Feb. 16, 1954

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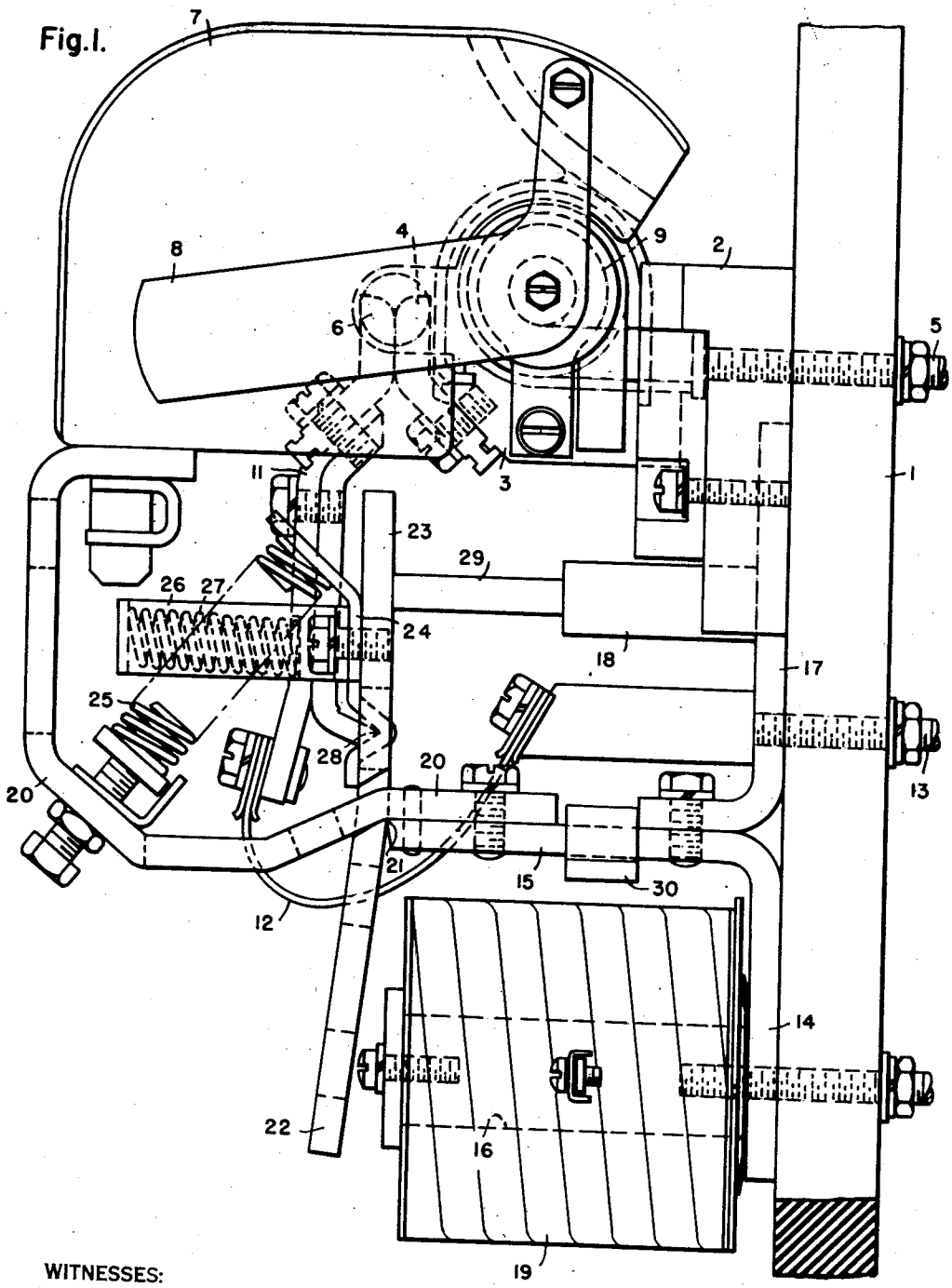
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ELECTROMAGNETIC CONTACTOR

Filed Nov. 28, 1951

2 Sheets-Sheet 1

Fig. 1.



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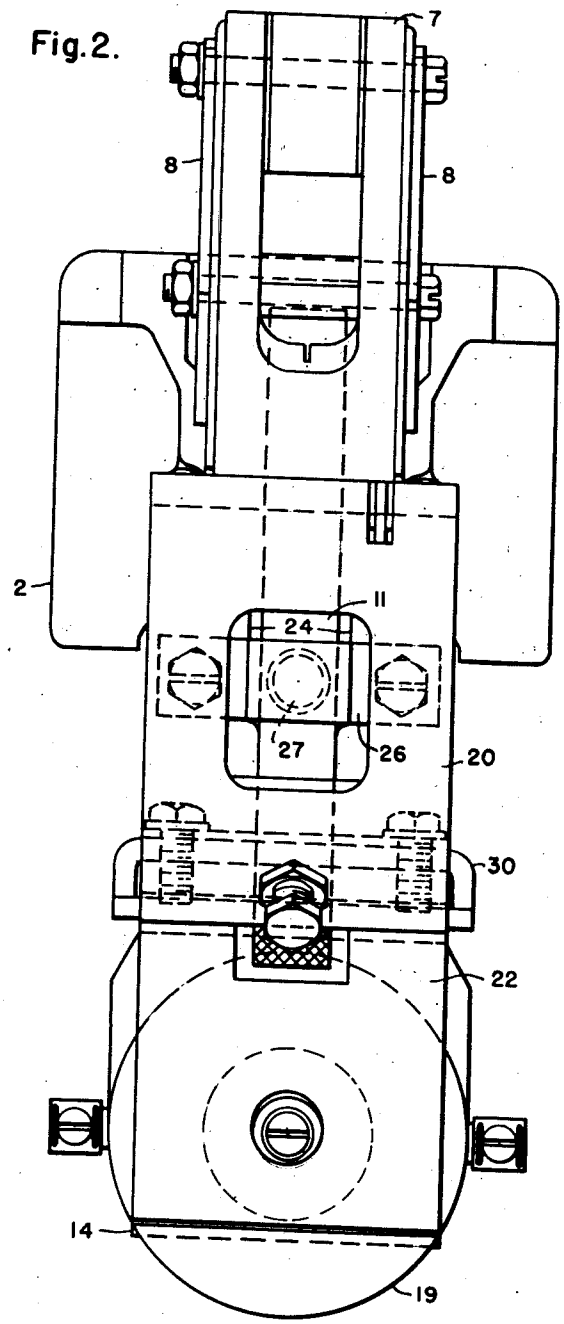
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2 Sheets-Sheet 2

Fig. 2.



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UNITED STATES PATENT OFFICE

2,669,620

ELECTROMAGNETIC CONTACTOR

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Application November 28, 1951, Serial No. 258,598

4 Claims. (Cl. 200—87)

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Our invention relates to electromagnetic relays, switches, and the like contactors whose armature is biased toward one position and magnetically moved to another position for controlling electric contacts by the armature movement. In a more specific aspect, our invention relates to contactors the contacts of which are normally closed by spring bias and opened by energization of a magnet coil preferably energized by direct current.

It is an object of our invention to reduce or eliminate the tendency of a sluggish or temporarily hesitant armature movement often encountered with such contactors. In conjunction therewith, it is also an object of the invention to permit increasing the current carrying capacity of the contact device of such contactors, or to reduce the sparking, contact burning, or sticking tendency that such contactors may show when operating with relatively high currents.

With particular reference to contactors with spring-closed and electromagnetically opened contacts, a more specific object of our invention will be explained in the following. Contactors of this type usually operate poorly as current interrupting devices. In order to keep the size of the magnet coil as small as possible, the armature closing or biasing spring should be just strong enough to overcome the opposing force of the contact pressure spring.

As a result, the armature is in nearly balanced condition when the contacts are closed. When the coil is energized, the magnetic flux builds up slowly due to the inductance of the coil. However, since the armature is nearly balanced, little flux is required to produce a magnetic pull sufficient to move the armature. Hence, the armature movement starts almost immediately. As long as the armature moves through its range of overtravel, the contacts remain closed. At the moment when the moving armature starts engaging the movable contact, the reaction force of the contact spring, which has been counteracting the force of the armature closing spring, is entirely lost. Hence, the force required to continue moving the armature goes up to a much higher value.

Since the magnet coil is building up its field rather slowly, it will likely not have enough pull as yet to overcome the increase in spring load that it now encounters. As a result, the armature tends to stop at the contact touch position until the coil flux has built up to a sufficiently high value. Under these conditions, the contact separation occurs initially at a relatively slow rate. This results in excessive contact burning,

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especially if relatively high current loads are to be interrupted. Besides, the inertia of the moving armature may cause the contacts to open a little and then to reclose before they are finally separated by the increased force of the magnetic pull. The arc drawn during such temporary opening may produce a small molten spot on the contact surfaces which may solidify during subsequent temporary closing of the contacts and then cause the contacts to stick. It is, therefore, also an object of our invention to eliminate the stopping or hesitating tendency of the armature at the contact touch position in order to avoid the just-mentioned detrimental effects.

One means of achieving to some extent the above-mentioned objects is disclosed in Patent No. 2,542,835, issued February 20, 1951, to Lawrence Pierce and assigned to the same assignee. According to the teachings of this patent the electromagnetic contactors are designed in such a manner that the coil-energized magnet or field structure and the armature of the contactor form together not only a main magnetic circuit or flux path for moving the armature against its spring bias but establish also an auxiliary magnetic circuit or flux path which extends in magnetic parallel relation to the main path and exerts a magnetic pull on the armature in the direction of the spring bias when the armature is in its biased position of rest.

The method and means of achieving the objects in accordance with our present invention gives much better results than any previously known. These objects we accomplish by providing a closed current conducting loop around a part of the flux path of the electromagnetic relay which is for the purpose of moving the armature against its spring bias. The current induced in the closed loop opposes the buildup of flux in the flux path until steady state conditions obtain, and thus the movement of the armature is prevented until such steady state conditions come about.

For a better understanding of our invention, reference should be had to the accompanying drawings, wherein:

Figure 1 shows a side view of an electromagnetic contactor of the preferred type; and

Fig. 2 shows a front view of the same electromagnetic contactor.

The illustrated contactor when properly installed is so directed that its base plate is attached to a vertical wall or panel so that the arc chute of the contactor lies on top and the magnet coil at the bottom of the installed apparatus as shown in Fig. 1.

An insulating body 2 is firmly secured to the base plate 1 and carries a standard 3 equipped with a stationary contact 4 which is conductively connected with a terminal screw 5. The movable contact to cooperate with the stationary contact 4 is denoted by 6. Both contacts are in use disposed within an arc chute 7 which is flanked by arcing horns, such as the one denoted by 8, between which a magnetic blowout is produced by means of a blowout coil 9. The blowout coil is electrically series connected between the stationary contact 4 and the appertaining terminal 5. The movable contact 6 is mounted on a rigid carrier 11 which is electrically connected by a flexible conductor 12 to a secondary terminal screw 13.

The field magnet of the contactor is a composite structure having a vertical element or base 14 integral with an arm portion 15 extending at a right angle to the base portion. A core 16 is firmly secured to the base 14 and extends parallel to the arm 15. A second vertical element 17 is firmly screwed to the arm 15 so as to form an aligned extension of the base 14. A magnetizable member 18 is attached to the second vertical element 17 and extends in parallel relation to arm 15 and core 16. It will be recognized that the stationary part of the magnetic frame or field structure just described has generally the shape of the letter E with three mutually parallel portions 15, 16 and 18 extending at a right angle to the elements 14 and 17. The control coil 19 for magnetizing the field structure is disposed on the core 16.

A bracket 20 is attached to the arm 15 and forms at the beveled end of arm 15 a pivot bearing 21 on which the armature is fulcrumed. The armature has generally the shape of a lever having two arms 22 and 23. A bracket 24, attached to the arm 23 of the armature, forms abutments for two parallelly disposed biasing or armature closing springs 25, only one of which is shown, whose respective other ends abut against adjusting screws mounted on the bracket 20. Attached to the armature arm 23 is a stirrup 26 which is equipped with a contact spring 27 whose lower end presses against contact carrier 11 and forces it towards the armature. The contact carrier 11 has a pivot edge inserted into a corresponding groove 28 of the bracket structure 24 so that the carrier 11 with contact 6 is capable of pivotal movement about the pivot axis in groove 28 in opposition to the contact spring 27.

The magnetizable member 18 has a smaller cross-section than the core 16 and hence has a higher magnetic reluctance. Member 18 is further provided with a neck portion 29 of still smaller diameter to provide a section of further increased magnetic reluctance. The free end of member 18 forms a stop which abuts against the armature arm 23 when the latter is in the illustrated contact-closing position.

A closed current conducting loop 30, preferably of copper strap brazed into a loop as shown more clearly in Fig. 2, is disposed around the arm 15 of the field magnet of the contactor. This conducting loop opposes the build-up of flux in the arm 15 until the flux in the core 16 builds up to its steady state value.

The above-described field structure and armature form together two magnetic circuits or flux paths. The main magnetic circuit extends through the core 16, the vertical element 14, the arm 15, and the armature arm 22. This main

circuit when magnetized by the coil 19, provides the magnetic pull for moving the armature and the associated contact structure into the contact opening position. The secondary auxiliary magnetic circuit extends through the vertical element 17, the member 18, and the arm 23 of the armature thus is disposed in magnetic parallel, or shunt, relation to the main magnetic circuit. Due to the above-mentioned dimensions of the magnetizable member 18, the auxiliary magnetic circuit has higher reluctance than the main magnetic circuit. When the coil 19 is energized, it takes a certain time period for the flux through core 16 to build up to its steady state value. During this period some flux builds up through the arm 15 causing a current to be induced in the closed current conducting loop 30 which opposes the buildup of flux in the arm 15 thus forcing the flux to flow through magnetizable member 18. The member 18 then exerts a pull on arm 23 of the armature which is in the same direction as the force applied by armature closing spring 25. The effect is for the time being to lock the armature arm 23 to the magnetizable member 18 as shown in Fig. 1. When the flux reaches its steady state value, the current conducting loop 30 is no longer as effective to oppose the flux buildup in arm 15 and the armature arm 22. The sectional dimension of the neck portion 29 is so selected that at the conditions of steady state neck portion 29 is saturated and in consequence the arm 22 is pulled against core portion 16 very rapidly. This arrangement insures against creepage of the armature.

A definite instantaneous release value is thus secured by the reduced section of member 18, at 29. The cross-section and length of portion 29 determine the flux value at which the iron becomes saturated. Hence, the magnetic pull produced by the auxiliary magnetic circuit increases only to a predetermined maximum which is at the steady state condition of the flux. When the flux reaches its steady state value, the current conducting loop 30 becomes substantially ineffective and thereafter the flux increase in arm 15 and arm 22 of the armature is quite rapid, causing the armature to move to contact open position very rapidly. Thus the armature does not start to move until the flux through the arm 15 reaches a relatively high value and the armature will close very rapidly because maximum flux is available to act on it. Further, once the armature starts moving, the magnetic pull of the flux through 29 decreases very rapidly by reason of the increased air-gap between arm 23 and neck portion 29.

It is to be particularly understood that the invention is not limited to or by the embodiment illustrated, but that the inventive scope is defined in the appended claims.

We claim as our invention:

1. In an electromagnetic contactor device, a magnetizable field structure having a core portion and an arm portion extending substantially parallel with each other, an armature pivoted on the arm portion and having two arms of which one forms a main flux path together with the core portion and the arm portion, a stationary contact, a movable contact mounted on the other arm to cooperate with the stationary contact, a spring biasing the armature toward closed position of the contacts, a coil disposed on the core portion for moving the armature toward open position of the contacts in opposition to the biasing spring when the coil is energized,

a magnetizable member disposed between the field structure and said other arm of the armature and spaced from the core portion to form an auxiliary flux path together with said other arm for exerting magnetic pull on the said other arm in the biasing direction of the biasing spring, the member extending parallel to the core portion and having a higher magnetic reluctance than the core portion, the member thus being adapted to saturate when the attractive force of the core portion exceeds a given value sufficient to move the armature toward open position of the contacts against the spring bias and magnetic pull, and a closed current conducting loop around part of the arm portion in the main flux path to delay movement of the armature until the flux reaches its steady state value.

2. An electromagnetic contactor consisting of a magnetizable field structure having a core portion and an arm portion extending substantially parallel with each other, an armature pivoted on the arm portion and having two arms of which one forms a main flux path together with the core portion and the arm portion, a stationary contact, a movable contact mounted on the other arm and capable of limited movement relative thereto, a spring biasing the armature toward closed position of the contacts, a contact pressure spring adapted to be stressed in opposition to the biasing spring when the armature is in said position, a coil disposed on the core portion for moving the armature toward open position of the contacts in opposition to the biasing spring when the coil is energized, a magnetizable member disposed between the field structure and said other arm of the armature and spaced from the core portion to form an auxiliary flux path together with said other arm for exerting magnetic pull on the said other arm in the biasing direction of the biasing spring, the member extending parallel to the core portion and having a higher magnetic reluctance than the core portion, the member being adapted to saturate when the attractive force of the core portion exceeds a given value sufficient to move the armature toward open position of the contacts against the spring bias and magnetic pull, and a closed current conducting loop around part of the arm portion in the main flux path to lock the armature in contact closed position until the flux reaches its substantially steady state condition.

3. A normally closed electromagnetic contactor, comprising a magnetizable field structure having a core portion and an arm portion extending substantially parallel to each other, an armature pivoted on said arm portion and having two arms of which one forms a main flux path together with the core portion and the arm portion, a stationary contact, a movable contact mounted on the other arm and capable of limited movement relative to said other arm, a spring biasing the armature toward closed position of the contacts, a contact pressure spring disposed between the movable contact and the other arm so as to be stressed in opposition to the biasing spring when the armature is in said position, a coil

disposed on said core portion for moving the armature toward open position of the contacts in opposition to the biasing spring when the coil is energized, a magnetizable member disposed between the field structure and the other arm and spaced from the core portion to form an auxiliary flux path together with said other arm for exerting magnetic pull on said other arm in the biasing direction of said biasing spring, the member extending parallel to the core portion and having a higher magnetic reluctance than the core portion, the member being saturable when the attractive force of the core portion exceeds a given value sufficient to move the armature toward the open position of the contacts against the combined spring bias and magnetic pull, and a closed current conducting loop around part of the arm portion in the main flux path to lock the armature in contact closed position until the flux reaches its steady state condition.

4. An electromagnetic contactor, comprising a field magnet having the shape of the letter E; the three parallel legs of the E being a core portion at one end, a magnetizable member at the other end, and an arm portion forming the center arm, the magnetizable member having over a certain portion of its length a smaller transverse cross section than the core portion to thus have a higher reluctance than the core portion and having a neck portion of selected further reduced cross section near its outer end to further increase the reluctance of the magnetizable member; an armature pivoted on the arm portion and having two arms of which one forms a main flux path together with the core portion and arm portion, the other arm together with the magnetizable member forms an auxiliary flux path; a stationary contact, a movable contact mounted on said other arm and capable of limited movement relative to said other arm, a spring biasing the armature toward closed position of the contacts, a contact pressure spring disposed between the movable contact and said other arm so as to be stressed in opposition to the biasing spring when the armature is in the contact closed position, a coil disposed on the core portion for moving the armature toward open position of the contacts in opposition to the biasing spring when the coil is energized, and a closed current conducting loop around the arm portion of the field magnet to delay movement of the armature from its contact closed position until the flux reaches its steady state condition.

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