

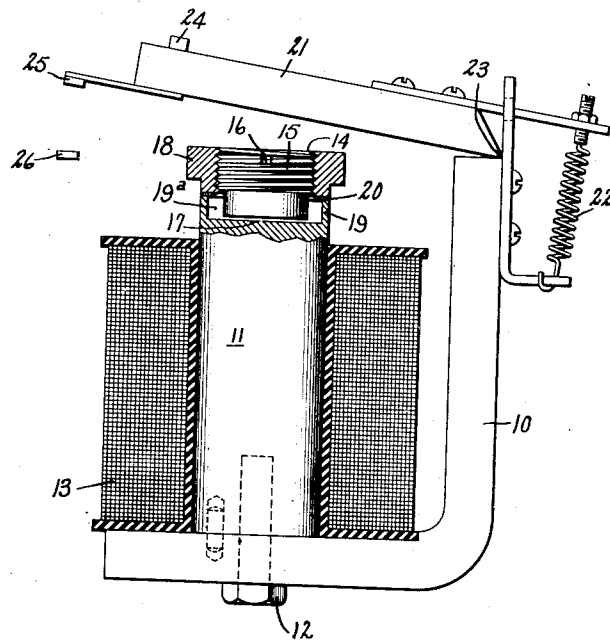
May 4, 1943.

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2,318,359

ELECTROMAGNET

Filed July 30, 1941



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UNITED STATES PATENT OFFICE

2,318,359

ELECTROMAGNET

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Application July 30, 1941, Serial No. 404,655

5 Claims. (Cl. 175—336)

My invention relates to electromagnets and has for its object a simple and inexpensive construction of the magnetic core providing an adjustable air gap in the magnetic circuit.

My invention is especially useful in direct current electromagnets for operating electric switches wherein a predetermined adjustable time interval is desired in the release of the armature after the operating coil of the electromagnet has been deenergized. This time interval may be obtained by means of a short-circuited conductor, such as by short-circuiting the operating coil or by means of a closed cylinder on the magnet core. A relay of that type is disclosed, for example, in United States Patent 1,919,991, issued on July 25, 1933, to George B. Starie.

Also, my invention is useful in magnets which are adjusted so that the armature drops out, i. e., moves in accordance with its bias to its unattracted position, when the current in the coil of the magnet decreases to a predetermined low value. My invention provides in such magnets for a small air gap which can be adjusted with precision so as to adjust thereby with precision the dropout current value of the magnet.

In carrying out my invention in one form I divide the magnetic flux path into two paths, one of which has a fixed magnetic reluctance while the other is adjustable. In one form of my invention, I provide an adjustable plug of magnetic material in a recess in an end of one leg of the magnetic circuit, with the annular portion or wall of the leg around the plug forming a pole face for engagement with the armature of the magnet. Thus one flux path is directly through the annular portion or wall while the other path is from the annular portion through the plug and through an air gap between the end of the plug and the bottom of the recess. The first path through the annular portion is of restricted cross section to increase its reluctance and preferably also provided with an air gap as by the insertion of a layer of non-magnetic material. Thus by adjusting the position of the plug very sensitive and accurate control of the resultant air gap in the magnetic circuit is obtained and thereby an adjustment is obtained of the drop-out time of the magnet armature, or the drop-out current value of the magnet armature.

For a more complete understanding of my invention, reference should be had to the accompanying drawing, the single figure of which shows an electromagnet embodying my invention.

Referring to the drawing, I have shown my invention in one form as applied to a time ele-

ment relay of the type in which the operating coil or winding of the relay is short-circuited to give a predetermined time interval in the operation of the relay armature to its unattracted position.

The device, as shown, comprises a U-shaped magnetic circuit comprising an L-shaped iron core member 10 and a cylindrical iron core member 11 forming one leg of a magnetic circuit and secured to the member 10 by means of a suitable screw 12. Surrounding the leg 11 is an operating coil or winding 13.

In the exposed upper or outer end of the leg 11 is a tapped substantially central recess 14 into which fits a threaded plug 15 made of magnet iron material. The upper end of the plug is provided with a slot 16 to receive a screw driver by means of which the spacing between the lower or inner end of the plug and the bottom 17 of the recess can be adjusted to provide an adjustable air gap. Preferably, as shown, the internally threaded annular portion or ring 18 at the upper end of the leg is constructed as a separate part made of magnet iron and is secured to the upper end of the relatively thin integral wall 19 left by the central recess 19a in the upper end of the leg 11. A relatively thin annular layer or ring 20 of a non-magnetic material, such as copper or brass, is inserted between the parts 18 and 19, and the three parts are secured together integrally as by brazing or welding, preferably by brazing.

Thus the upper or outer end of the annular member 18 forms a pole face which is engaged by the armature 21 in its attracted position. As shown, it is provided with a flange to increase its pole face area. Also the plug 15 is short enough so that its upper or outer end is spaced from the plane of the pole face formed by the outer end of the annular member 18 and from the armature when in its attracted position far enough to provide a prohibitively long magnetic flux insulating air gap between the upper end of the plug and the armature, whereby substantially all the magnetic flux passes through the annular member 18 when the armature is in its attracted position. This construction provides two paths for the flux, one path leading from the armature through the member 18, the air gap 20 and the wall 19 to the main body portion of the leg 11. The other path is in shunt to the first path and leads from the member 18 through the plug and across the air gap between the lower end of the plug and the member 11. Preferably, as shown, the lower or inner end of the plug is provided with a portion which is substantially smaller in diameter than the recess 19a so that a prohibitively wide flux

insulating air gap is provided between the lower end portion of the plug and the wall 19 as compared with the air gap between the inner end of the plug and the bottom of the recess.

This arrangement of two parallel paths for the flux, one having a fixed reluctance and the other a variable reluctance, provides for a gradual change, by adjustment of the plug, in the total effective air gap in the magnetic circuit, with resulting finer and more accurate adjustment of the effective air gap and drop-out time of the armature or drop-out current value of the armature. It is important, however, that the relative reluctances of these two parallel paths be such that the appropriate division of flux for effective sensitivity of adjustment is obtained. This division of flux depends upon the physical size of the magnetic core, the method of obtaining time delay, and the range of time adjustment required. Obviously, if the reluctance of the path through the member 18, air gap 20, and wall 19 is relatively high, fine adjustment will be obtained only when the lower end of the plug 15 is spaced from the core to give a correspondingly high reluctance through that path also. Conversely, if the plug is screwed down close to the core to provide a short air gap and hence low reluctance through the path, then most of the flux will flow through the plug with consequent loss in sensitivity of the adjustment obtained by movement of the plug.

As shown, the armature 21 is biased by a spring 22 about a knife-edge bearing 23 at one end to its unattracted position against a suitable stop 24. Also, the armature is shown as provided with a movable contact 25 arranged to engage a stationary contact 26 when the armature is picked up by energization of the coil 13.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto, since many modifications may be made and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A magnet comprising a magnet core including a leg made of magnetic material, a substantially central recess in one end of said leg leaving a wall integral with said leg, the outer end of said wall forming a pole face, a plug made of magnetic material in said recess, means adjustably securing an outer end portion of said plug to an outer end portion of said wall in good electromagnetic flux conducting relation therewith and for movement of said plug in said recess to vary the air gap between the inner end of said plug and the bottom of said recess, said plug having an inner end portion of smaller diameter than said recess to provide a peripheral flux insulating air gap between said portion and said wall, and the outer end of said plug terminating inside of the plane of said pole face so as to be in magnetic flux insulating spaced relation with the plane of said pole face whereby substantially all of the magnetic flux passing through said leg is caused to pass through the outer end of said wall to said pole face, said plug and said air gap forming a magnetic flux path from the outer end of said wall to said leg in parallel with the magnetic flux path directly through said wall to said leg and the combined magnetic reluctances of said paths being adjustable by adjusting said plug in said recess thereby to adjust the length of said air gap.

2. A magnet comprising a magnet core includ-

ing a leg made of magnetic material, a recess in one end of said leg leaving a wall integral with said leg, a first ring made of non-magnetic material on the end of said wall forming a fixed first air gap, a second ring made of magnetic material on said first ring, said wall and said two rings being secured together to form a first magnetic flux path from the outer end of said second ring to the unrecessed portion of said leg, a plug made of magnetic material extending through said rings into said recess, means adjustably securing an outer end portion of said plug to an outer end portion of said second ring in good electromagnetic flux conducting relation therewith and for movement of said plug in said recess to vary the air gap between the inner end of said plug and the bottom of said recess, said plug being provided with an inner end portion of smaller diameter than said recess to provide a peripheral flux insulating air gap between said portion and said wall, and the outer end of said plug terminating inside of the plane of said pole face so as to be in magnetic flux insulating spaced relation with the plane of said pole face, said plug and said air gap forming a magnetic flux path from the outer end of said second ring to the unrecessed portion of said leg in parallel with said first flux path, and the combined magnetic reluctance of said paths being adjustable by adjusting said plug in said recess thereby to vary the length of said second air gap.

3. A magnet comprising a magnet core including a leg made of magnetic material, a substantially central recess in one end of said leg leaving a wall integral with said leg, a first ring made of non-magnetic material on the end of said wall forming a fixed first air gap, a second ring made of magnetic material on said first ring, said rings forming an extension of said recess and said wall and said two rings being connected together in integral relation with each other thereby to form a first magnetic flux path from the outer end of said second ring forming a pole face to the unrecessed portion of said leg, a plug made of magnetic material in said recess, means adjustably securing an outer end portion of said plug to an outer end portion of said second ring in good electromagnetic flux conducting relation therewith and for movement of said plug in said recess to vary the air gap between the inner end of said plug and the bottom of said recess, said plug being provided with an inner end portion of smaller diameter than said recess to provide a peripheral flux insulating air gap between said portion and said wall, and the outer end of said plug terminating inside of the plane of said pole face so as to be in magnetic flux insulating spaced relation with the plane of said pole face, said plug and said air gap forming a magnetic flux path from the outer end of said second ring to the unrecessed portion of said leg in parallel with said first flux path, and the combined magnetic reluctance of said paths being adjustable by adjusting said plug in said recess thereby to vary the width of said second air gap.

4. A magnet comprising a magnet iron core including a leg made of magnetic material, a recess in the end of said leg providing a wall made of magnet iron integral with said leg and extending around the periphery of said leg, a first ring made of non-magnetic material on the end of said wall forming a fixed first air gap, a second ring made of magnetic material on said first ring, said second ring being provided with a bore tapped at its outer end and its outer end forming

a pole face, said wall and said two rings being connected together in integral relation with each other thereby to form a first magnetic flux path from said pole face to the unrecessed portion of said leg, a plug made of magnetic material having external threads on an outer end portion fitting into said tapped bore with its outer end in magnetic flux insulating spaced relation with the plane of said pole face and its inner end in abutting spaced relation with the bottom of said recess to form an adjustable second air gap, said plug being provided with an inner end portion of smaller diameter than said recess so as to provide a peripheral flux insulating air gap between said portion and said wall and said plug and said second air gap forming a magnetic flux path from said second ring to the unrecessed portion of said first leg in parallel with said first flux path, said plug being adjustable by turning it to vary the length of said second air gap thereby to vary the combined magnetic reluctance of said paths constituting the effective air gap in said first leg.

5. A magnet comprising a U-shaped magnet iron core, a coil on a first leg of said core, an armature pivotally mounted on a second leg of said core movable when said coil is energized toward said first leg to an attracted position, a recess in the end of said first leg providing a wall made of magnet iron integral with said first leg and extending around the periphery of said leg, a first ring made of non-magnetic material on

the end of said wall forming a fixed first air gap, a second ring made of magnetic material on said first ring, said second ring being provided with a bore tapped at its outer end and its outer end forming a pole face for engagement by said armature, said wall and said two rings being connected together in integral relation with each other thereby to form a first magnetic flux path from said pole face to the unrecessed portion of said leg, a plug made of magnetic material having external threads on an outer end portion fitting into said tapped bore with its outer end in magnetic flux insulating spaced relation with the plane of said pole face and its inner end in abutting spaced relation with the bottom of said recess to form an adjustable second air gap, said plug being provided with an inner end portion of smaller diameter than said recess so as to provide a peripheral flux insulating air gap between said portion and said wall and said plug, and said plug and second air gap forming a magnetic flux path from said second ring to the unrecessed portion of said first leg in parallel with said first flux path, said plug being adjustable by turning it to vary the length of said second air gap thereby to vary the combined magnetic reluctance of said paths constituting together the effective air gap in said first leg, and means for moving said armature to an unattracted position when said coil is deenergized.

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