to engage the pair of contact points to effect an electrical switching operation.

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The following references are of record in the file of this patent:

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