

July 13, 1943.

A. J. McMASTER

2,324,265

D'ARSONVAL RELAY

Filed July 19, 1940

Fig. 1

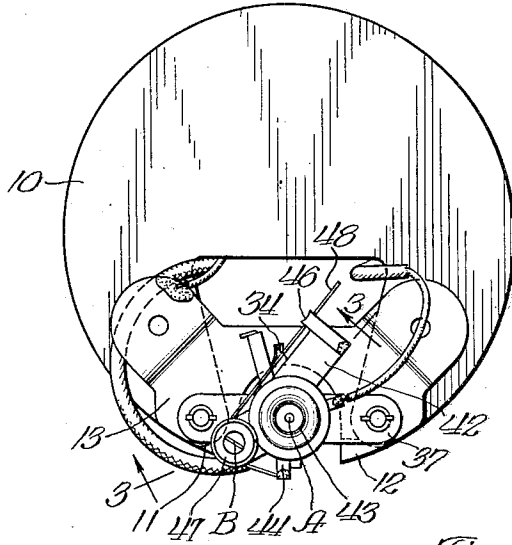


Fig. 2

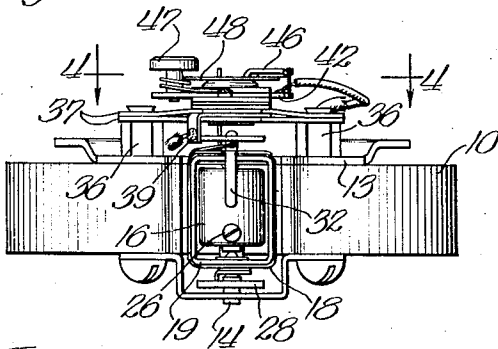


Fig. 3

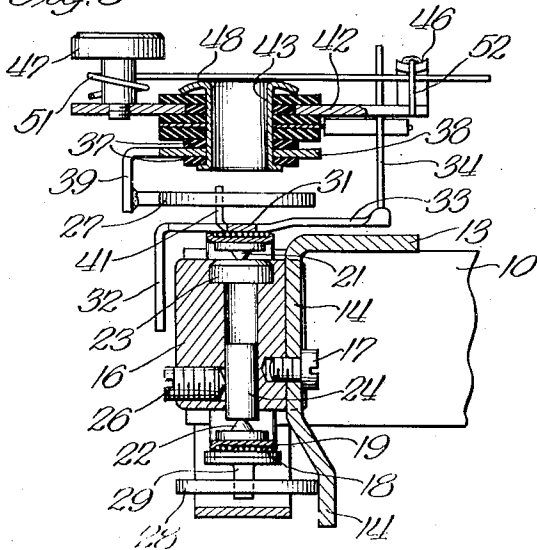


Fig. 4

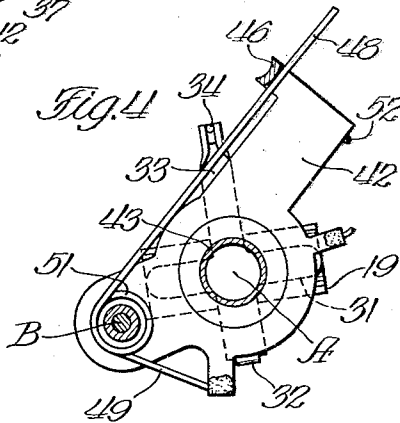
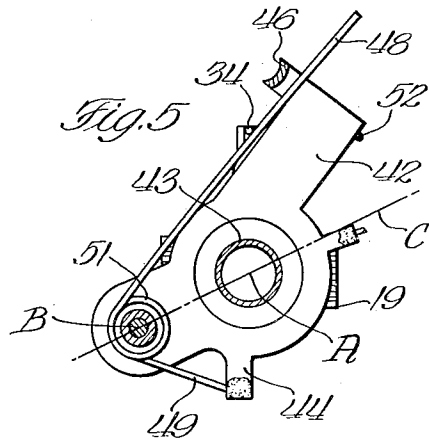


Fig. 5



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UNITED STATES PATENT OFFICE

2,324,265

D'ARSONVAL RELAY

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Application July 19, 1940, Serial No. 346,272

12 Claims. (Cl. 200—110)

My invention relates to electrical relays. It relates more in particular to a sensitive relay of the D'Arsonval type.

The D'Arsonval relay makes use of a D'Arsonval meter apparatus, which includes a coil situated in a magnetic field and mounted to have a rotary motion about an axis substantially perpendicular to the direction of the lines of force of the magnetic field, for example, the field of a permanent magnet. When a current flows through the coil, the coil rotates in response to reaction between its field and the field of the permanent magnet, the tendency being for the coil to move into a position where its plane cuts straight across the lines of magnetic force, the direction of movement, of course, depending upon the direction of the current in the coil. Spring means are used to hold the coil in "zero" position when no current is flowing. The coil, therefore, rotates in response to the passage of an electric current therethrough and returns to its zero or rest position when this current is interrupted.

When the D'Arsonval movement is used in relays, the moving coil, or a portion of an assembly of which the moving coil forms a part, carries a contact, and a second or stationary contact is engaged by the movable contact when the current in the coil is sufficient to move it against the torque of the spring a sufficient distance. The two contacts, one of which is carried by the movable coil, usually operate auxiliary equipment, so that the ordinary D'Arsonval relay involves at least two circuits, one flowing through the meter coil and the other supplying current to the auxiliary apparatus.

D'Arsonval relays are used quite extensively because of certain inherent advantages, among the most important being relatively high sensitivity as compared to relays of more conventional type employing a stationary coil, pole piece and movable armature. Disadvantages which have been found in D'Arsonval relays relate almost entirely to the difficulty of obtaining good, low resistance contact at all times between the stationary and moving contact members which control the auxiliary apparatus. Because of the relatively low contact pressure, the greatest difficulty is probably due to the presence of surface films which are not completely penetrated when the contacts close mechanically, and therefore offer a high resistance to the circuit controlled by the contacts. This is particularly true when the contacts are relatively rigid and have substantially no flexing action when they meet. In

the design of D'Arsonval relays, therefore, attempts have been made to provide a flexible contact, usually on the rotating or moving contact member. The structures employed have not been fully satisfactory for many reasons known in the art, and it is not unusual to find instances where very firm mechanical contact has been made and yet there is a failure to make electrical contact.

The principal object of the present invention is the provision of an improved sensitive relay.

Another object is to overcome problems and disadvantages which have heretofore been encountered in the so-called D'Arsonval type of relay.

A further object is the provision of a D'Arsonval type of relay, so constructed and arranged that good electrical contact will be made at all times and wherein there will be no cohesion or sticking of the contacts due to welding, friction, binding action of surface films, or the like.

Other specific objects and features of the invention will be apparent from the following description taken with the accompanying drawing, wherein

Fig. 1 is a plan view showing one embodiment of the relay of my present invention, the view being approximately twice full scale;

Fig. 2 is an elevational view looking along the front edge of the relay shown in Fig. 1;

Fig. 3 is a sectional view through the pivots of the moving coil, the section being taken on the line 3—3 of Fig. 1 looking in the direction of the arrows, and the view being about double the scale of Fig. 1;

Fig. 4 is an enlarged plan sectional view taken on the line 4—4 of Fig. 2 looking in the direction of the arrows and illustrating the relative positions of the stationary and moving contacts when the coil is in zero position; and

Fig. 5 is a view similar to Fig. 4 and illustrating positions of the parts when electrical engagement has been made between the movable and stationary contact members.

In general, my invention provides a normally stationary contact, in the form of a wire, spring-pressed against a stop whereby to fix its position. This wire is flexed in response to engagement by a wire at right angles to it carried by the moving coil so that actually it is not literally stationary. For the purpose of differentiating it from the moving contact member carried by the coil, however, I have referred to it as a stationary contact member and throughout this specification and in the claims shall refer to it as the stationary contact member. It corresponds in its function

with the normally stationary contact member on this type of instrument.

The wire which comprises the stationary contact member may be relatively long and straight so as to flex along its entire length from the point of its support. Preferably, however, it comprises a straight portion and a helical spring portion, thus permitting its being carried in a much smaller space than would be required if a single, relatively long, straight wire were used in its place. The use of a stationary contact of this character, having a coil spring portion, also permits using a wire which is relatively large in diameter, thereby avoiding excessive local heating due to sparking and a consequent welding between the two contacting wires. It is obvious that, with a highly sensitive instrument having low torque, a relatively heavy wire would have to be quite long in order to obtain the requisite flexing action.

The wire comprising the stationary contact is so adjusted that, if it were not constrained by a stop, it would spring a substantial distance in the direction of the moving contact member. When held in its proper place, it exerts a positive pressure against its stop, preferably against the smooth inside surface of a U-shaped clip, and its position is, therefore, definite and permanent. This prevents the stationary contact member from vibrating as it otherwise would and prevents its position becoming changed due to the relief of strains which might have occurred in its fabrication.

The movable contact member, as previously noted, is a wire of alloy material mounted to engage the wire comprising the stationary contact member at right angles to it, thereby forming a point to point contact with comparatively high unit pressure considering the relatively low torque exerted by the rotating coil. The moving contact member and stationary contact member are so constructed and arranged, as will be pointed out hereinafter, that there is a decided wiping action when they come into mutual engagement. The self-cleaning action which results from the wiping of the contacts is very effective in breaking through any surface film which may be present and in maintaining the contacts in a clean condition at the point of engagement—in short, the wiping action is very important in overcoming high contact resistance.

While the invention may have various embodiments, the drawing shows the features discussed in a combination which has been found very effective in actual commercial operation. Looking at the drawing, a permanent magnet 10 is provided having soft iron pole pieces 11 and 12 between which the moving coil of the instrument is mounted. The construction utilizes a non-magnetic mounting yoke 13 having a downwardly extending mounting clip 14. A core 16 is secured to the mounting strip 14 by a small screw 17, and, in addition to its usual magnetic function, the core 16 acts as a support for pivotally mounting the coil. The coil proper 18, consisting of a suitable number of turns of wire, is wound on a rectangular yoke 19 which carries two pivot points 21 and 22. These pivot points engage in depressions in bearing members 23 and 24 carried axially within the core 16. Any suitable bearing surfaces may be provided for the pivot points such as the usual "jewels" employed in this general type of moving coil instrument. The bearing member 24 is relatively loose within the core 16, and a set screw 26,

threaded radially through the core, engages the bearing member 24 to adjust it to a position to provide the proper amount of friction on the pivots.

To return the coil assembly to zero position after actuation, relatively light helical springs 27 and 28 are provided at top and bottom, in each instance one end of the helical spring being secured to the coil assembly and the other end being secured to a stationary portion. Looking at spring 28, it will be seen that one end thereof is secured to the lower end of the mounting strip 14 and the other end is secured to a small tab 29 projecting downwardly from a right angular portion of the same member which is secured to the bottom of the moving coil assembly so as to move it. It will simplify explaining the mounting for the spring 27 if some of the related parts are first described.

Secured to the outside of the coil assembly at the top thereof is a strip 31 having a portion 32 extending downwardly in front of the core 16 and serving as a counterbalance for the moving coil, and a movable contact carrying member 33 having mounted at its end a vertical wire 34 which comprises the movable contact member.

Secured above the core 13 by spacers 36 are a pair of transverse insulating and mounting strips 37. These carry between them a washer-like spring supporting member 38 and a downwardly extending spring mounting portion 39. The strip 31 has an upturned portion 41. The helical return spring 27 has its outside end secured to the member 39 and its inside end to the member 41.

Stacked with respect to the strips 37 and the washer-like member 38 are additional members which need not be described in detail but which include a stationary contact carrying member 42. These stacked members are held in assembly by a hollow rivet 43, and, in addition to having the supporting function already noted, this assembly provides means for establishing suitable circuits which may vary depending upon the specific construction and use to which the instrument is to be put, but which need not be considered so far as the present invention is concerned.

The stationary contact carrying member 42 is shown in detail in Figs. 4 and 5, and includes a projection 44 and a projecting U-shaped portion 46 which, in a manner to be described, acts as a stop for the stationary contact member. Also secured to the member 42 and projecting upwardly therefrom is a headed stud 47. A stationary contact member 48, in the form of a spring wire, has one end secured by suitable means, such as welding, to the projection 44, a portion 49 extending to the stud 47, and a coil portion 51. The extending end of the stationary contact member 48 is free, but a short wire 52, secured across the legs of the U-shaped projection 46, functions to maintain the movable contact member within the area defined by the U.

My invention is concerned substantially entirely with the construction and arrangement of the contact members, although the moving coil and associated parts have been shown and described so that those skilled in the art will understand how the contact members are mounted and operated. Since the circuits involved may vary, I do not deem it essential to consider either the manner in which the current is delivered to the coil nor the manner in which the contact members 34 and 48 may comprise a part of a circuit including auxiliary apparatus. These are conventional matters. I wish, however,

to point out certain features with respect to the construction and operation of the relay so far as the contacts 34 and 48 are involved.

In a relay of the type shown, the initial contact may be made on less than one microwatt of energy. This figure is illustrative and, of course, not limiting. The result is that the torque is relatively low and the energy available to establish and maintain adequate electrical contact is limited. I have already pointed out that the stop, in the form of a U-shaped clip in the drawing, definitely positions the so-called stationary contact member 48, but that the spring action embodied in this contact member is such as to cause it to move about the stud 47 as a pivot a substantial distance if it were released from its stop. The result is that, while the stationary contact member 48 is resilient with an advantage which will be pointed out, it is not subject to vibration as an unsupported wire would be and, even though the tension on the spring might be relieved considerably, it will always be in the same position and the operating voltage value of the relay effective to close the contacts will remain substantially uniform during the life of the instrument. It will be noted, by comparing the shape of the member 45 as seen in Fig. 3 and the cross section thereof as shown in Fig. 4, that it presents a smooth surface to the wire forming the stationary contact, and there are no rough edges on which it might catch and be prevented from returning to its fixed stop position.

The wires comprising the contact members may be formed of various materials, but preferably the material used in one contact member is different from the material used in the other. I have found that silver palladium wire is an excellent material for the fabrication of the contact member 48, and the contact member 34 may be formed of platinum iridium or other relatively harder contact material. The wiping and resulting cleaning action is more satisfactory when the materials are different than when the same material is used in both contacts.

By employing wires placed at right angles to each other, a point to point contact is obtained, thereby producing a relatively strong unit pressure at the point of contact. Whatever wiping action takes place, the point to point contact is maintained. As will be explained more in detail, the support for the stationary contact member is not along the radius line of the moving contact member, and the result is that, when the wires engage, there is a motion of the moving contact member along the stationary contact member as the latter is deflected slightly, thereby creating the wiping action to which reference has been made. It is essential, therefore, that the stationary contact member be so constructed and arranged that it will be deflected an appreciable amount in order to make possible this sliding action.

Keeping in mind that the energy available for deflecting the wire comprising the stationary contact member is very small, it follows that this wire would have to be very small in cross section or long enough so that the small force available could move it. If the wire is too small in cross section, then there is insufficient metal present to carry away the heat resulting from the arcing on breaking contact, and welding will occur. If the wire is made of sufficiently large cross section to avoid the possibility of welding due to arcing, then it must be longer than ordinary design principles will usually permit. By employing a

straight section with a spring coil portion intermediate this straight section and the point of support, the same effect is obtained as if the wire were very much longer. By the use of this construction, I may employ a wire wherein the cross section throughout is not uniform, that is to say, the cross section along the straight portion engaged by the moving contact member may be somewhat greater than the cross section of the remaining portion of the wire. This may be accomplished by employing a separate sleeve, by securing together two different types of wire, or in other ways familiar to fabricators of metals. This arrangement has the added advantage of permitting the use of two different types of metals, one type suitable for a contact and another type more suitable so far as spring action, conductivity and the like are concerned.

I wish now to refer more in detail to the construction employed for securing the wiping action. Looking at Figs. 1 and 4, it will be noted that the effective pivot point of the moving contact member 34 may be identified by the reference character A which corresponds to the axis about which the coil 18 rotates. For convenience, we may assume that the point B, corresponding to the axis of stud 47, is a point about which the stationary contact 48 pivots in response to being moved by engagement of the moving contact member 34. If we compare Figs. 4 and 5, we will see that, in the unactuated position shown in Fig. 4, the contact 48 is against the stop 46, but, in Fig. 5, it has been engaged by the moving contact 34 and forced in a clockwise direction away from the stop 46. Some of this movement is due to a slight flexing of the straight portion 48, but the greater portion of this movement is due to movement at the coil spring portion 51. For our purpose, however, in explaining the construction and arrangement, we may assume that this movement of the stationary contact member 48 is about the point B.

By examining the figures which show the parts in plan view, it will at once be apparent that, if a line is drawn from the point A to the point of initial engagement of the two contact members, and another line is drawn from the point B to this point of engagement, there will be a subtending angle which will indicate the extent to which the point B is removed from the radius of the circle defined by the arc over which the moving contact member is actuated about its axis A. If we now take the position at which the parts come to rest after full actuation and draw lines from the points A and B to the point of ultimate engagement of the two contact members, we will find that this angle is smaller than the angle previously considered. The difference is represented by the movement in a clockwise direction tending to establish the point B in a position along the radius line of the circle in which the contact 34 moves, or a continuation thereof. It will at once be seen that, if the stationary contact member 48 were forced to a position to lie along the dotted line C in Fig. 5, then the point B would fall along the radius line previously referred to. During the entire movement from the position of the parts shown in Fig. 4 to the position of the broken line C in Fig. 5 (if the parts were to move this far), there would be a wiping action of the moving contact member 34 along the stationary contact member 48. It is desirable that the wiping action be as great as possible, but those skilled in the art will see

that there are other factors which prevent the use of a design which will permit extreme wiping action such as that suggested. The point is raised, however, to illustrate that, if the point B should be so located with respect to the point A that movement of the moving contact member 34 would carry the stationary contact 48 past the point A (that is, beyond a point where the point B would coincide with the radius line), there would still be a wiping action, but the angle from the point A to the point of engagement between the contact members and to the point B would then be a negative angle. While this is permitted and a wiping action would definitely occur, I prefer, in the design, to maintain the angle referred to positive when the parts have reached their extreme of movement.

I have determined that the angle from the point A to the point of initial contact between the members 34 and 48, and then to the point B, should be at least approximately 25 degrees. This angle, however, may be greater, in theory very much greater, because, in general, the greater the angle the greater the wiping action. There are other factors involved, however, including the friction between the two wires when the angle is relatively great, cohesion of the wires due to thin films, and the welding action which may occur. Concerning the latter, welding at the break, welding during wiping due to spot on the wire of low conductivity and possible arcing, and welding at the make due to bouncing are factors to consider. After extensive tests and analysis of the factors involved, I have determined that this angle defined by the position of the points A and B and the point of initial contact between the contact members should not be greater than about 75 degrees. A very desirable angle is approximately 45 degrees with plus or minus 20 degrees suitable if the most important advantages of my invention are to be secured.

In connection with the practice of my present invention, I wish to point out that the circuit shown in my prior Patent 2,113,737 may be used to great advantage with my present invention. When this circuit is employed, it is only necessary that the two wires just make contact, and the extra energy resulting from the use of the energy transfer circuit causes a substantial further movement of the contacts and, of course, a definite wipe over the maximum range permitted by the design of the instrument. When the locking-in circuit forming a part of the energy transfer circuit, as shown in my prior patent, is opened, the stored energy of the stationary contact member accelerates the return movement of the moving contact member 34, and acts to prevent sticking of the moving contact member to the stationary contact. I have found that, even when I applied grease films for test purposes, sticking did not occur. I wish to call attention to the fact, however, that, due to the initial spring tension in the contact member 48, which is a major force as compared to the added tension resulting from deflecting it during operation of the meter, this pronounced return movement takes place at all times if enough torque has been applied to the moving contact assembly to take the stationary contact member 48 away from its stop 46. It is at least in part due to the energy stored in the contact member 48 that I am able to employ as large an angle between the points A and B as that described.

Those skilled in the art will appreciate that

the structure, size, purpose and general arrangement of parts of my improved relay may be modified quite extensively while still obtaining the very desirable advantages which the invention makes possible. It is obvious, for example, that the two contact wires may be caused to engage each other at right angles and still not have the conformation and relationship shown in the drawing. The normally movable contact, for example, could lie in a horizontal plane and the normally stationary contact in a vertical plane. This would modify the force of contact when the contacting wires slide relatively to each other, but, under some circumstances, would not be objectionable, particularly if the point of engagement moved closer to the axis of the movable contact member as wiping occurred.

Throughout the specification, where I refer to wire contact, it should be understood that the significant criteria is not the circular cross section normally found in wire, but rather the provision of a cylindrical or partly cylindrical engaging surface affording a substantially point-to-point contact between the contact members while still permitting free sliding action. It is at once apparent, therefore, that, if the contacts are of solid cross section, it is not essential that they be of circular cross section. For this reason, the contact members may be hollow, as in a tube, flat or ribbon-like in cross section, V-shape, the shape which is assumed by a partially flattened solid circular wire, or similar shape which will provide, at the point of engagement, the same general kind of engagement as that occurring between relatively small cross section wires engaging at right angles to each other.

I wish to point out further that, in the claims, I refer to the coil as being on a vertical axis, in order more clearly to define the relative positions of the parts. It should be well understood by those skilled in the art, however, that the instrument may be mounted in substantially any position, and references to fixed positions of the parts in the claims are not a limitation except in so far as the relative positions of the parts are defined.

The invention is defined by the appended claims when interpreted in the light of the specification.

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

1. In a D'Arsonval relay, a D'Arsonval meter apparatus including a coil assembly rotatable about a vertical axis, a movable contact member carried by the coil assembly comprising a wire of relatively small cross section disposed in a plane substantially parallel to the axis of the coil assembly, but spaced therefrom, and a normally stationary contact member in the form of a wire disposed in the path of said movable contact member and lying in a plane at right angles thereto so that said contact members engage each other in point to point relation, said normally stationary contact member being supported at a point spaced from a line drawn at any point through the axis of rotation of the coil assembly, and being so constructed and arranged as to flex between the point of its support and the point of engagement by the movable contact member, the angle formed by drawing two lines, one from said axis and one from the point of support of the normally stationary contact member, each line extending to the point of initial engagement between the contact members, being not less than about 25 degrees nor more than about 75 degrees.
2. In a D'Arsonval relay, a D'Arsonval meter

apparatus including a coil assembly rotatable about a vertical axis, a movable contact member carried by the coil assembly comprising a wire of relatively small cross section disposed in a plane substantially parallel to the axis of the coil assembly, but spaced therefrom, and a normally stationary contact member in the form of a wire disposed in the path of said movable contact member and lying in a plane at right angles thereto so that said contact members engage each other in point to point relation, said normally stationary contact member being supported at a point spaced from a line drawn at any point through the axis of rotation of the coil assembly, and being so constructed and arranged as to flex between the point of its support and the point of engagement by the movable contact member, the angle formed by drawing two lines, one from said axis and one from the point of support of the normally stationary contact member, each line extending to the point of initial engagement between the contact members, being about 45 degrees.

3. In a D'Arsonval relay, D'Arsonval meter apparatus including a coil assembly rotatable about a vertical axis, a vertical contact wire carried by said assembly and rotatable therewith, and a second contact wire having a straight portion lying in the path of said vertical contact wire, and a coil spring portion disposed around a stationary stud as a support, said straight portion lying in a plane at right angles to the plane of said vertical contact wire.

4. In a D'Arsonval relay, D'Arsonval meter apparatus including a coil assembly rotatable about a vertical axis, a vertical contact wire carried by said assembly and rotatable therewith, and a second contact wire having a straight portion lying in the path of said vertical contact wire, and a coil spring portion disposed around a stationary stud as a support, said straight portion lying in a plane at right angles to the plane of said vertical contact wire, said stud being spaced from a radius line of a circle defined by the arc over which said vertical contact wire travels.

5. In a D'Arsonval relay, D'Arsonval meter apparatus including a coil assembly rotatable about a vertical axis, a vertical contact wire carried by said assembly and rotatable therewith, and a second contact wire having a straight portion lying in the path of said vertical contact wire, and a coil spring portion disposed around a stationary stud as a support, said straight portion lying in a plane at right angles to the plane of said vertical contact wire, said straight portion and a radius line running from the point of initial engagement of said contact members and passing through the axis of rotation of said coil assembly defining an angle.

6. In a D'Arsonval relay, D'Arsonval meter apparatus including a coil assembly rotatable about a vertical axis, a vertical contact wire carried by said assembly and rotatable therewith, and a second contact wire having a straight portion lying in the path of said vertical contact wire, and a coil spring portion disposed around a stationary stud as a support, said straight portion lying in a plane at right angles to the plane of said vertical contact wire, said straight portion and a radius line running from the point of initial engagement of said contact members and passing through the axis of rotation of said coil assembly defining an angle of about 45 degrees.

7. In a D'Arsonval relay, D'Arsonval meter apparatus including a coil assembly rotatable about

a vertical axis, a vertical contact wire carried by said assembly and rotatable therewith, and a second contact wire having a straight portion lying in the path of said vertical contact wire, and a coil spring portion disposed around a stationary stud as a support, said straight portion lying in a plane at right angles to the plane of said vertical contact wire, said straight portion and a radius line running from the point of initial engagement of said contact members and passing through the axis of rotation of said coil assembly defining an angle of between about 25 degrees and about 75 degrees.

8. In a D'Arsonval relay, D'Arsonval meter apparatus including a coil assembly rotatable about a vertical axis, a contact wire carried by said assembly and rotatable therewith, a second contact wire having a straight portion lying in the path of said vertical contact wire in a plane at right angles to the plane of said vertical contact wire and adapted to be flexed in response to continued movement after engagement has been made, said second contact wire being spring-pressed in a direction opposite to that in which it is moved by said vertical contact wire, and stop means to limit the movement of said second contact wire whereby its position when engaged by the vertical contact wire is fixed.

9. A relay as defined in claim 8 wherein said stop comprises a U-shaped yoke.

10. In a D'Arsonval relay, a stationary contact in the form of a wire having a straight portion, springs means urging said straight portion in one direction about a pivot point, stop means limiting the movement of said straight portion whereby it is normally held spring-pressed in a fixed position against said stop, and a movable contact member having a straight wire portion disposed in a plane at right angles to the plane of the straight wire portion of the stationary contact, and adapted on movement to engage said straight portion at a point to move it about its pivot against the force of said spring means.

11. In a D'Arsonval relay, a stationary contact in the form of a wire having a straight portion, spring means urging said straight portion in one direction about a pivot point, stop means limiting the movement of said straight portion whereby it is normally held spring-pressed in a fixed position against said stop, and a movable contact member having a straight wire portion disposed in a plane at right angles to the plane of the straight wire portion of the stationary contact, and adapted on movement to engage said straight portion at a point to move it about its pivot against the force of said spring means, the said contacts being so constructed and arranged that, on continued movement of the movable contact after initial engagement of the said straight portion, said contacts slide relatively to each other and produce a distinct wiping action at the points of engagement.

12. In a D'Arsonval relay, a D'Arsonval meter apparatus including a coil assembly rotatable about a vertical axis, a movable contact member carried by the coil assembly comprising a member having a contact surface of relatively small arcuate cross section disposed in a plane substantially parallel to the axis of the coil assembly, but spaced therefrom, and a normally stationary contact member in the form of a member having a contact portion of relatively small arcuate cross section disposed in the path of the movable contact member and having its contact surface disposed at right angles to the contact

surface of the movable contact member so that said contact members engage each other substantially in point to point relation, said normally stationary contact member being supported at a point spaced from a line drawn through the axis of rotation of the coil assembly and being spring pressed to a stop position toward and to the point

of engagement by the movable contact member, whereby said normally stationary contact member may relax from said stop position after engagement and cause a wiping action between the contact members.

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