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F. X. REES  
ELECTROMAGNETICALLY OPERATED PRETENSIONED  
CONTACT SPRING  
Filed Feb. 9, 1946

2,490,280

FIG. 1.

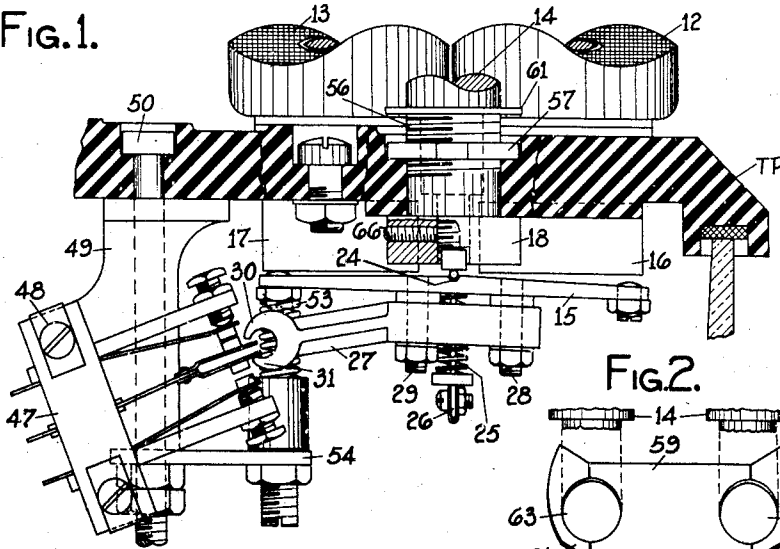


FIG. 2.

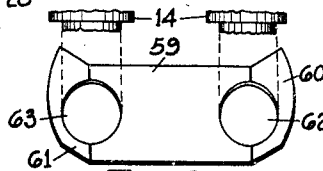


FIG. 4.

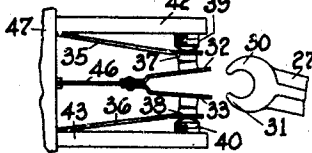


FIG. 5.

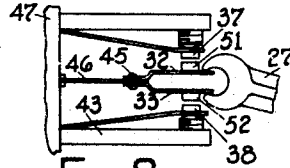


FIG. 6.

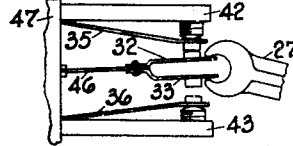


FIG. 7.

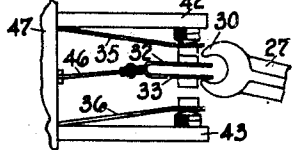


FIG. 8.

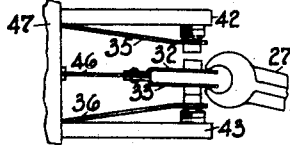


FIG. 9.

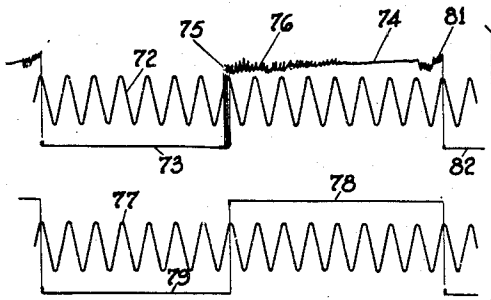
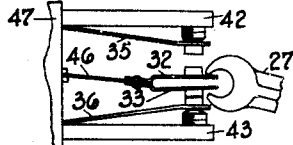


FIG. 10.

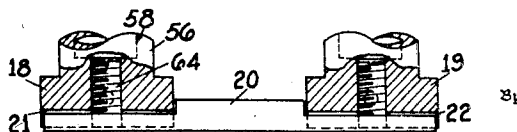
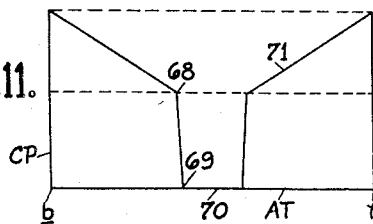


FIG. 3.

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## UNITED STATES PATENT OFFICE

2,490,280

## ELECTROMAGNETICALLY OPERATED PRE-TENSIONED CONTACT SPRING

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Original application March 29, 1944, Serial No. 528,556, now Patent No. 2,425,562, dated August 12, 1947. Divided and this application February 9, 1946, Serial No. 646,632

6 Claims. (Cl. 200—87)

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This invention relates in general to relays of the electromagnet type, and has more particular reference to an improved form of code following relay, adapted more particularly for use in connection with railway operation.

This application is a division of my prior application Ser. No. 528,556, filed March 29, 1944, now Patent No. 2,425,562, dated August 12, 1947.

The relay of the present invention is an improvement in the form of relay disclosed in the Field application, Ser. No. 351,003, filed August 3, 1940, for Relays, now Patent No. 2,360,644, dated October 17, 1944.

In the operation of relays of the type to which the present invention relates, there is a tendency upon movable contacts striking against fixed contacts, to vibrate and bounce for a short period of time, during which time the control circuits are not effectively made, and during which time there is excessive arcing at the contacts and burning of the points. This is particularly the case if the contacts carry heavy currents and the relay is energized at a low level in the interest of economy in operating costs. As a result, this faulty type of operation materially decreases the useful life of the relay contacts and reduces the efficiency and economy of operation and maintenance.

With the above and other considerations in mind, it is proposed in accordance with this invention, to provide a relay in which these defects are very largely obviated.

One of the objects of the present invention is to produce a relay wherein the movable contacts do not bounce or vibrate on the fixed contacts, whereby to vastly improve the operating characteristics of relays of this type.

Another object of the present invention is to produce an improved, yet simple, form of adjusting means for the air gap between the armature and certain of its cooperating pole pieces.

Further objects, purposes and characteristic features of this invention will appear as the description progresses, reference being made to the accompanying drawings showing, solely by way of example, and in no manner whatsoever in a limiting sense, one form which the invention can assume.

In the drawings:

Fig. 1 is a fragmentary sectional view, with parts shown in elevation, of a relay constructed in accordance with the present invention.

Fig. 2 is a fragmentary view of a detail of construction.

Fig. 3 is a fragmentary view, with parts shown in section, of air gap adjusting means.

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Figs. 4-9 are fragmentary views showing various operative positions of the relay contacts.

Fig. 10 is a view showing operative characteristics of a relay in accordance with this invention.

Fig. 11 is a view showing oscillograms of current conditions in a conventional relay and in a relay in accordance with the present invention.

Referring now to the drawings, a fragmentary portion of a relay, in accordance with this invention, is shown in Fig. 1. Only such parts of the relay will be described as are necessary for a complete understanding of this invention. The relay is shown as of the polar neutral type, but can, of course, be of any other type, and is biased by spring means to make up its back contacts, whereby it responds only to current of a particular polarity, to move its movable contact fingers so as to make up its front points. This operation is the same as set forth in the Field application, above referred to.

The relay includes a top plate TP, on which are supported the electromagnetic operating means 12 and 13, and the permanent magnets 14. The relay includes an armature 15, cooperating with the electromagnet pole pieces 16 and 17, and the permanent magnet pole pieces or shoes, 18 and 19. The armature rocks on a bearing comprising a hardened bearing block 20, extending across the permanent magnet pole shoes and received in slots in the shoes, as shown at 21 and 22 (Fig. 3). Between the block 20 and the armature, and received in a V-shaped slot in the armature, is a cylindrical pivot rod 24.

The armature is shown in its spring biased position, that is, rocked clockwise so as to bear against the electromagnet pole shoe 17 by adjustable spring bias means 53 and 54. The armature is supported by a spring supporting means 25, suitably carried by, and adjustable on, a support arm 26, carried by the top plate.

Connected to, and carried by, the armature is an operating arm 27, having one end fastened to the armature, as by bolts 28 and 29. The operating arm 27 terminates, at its outer end, in a tong-like jaw having an upper portion 30, and a lower portion 31, which jaw receives, and holds in compressed, pretension fashion, spaced contact fingers 32 and 33.

These contact fingers 32 and 33 constitute movable fingers which are operated by the jaw portions 30 and 31, by means of the armature of the relay, and cooperate with fixed contact fingers 35 and 36. The contact fingers 35 and 36 carry contact points 37 and 38, and are backed up by adjusting screws 39 and 40 carried by stiff, ab-

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solutely rigid arms 42 and 43, whereby to make the back contacts absolutely fixed and unyielding when the movable contacts strike them.

The movable contact fingers 32 and 33 are made of relatively thin, light springy ribbon like material, are relatively short in length, and are connected at one end, as at 45, to a short light spring member 46, which, together with arms 42 and 43, are carried by a contact block 47, connected as by screws 48, to a bracket 49, supported from the top plate as by bolts 50.

As shown in the drawings, the movable contact fingers 32 and 33, carry contact points 51 and 52, for cooperating, respectively, with the fixed contact points 37 and 38.

The armature is biased to its deenergized, or non-operative polarity position, by the means 53 and 54. Thus, the relay, as shown in Fig. 1, can be considered to be making up its back points, in which condition the movable contact point 51, is in contact with the fixed contact point 37.

Means are provided, in accordance with this invention, to readily adjust the polar air gap between the armature and the permanent magnet pole shoes. The permanent magnets, as 14, are each received in a socket member 56, which constitutes the permanent magnet pole shoes 18, and is bolted to the top plate, as by means 57, as clearly shown in Fig. 1.

The permanent magnet, as 14, is received in a socket 58 in this receiving member, and is held against becoming loose by a spring locking means 59, as shown in detail in Fig. 2. This spring locking means 59 comprises a flat central portion with upturned ends 60 and 61, drilled as at 62 and 63, to receive the ends of the permanent magnets. When the parts are assembled the upsprung ends 60 and 61 are sprung, as shown in Fig. 1, between each permanent magnet and its receiving socket, and thus the spring operates to hold the two permanent magnets in fixed position and free from all vibration and play.

Extending from the lower face of each receiving socket, as the socket 58, is a drilled hole, which receives a threaded adjusting screw 64, which bears at its lower end against one end of the pivot bearing bar 20. This screw and the corresponding one in the other socket, can be moved inwardly or outwardly to position the bearing bar 20 a greater or lesser distance from the lower face of the permanent magnet pole shoes, whereby to vary the gap between the armature and the permanent magnet pole shoes. The adjusting screws, as 64, are held in adjusted position by set screws, as 66.

From the above description it can be seen that very rigid and quite immovable back and front fixed contact fingers and contact points are provided for cooperation with movable contact fingers which are relatively short and light. Hence, in making contact with either of the fixed contact points, there is but little energy in the movable fingers to tend to produce vibration, or bouncing, with respect to the fixed contact points. Furthermore, the armature, with its operating arm 27 for operating the movable contact fingers, does not carry the movable contact fingers, and hence the mass of the armature is not involved in tending to produce any bouncing, or vibration, upon making up of front, or back, points.

In Figs. 4-9 are shown various operative positions of the contacts of this invention, and it may be helpful to consider them somewhat in detail.

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In Fig. 4, the movable contact fingers are shown separate, and entirely free, from the operating arm 27. It can be seen that they are formed to have a natural bias to position them in a widely spaced relation, of an extent considerably greater than the spacing between the jaw parts 30 and 31. Thus, when these movable fingers are pressed towards each other so as to be received in the operating jaw parts, as shown in Fig. 5, there is a very considerable amount of trapped tension or pretension. This condition is shown in Fig. 5, and the operating arm 27 is shown in its position half-way between full deenergized, and energized, positions.

In Fig. 6 is shown the position of the contacts, and associated parts, when the operating arm 27 has moved the movable contact fingers so as to pass just very slightly beyond the point where the movable point 51 touches the fixed point 37 and thus to transfer the trapped tension in the movable finger 32, to contact pressure between the two contact points in contact with each other.

In Fig. 7 the parts are shown in the positions they assume when the back contact is fully made up. It can be seen that the operating arm 27 has moved somewhat further than as shown in Fig. 6, and that the upward jaw part 39, which in Fig. 6 is still in contact with its movable contact finger 33, is now spaced therefrom (Fig. 7), whereby to, in effect, largely separate the mass of the armature from contributing to any tendency for the contact points to vibrate or bounce. Also, further contact pressure has been developed.

In Fig. 8, the parts are shown in the positions assumed in moving from fully making up its back point, as shown in Fig. 7, to having just made up its front point. This corresponds to the showing in Fig. 6.

In Fig. 9 the parts are shown in the positions assumed when the front point is fully made up, and full contact pressure is realized; and this corresponds to the showing in Fig. 7, where the back point is fully made up and full contact pressure is realized.

In Fig. 10, is a diagrammatic showing of the above described operative characteristics of the contacts of this invention. Represented along the horizontal axis AT, is armature travel, while represented along the vertical axis CP, is contact pressure. As seen by the curves in this figure, the contact pressure is at a maximum at the armature position b, which is the position of the armature when the back contact is fully made up, as for instance, in the condition shown in Fig. 7. As the contact fingers move toward making up the front contact, and just before they break contact with the back contact, the contact pressure is as shown at 68, and is the pressure produced by the trapped tension in contact finger 32, and as can be seen, is about one-half of what the pressure is when the points are fully made up.

Upon a very slight further movement toward the front contact making position, the pressure on the back point falls to zero, as represented at 69. The condition when neither fixed contact point is made up, and the movable fingers are intermediate the front and back fixed contact points, is represented in Fig. 10 at the zero portion 70 of the curve. The contact pressure curve 71, for the front points, is identical with the one just described. This portion 71 has a portion made up by the trapped tension, and a further portion made up by further armature travel.

Referring now to Fig. 11, there are here shown two oscillograms, the lower of which represents contact current conditions in an improved relay

in accordance with the present invention, while the upper represents the corresponding characteristics in a conventional type of relay. Such relay is one in which the contact fingers are carried by the armature, and in which there is no pretension or trapped tension in the contact fingers.

Referring first to the upper oscillogram, the tracing 72, is produced by an alternating current of 60 cycles and furnishes a suitable scale for reading elapsed time. The other tracing in this oscillogram represents the amount of current flowing through a movable contact point, and hence is a measure, under fixed conditions of voltage, etc. of the resistance between the movable contact point and its fixed point. The portion 73 of the curve indicates that the contacts are fully open and no current flows through the movable contact point. In other words, there is a sufficient gap, as when the contact points are open to prevent all current flow. The portion 74 of the curve represents current flow at its highest level, and thus represents the condition with the contacts fully made up, and with full pressure. In the conventional relay, on making up a movable point with a fixed point, there is considerable vibration and bouncing for a considerable period of time. During this time the resistance across the points varies widely from the minimum, when the contact pressure is fully established, to a resistance equal substantially to that when the contacts are fully open.

In the oscillogram, the portion 75 of the curve, comprising a series of vertical lines arranged closely side by side, and connecting the lower and upper lines 73 and 74, indicates that, for a period of time, the contact point resistance varies back and forth from a maximum to a minimum. After this, as represented by the portion 76 of the curve, the resistance fluctuates considerably, but within narrower limits than earlier, and changes, over a period of two or three cycles of the 60 cycle current, from a minimum resistance, to a very substantially increased resistance.

As a result, it can be seen from this oscillogram that, upon making up a movable contact with a fixed contact (in the conventional relay), the circuits thus controlled, are not properly closed for a considerable period of time at the beginning of the circuit closed period, and that during this time a very considerable amount of sparking and burning and even mechanical wear, of the contact points, necessarily takes place.

Referring now to the lower oscillogram, the 60 cycle timing tracing is represented at 77, the maximum level of current flow is represented at 78, and the period of zero current flow is represented at 79. It can be seen from this oscillogram that no current flows when the contacts are open and that, upon the movable contact touching the fixed contact, the circuit is at once closed with the minimum resistance, so that, for the entire period of contact closed condition, current flows in the circuit at a uniform, and the highest, level. As a result, substantially all arcing and burning of contacts, and mechanical wear of the same, is obviated, and the relay is much longer lived, and more dependable. Also, the circuits controlled, as, particularly, in the case of a relay following a relatively fast code, are controlled much more accurately and dependably.

Thus, in applicant's relay, unlike the conventional relay, there is no tendency, during mid stroke and at the time contact is made, to vibrate

or whip, because of the fingers being held, with trapped tension, in the operator.

Also, the anvil effect, i. e. the tendency for the finger to bounce off of the fixed contact so generally present in conventional constructions, is largely eliminated in applicant's relay, due to the high degree of trapped tension in comparison with the small mass of the moving parts involved.

While the proportions, and relative amounts of movement, of the various parts of this relay, can be varied within any reasonable limits, without departing from the spirit of the present invention, it should be understood that the construction described above, and the relative lightness of the fingers, and amounts of trapped tension, and movements, are to a large extent an essential part of the present invention. While not restricting the invention to any particular set of values, one set which has been found in actual practice, to work out to distinct advantage, may well be given. It is a relay constructed in accordance with this particular set of values, that produced the oscillograph readings shown in the lower oscillogram of Fig. 11.

In this relay, the full contact finger pressure is 55 grams, while the trapped tension is 30 grams. The travel from full contact pressure to trapped tension pressure, that is, on Fig. 10, the horizontally measured distance from the point *b* to the point 68, is .025", and the movement, measured horizontally from the point 68, to the point 69, is something less than .001". The movement over the period where zero pressure exists, is in the order of about .013". The spacing between the movable contact fingers 32 and 33, when they are open, as in Fig. 4, is about .110" while, when they are compressed so as to be received in operator 27, but still out of contact with either front or back fixed contacts, as in Fig. 5, the spacing between the fingers is about .070".

As indicated above, the relay of this invention is particularly adapted to be used to follow coded current, often times of a high rate, and to be energized from a track circuit. Thus, under varying weather conditions, the level of energy applied to the relay, and depended upon to produce proper relay operation, will vary widely from time to time. Furthermore, the utmost economy in energy consumption is sought.

Under conditions such as outlined above, the usual and conventional relay is often rather unsatisfactory, and is particularly so when the level of energization falls to its minimum. Under such conditions and requirements, however, relays constructed in accordance with this invention, perform in a most satisfactory manner, and thus solve the very difficult problem of providing a relay of satisfactory operative characteristics, even when employed so as to effect the maximum of economy in energy consumption, and under conditions of widely varying degrees of energization.

The above rather specific description of one form which the present invention can assume, is given solely by way of example, and is not intended, in any manner whatsoever, in a limiting sense. It is to be understood that various modifications, adaptations and alterations may, from time to time, be applied to meet the requirements of practice, without in any manner departing from the spirit or scope of the invention, except as may be limited by the appended

## What I claim is:

1. In an electromagnetic relay having a pivoted armature; an elongated contact operator fixed at one end to the armature and having two spaced opposed holding jaws on the other end, a fixed contact block, a back contact finger and contact point carried by the block, a movable contact finger carried by the block and comprising, a flexible arm carried by the block and two flexible ribbons each connected at one end to the flexible arm and having their other ends extending toward said jaws and received within the jaws and strongly biased apart so as to tend to further space the jaws, a movable contact point on one flexible ribbon and positioned between the jaws and the flexible arm and opposed to the back contact point, and means for moving the armature from a position where the contact points are spaced from each other, to a position beyond the place where the contact points first touch each other.

2. In an electromagnetic device having a pivoted armature; an elongated rigid contact operator fixed at one end to the armature and having two spaced opposed holding jaws at the other end, a fixed contact block, a rigid back contact finger and back contact point carried by the block, a flexible movable contact finger carried by the block and comprising a short flexible light arm carried by the block and two light flexible short ribbons each connected at one end to the flexible arm and having their other ends extending toward said jaws and received at their said other ends within the jaws and strongly biased apart so as to tend to further space the jaws, a movable contact point on one flexible ribbon and positioned between the jaws and the flexible arm and opposed to the back contact point, and means for moving the armature from a position where the contact points are spaced from each other to a position beyond the place where the contact points first touch each other.

3. In an electromagnetic device having a pivoted armature; an elongated rigid contact operator fixed at one end to the armature, two spaced opposed holding jaws at the other end of the operator, a fixed contact block, two spaced rigid contact fingers and contact points carried by the block, a movable contact finger fixed to the block between the rigid fingers and comprising a flexible arm fixed to the block and two flexible ribbon contact fingers each connected at one end to the flexible arm and having their other ends extending toward said jaws and received within the jaws and strongly biased apart so as to tend to further space the jaws, a movable contact on each flexible finger and each opposed to a contact point on a rigid finger, and means for moving the armature from a position beyond in one direction of where two opposed contacts first touch to a position beyond in the other direction of where the other two opposed contact points first touch.

4. In an electromagnetic device having a pivoted armature; an elongated contact operator fixed at one end to the armature and having two spaced opposed holding jaws on the other end, a fixed contact block, a back contact finger and contact point carried by the block, a movable contact finger carried by the block and comprising, a flexible arm carried by the block and two flexible ribbons each connected at one end to the flexible arm and having their other ends extending toward said jaws and received within the jaws and strongly biased apart so as to tend to further

space the jaws, a movable contact point on one flexible ribbon and opposed to the back contact point, and means for moving the armature from a position where the contact points are spaced from each other, to a position beyond the place where the contact points first touch each other.

5. In a contact structure for use in an electromagnetic relay of the tractive type, two spaced fixed contacts insulated from each other, a spring arm anchored at one end adjacent said fixed contacts but insulated therefrom in a position to allow its free end to swing between such fixed contacts, two spring contacts attached to the free end of said spring arm and self-biased away from each other, an armature operated member having two spaced rigid fingers confining said two spring contact fingers within a limited space to produce an initial trapped pressure, said member being operable between two extreme positions, in one of which positions it causes one spring contact to engage one fixed contact with a pressure determined by the added compression of the other spring contact, and in the other of which positions it causes said other spring contact to engage the other fixed contact with a pressure determined by the added compression of said one spring contact, whereby each spring contact initially contacts its respective fixed contact with an initial trapped pressure to prevent its bouncing due to the impact.

6. In an electromagnetic relay having a pivoted armature, a contact block located to one side away from said pivoted armature, a spring arm anchored to one end to said contact block with its free end extending toward said pivoted armature, two spring members attached to the free end of said spring arm and tensioned so as to be biased away from each other, an operating arm attached to the armature and extending toward said contact block, said operating arm having two spaced rigid fingers grasping said two spring members for confining them to produce an initial trapped pressure, a contact point attached to one of said two spring members, and a fixed contact attached to said contact block and adapted to be engaged by said contact point on said spring member, whereby said operating arm is capable of closing and opening said contacts as it is operated to its two opposite positions, said contacts being initially made with trapped pressure equal to the tension of said spring members between said rigid fingers.

FRANK X. REES.

## REFERENCES CITED

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

## UNITED STATES PATENTS

| Number    | Name            | Date          |
|-----------|-----------------|---------------|
| 1,269,917 | Field           | June 18, 1918 |
| 1,799,629 | Lockhart et al. | Apr. 7, 1931  |
| 1,849,403 | Jefferson       | Mar. 15, 1932 |
| 1,958,646 | Snively et al.  | May 15, 1934  |
| 2,134,448 | Knos            | Oct. 25, 1938 |
| 2,197,607 | Brown           | Apr. 16, 1940 |
| 2,258,123 | Merkel          | Oct. 7, 1941  |
| 2,333,971 | Ashworth        | Nov. 9, 1943  |
| 2,360,664 | Field           | Oct. 17, 1944 |

## FOREIGN PATENTS

| Number | Country | Date          |
|--------|---------|---------------|
| 61,210 | Germany | Feb. 18, 1892 |