Aug. 19, 1947. C. S. SNAVELY 2,425,843

THREE POSITION ELECTROMAGNET

Filed Jan. 25, 1945

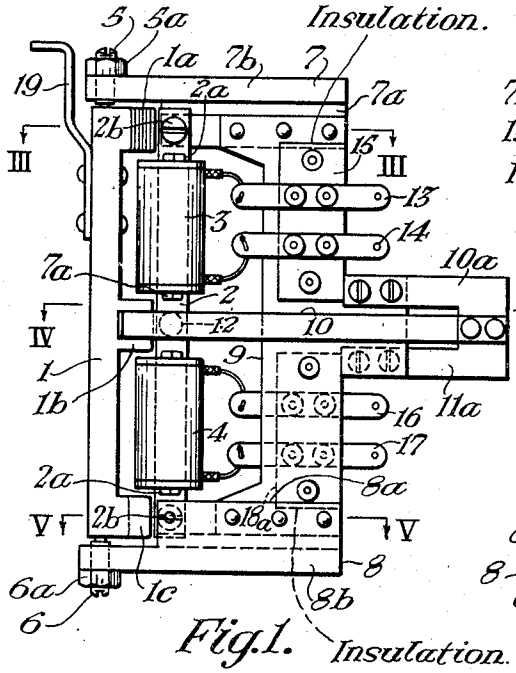


Fig.1.

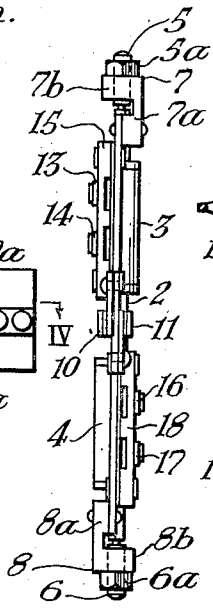


Fig.2.

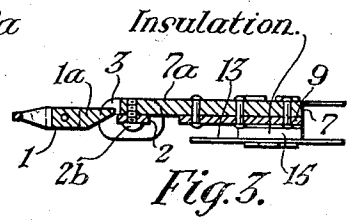


Fig.3.

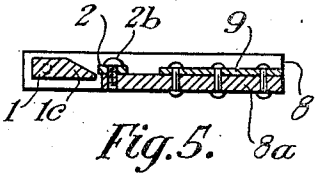


Fig.5.

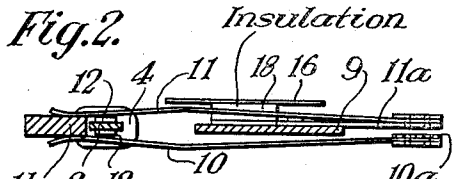


Fig.4.

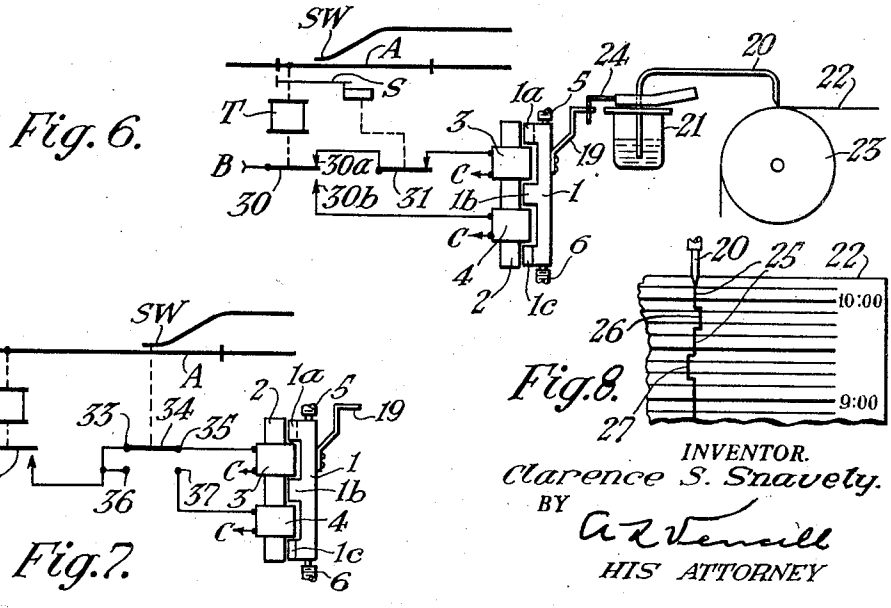


Fig.6.

Fig.7.

Fig.8.

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THREE-POSITION ELECTROMAGNET

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5 Claims. (Cl. 175—337)

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My invention relates to an electromagnet, and to control means therefor.

In certain forms of railway signaling systems, such for example, as centralized traffic controlling systems, an automatic recorder is provided to record the progress of trains moving along a stretch of railway track out in view of the train dispatcher. These recorders usually comprise a pen operatively connected with an associated electromagnet, and arranged to trace a line on a chart which is advanced at a uniform rate by suitable operating mechanism. Heretofore, the electromagnets for operating the pens have usually been of the type which are operated to one position or another in accordance with the presence or absence of a train in an associated indication section usually located at a track switch and generally referred to as an "OS" section. In some of the larger installations, a very large number of pens are required to accommodate the number of desired recording points, and to permit these pens to be mounted in the limited space available the magnets have to be of an extremely narrow design. One recorder which is being used commercially on a number of centralized traffic control installations, and which has become well standardized employs as many as 57 pens operated by magnets mounted on ⅜" centers.

Recent developments which have been made in centralized traffic controlling systems makes it desirable to record on the recorder not only the presence and absence of trains in the indication sections of the system, but also certain additional information, such as the position of a railway track switch, or the condition of a railway signal, associated with the section. Due to space limitations it is not practical to increase the overall size of the recorder, and one object of my invention is to provide an improved design of pen operating magnet which can be mounted in the same limited space heretofore available for the pen operating magnets, and which may therefore be applied to the existing recorder, but which is capable of operating the pens to an additional position to permit the recording of the desired additional information without increasing the space requirements for the recorder.

Another object of my invention is to provide a three position magnet of the type described employing two neutral windings.

Another object of my invention is to provide a magnet of the type described which can be mounted in a row with a plurality of other similar magnets with adequate clearance with only ⅜" between the mounting centers.

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Another object of my invention is to provide a magnet of the type described having improved operating characteristics over the prior type of magnets.

Still another object of my invention is to provide a magnet of the type described which is inexpensive to construct, operate and maintain.

A further object of my invention is to provide novel control means for the magnet.

According to my invention the magnet comprises a relatively thin flat magnetizable bar provided intermediate its ends with two longitudinally spaced energizing windings, and a magnetizable armature pivotally supported at its ends in the plane of the bar and provided with three spaced projections which extend toward the bar between, and on opposite sides, respectively, of the two windings, but which are spaced from the bar by air gaps. The armature is movable between an intermediate and two extreme positions, and is biased to its intermediate positions by relatively long flexible springs which cooperate at their free ends with the middle projection. The three projections are so shaped and the parts are so proportioned that when the one winding is energized the flux which is induced in said bar will traverse the middle and one outside leg to produce a torque which moves said armature to its one extreme position, but that, when the other winding is energized the flux which is induced in said bar will traverse the middle and other outside leg to produce a torque which moves said armature to its other extreme position.

Other objects and characteristic features of my invention will become apparent as the description proceeds.

I shall describe one form of electromagnet embodying my invention, and two forms of control means therefor, and shall then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a side elevational view showing one form of electromagnet embodying my invention. Fig. 2 is a right hand end view of the electromagnet shown in Fig. 1. Figs. 3, 4 and 5 are sectional views taken on the lines III—III, IV—IV, and V—V, respectively, of Fig. 1. Fig. 6 is a diagrammatic view showing an electromagnet embodying my invention applied to a recorder together with one form of control means for the electromagnet. Fig. 7 is a diagrammatic view showing another form of control means for the electromagnet. Fig. 8 is a fragmentary view of a part of a train graph as it appears when the recorder is equipped with an electromagnet embodying my invention.

Similar reference characters refer to similar parts in each of the several views.

Referring to the drawings, the electromagnet in the form here shown comprises a magnetizable armature 1 which cooperates with a relatively thin flat magnetizable bar 2 provided intermediate its ends with two longitudinally spaced relatively flat energizing windings 3 and 4. The armature 1 is pivotally supported at its ends at one side of the bar 2 for swinging movement between an intermediate and two extreme positions by means of two trunnion screws 5 and 6 adjustably mounted in a suitable supporting frame, and is provided on one side with three projections 1a, 1b and 1c, the functions of which will be made clear presently.

The supporting frame may have any desired construction, but in the form here shown it comprises two similar horizontally arranged oppositely disposed vertically spaced non-magnetizable L-shaped end members or brackets 7 and 8 secured together at their right hand ends, as viewed in Fig. 1, by means of a yoke 9 riveted or otherwise fastened to the legs 7a and 8a of the brackets in such manner that the two brackets lie in the same vertical plane. The trunnion screws 5 and 6 are adjustably screwed through threaded holes provided in the legs 7b and 8b of the brackets 7 and 8, and are arranged to be locked in their adjusted positions by means of jam nuts 5a and 6a screwed onto the outer ends of the trunnion screws. The portions of the legs 7b and 8b which receives the trunnion screws project beyond the legs 7a and 8a a sufficient amount to provide clearance for the upper and lower ends of the armature, as will be obvious from an inspection of Fig. 1.

The magnetizable bar 1 is secured to the legs 7a and 8a in the plane of the armature 1 by means of screws 2b in such a position that the left hand edge of the bar (as viewed in Fig. 1) is spaced from the projection 1a, 1b and 1c by small air gaps. The energizing windings 3 and 4 are somewhat shorter than the spaces between the armature projections, and are secured to the bar 2 directly opposite the spaces between these projections by means of cotter keys 2a. It will be seen, therefore, that when the winding 3 becomes energized the resultant flux induced in the bar 2 will traverse the armature 1 by way of the projections 1a and 1b, whereas when the winding 4 is energized, the resultant flux induced in the bar 2 will then traverse the armature 1 by way of the projections 1b and 1c. The armature 1 is somewhat thicker than the bar 2, and as shown in Fig. 4, the middle projection 1b has the same thickness throughout as the armature. This thickness is such that the end of the projection will remain in alignment with the contiguous edge of the bar 2 in all three positions of the armature. The upper projection 1a, however, has one side beveled off, as shown in Fig. 3, in such manner that the end of this projection will align with the edge of the bar 2 when and only when the armature is rotated to its one extreme position, and the lower projection 1c likewise has one side beveled off, as shown in Fig. 5, in such manner that it will align with the edge of the bar 2 when and only when the armature is rotated to its other extreme position. It follows, that when the upper coil 3 is energized the resulting magnetic forces which are set up will rotate the armature to its one extreme position, whereas when the lower coil 4 is energized the resulting magnetic forces will rotate the armature to its other extreme position.

The middle projection 1b of the armature, in addition to serving as a common part of the two magnetic circuits through the armature, also cooperates with two leaf springs 10 and 11 which bias the armature to its intermediate position. These leaf springs are similar, and are secured at one end to opposite sides of the yoke 9 through the medium of similar L-shaped supporting strips 10a and 11a, respectively. The springs cooperate adjacent their free ends with stop pins 12 (see Fig. 4) secured to opposite sides of the bar 2. The springs are adjusted by bending them so that when the armature is in its mid stroke position the springs will just touch the armature and the stop pins. To reduce friction and wear to a minimum the portions of the springs which engage the armature are preferably bent into a gradual curve and are chromium plated.

The terminals of the winding 3 are soldered to terminal strips 13 and 14 mounted on an insulating terminal board 15, and the terminals of the winding 4 are similarly soldered to terminal strips 16 and 17 mounted on an insulating terminal board 18. The two terminal boards are identical, and are secured to the opposite sides of the yoke 9 directly opposite the associated winding, in any suitable manner as by riveting.

Attached to the upper end of the armature 1 is a driving arm 19 for engagement with, and operation of, the pen of a graphic recorder, one well known form of which is shown diagrammatically in Fig. 6. Referring to Fig. 6, the pen of the recorder here illustrated is designated by the reference character 20, and is pivotally supported in an inkwell 21 in such manner that the point of the pen will trace a line on a chart 22 (see Fig. 8) which is moved over a roller 23 underneath the pen at a uniform rate by suitable driving mechanism not shown. The pen is operatively connected with the arm 20 of the electromagnet by means of a forked arm 24 which straddles the arm 20, and it will be seen therefore that the pen will occupy its intermediate position or will be moved to one extreme position or another according as the armature 1 occupies its intermediate position or is operated to one extreme position or the other. When the pen occupies its intermediate position it will trace a line along the path 25 on the chart 22, but when the pen is moved to its one extreme position it will then trace a line along the path 26, and when it is moved to its other extreme position it will trace a line along the path 27 on the chart. It will be obvious that the three paths are readily distinguishable from each other on the chart.

Graphic recorders embodying my invention may be used for any desired purpose where it is advantageous to have the pens trace lines in three distinctive paths. However, as was pointed out hereinbefore they are particularly useful in centralized traffic controlling systems for railroads, and when so used the two windings 3 and 4 may be controlled either as shown in Fig. 6 or Fig. 7. Referring again to Fig. 6, as here shown, the winding 3 is provided with an energizing circuit which passes from terminal B of a suitable source of current not shown in the drawing through a front contact 30—30a of a track relay T which is energized or deenergized according as an indication or "OS" section A provided with a switch SW is unoccupied or occupied, a contact 31 which is controlled in accordance with the position of a signal S governing the entrance of

trains into the section and which is closed only when the signal is clear, and the winding 3 to the other terminal C of the source; while the winding 4 is provided with an energizing circuit which passes from terminal B of the source through back contact 30—30b of the track relay T, and through the winding 4 to the terminal C of the source. With the electromagnet controlled in this manner when the section A is unoccupied and the signal is at stop, both windings 3 and 4 are then deenergized and the pen will trace a line on the chart along the path 25. When, however, the section A is unoccupied and the signal is clear the winding 3 will be energized and the pen will trace a line along the path 26; and when the section becomes occupied, the winding 4 will become energized and the pen will then trace a line along the path 28. The lengths of the various paths will indicate the duration of the particular condition indicated by the path, and it follows that the chart shows the occupied or unoccupied condition of the section, the condition of the signal S associated with the section and the exact time when a train entered, as well as the time when the train departed from the section.

Referring now to Fig. 7, as here shown, the winding 3 of the electromagnet is provided with an energizing circuit which passes from terminal B of the source through a back contact 32 of the track relay T, a contact 33—34—35 controlled in accordance with the position of switch SW and closed only when the switch A occupies its normal position, and the winding 3 to the other terminal C; while the winding 4 of the electromagnet is provided with an energizing circuit which passes from terminal B of the source through back contact 32 of relay T, a contact 36—34—37 controlled in accordance with the position of switch SW and closed only when the switch occupies its reverse position, and the winding 4 to the other terminal C of the source.

With the electromagnet controlled as shown in Fig. 7, whenever the section A is unoccupied, the pen will trace a line along the path 25, but when the section becomes occupied the pen will then trace a line along the path 26 or 27, according as the switch occupies its normal or its reverse position. It follows that the graph will indicate the time of entry of a train into the section A, the duration of occupancy of the section, and the route followed by the train.

The advantage of an electromagnet embodying my invention is that it produces a very definite angle of rotation of the armature in either direction from its normal or intermediate position, and requires no stops for limiting the stroke of the armature. This produces the maximum freedom of action with the minimum possibility of sticking, such as might develop if physical stops were provided for the armature and dirt were allowed to accumulate on these stops. Moreover, this arrangement of the parts provides a better cushioning action at the ends of the armature stroke than would be the case if the armature were allowed to strike fixed stops. This is a distinct advantage when the electromagnet is used to operate inking pens in the intended manner because it minimizes the tendency to overthrow, spatter ink, etc.

Another advantage of an electromagnet embodying my invention is that since the armature is of the rotary motor type rather than the usual lifting type there is less difference of torque between the initial and final stroke positions of the

armature. In the case of the lifting type of armature as ordinarily used in electrical relays, the magnetic pull greatly increases toward the end of the stroke, and the resulting impact against fixed core pins is undesirable for the operation of inking pens due to the tendency of such action to throw ink and smear the record.

Another advantage of an electromagnet embodying my invention is that the springs which bias the armature to its mid stroke position are relatively long. The use of long springs produces a uniform load condition throughout the armature stroke which load condition can be made to closely match the flat torque condition produced by the electromagnet. This matching of the mechanical and magnetic torque makes it possible to more closely equalize the thrust action on the recording pens for both pick up and release action. In this connection it should be noted that the work necessary for operation of the pens in either direction, that is, for pick up and release of the armature is theoretically of the same order.

Although I have herein shown and described only one form of electromagnet embodying my invention, and two forms of control means therefore, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. A three position electromagnet comprising a magnetizable bar, two windings disposed on said bar intermediate its ends in longitudinally spaced relation, a magnetizable armature pivotally supported at its ends at one side of said bar for swinging movement about its longitudinal axis between an intermediate and two extreme positions and biased to its intermediate position, said armature being provided with three spaced projections extending toward said bar in such manner that the flux set up in said bar when said one winding is energized will traverse the middle and one outside projection to produce a torque which urges said armature to its one extreme position but that the flux set up in said bar when said other winding is energized will traverse the middle and other outside projection to produce a torque which urges said armature to its other extreme position.

2. A three position electromagnet comprising a magnetizable bar, two windings disposed on said bar intermediate its end in longitudinally spaced relation, a magnetizable armature pivotally supported at its end at one side of said bar for swinging movement about its longitudinal axis between an intermediate and two extreme positions and biased to its intermediate position, said armature being provided with three spaced projections extending toward said bar in such positions that flux will traverse the middle and one outside projection when said one winding is energized and the middle and other outside projection when said other winding is energized, said two outside projections being so shaped and so positioned with respect to said bar that said armature will move to its one or its other extreme positions according as the one or the other projection is traversed by flux due to the energization of said one or said other winding.

3. A three position electromagnet comprising a magnetizable bar, two windings disposed on said bar, an armature pivotally supported at one side of said bar in the plane of said bar for swinging movement between an intermediate and two ex-

treme positions and provided with a middle and two outside projections which extend toward said bar between and on opposite sides of said two windings, respectively, and two flat springs cooperating with the opposite sides of said middle projection to bias said armature to its intermediate position, said projections being so shaped that a torque will be produced in said armature which urges said armature from its intermediate position to its one extreme position or the other according as said one winding or the other is energized.

4. A three position electromagnet comprising a flat relatively thin magnetizable bar, two windings disposed on said bar, an armature which is somewhat thicker than said bar pivotally supported at one side of said bar in the plane of said bar for swinging movement between an intermediate and two extreme positions and provided with a middle and two outside projections which extend toward said bar between and on opposite sides of said two windings, respectively, and means biasing said armature to its intermediate position, said projections being spaced from the edge of said bar by air gaps and being so shaped that the middle projection will remain in alignment with the edge of said bar in all positions of said bar but that the one outside projection will align with the edge of said bar when and only when said armature occupies its one extreme position and that the other outside projection will align with the edge of said bar when and only when said armature occupies its other extreme position, whereby said armature will occupy its intermediate position, its one extreme position, or its other extreme position according as both windings are deenergized or one winding or the other is energized.

5. An electromagnet comprising two similar oppositely disposed L-shaped end members secured together by a yoke attached to the one leg of each of said end members adjacent one end of the end members, a magnetizable bar secured

at its ends to said end members at one side of said yoke and provided intermediate its ends with two longitudinally spaced windings, an armature pivotally supported at its ends in said end member for swinging movement between an intermediate and two extreme positions, said armature being provided on one side with a middle and two outside projections which extend toward but are spaced from the adjacent edge of said bar between and on opposite sides of said two windings, respectively, two relatively long leaf springs secured at one end to said yoke by means of supporting brackets and engaging at their free ends at opposite sides of said middle projection, said springs acting to bias said armature to its intermediate position, and said projections being so shaped and the parts being so proportioned that said armature will move to its intermediate, its one extreme position or its other extreme position according as both windings are deenergized or one winding or the other is energized.

CLARENCE S. SNAVELY.

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