May 7, 1940. S. S. GREEN 2,199,991

MULTIELEMENT WATT-HOUR METER

Filed Jan. 13, 1938

Fig. 1

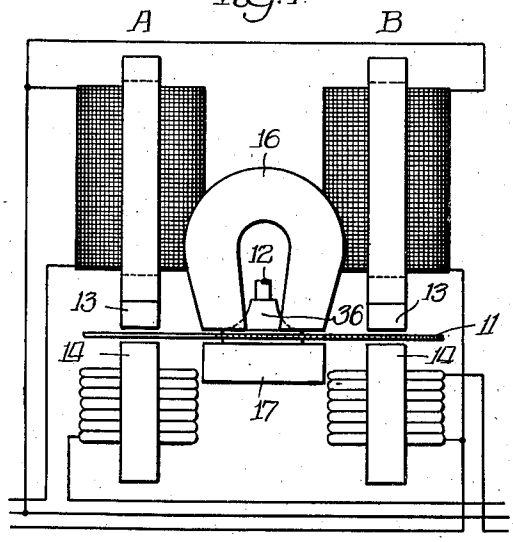


Fig. 2

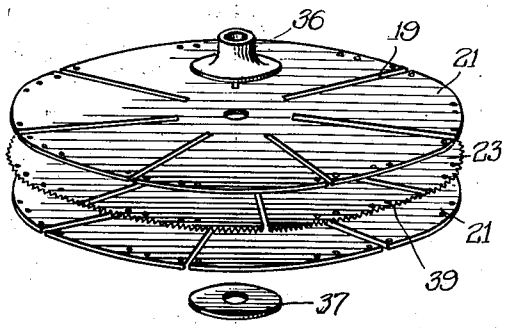


Fig. 3

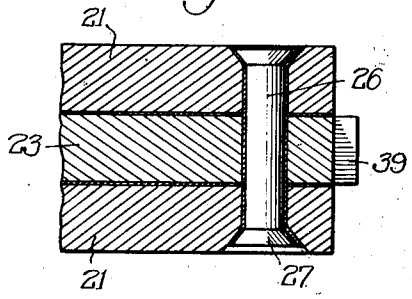


Fig. 4

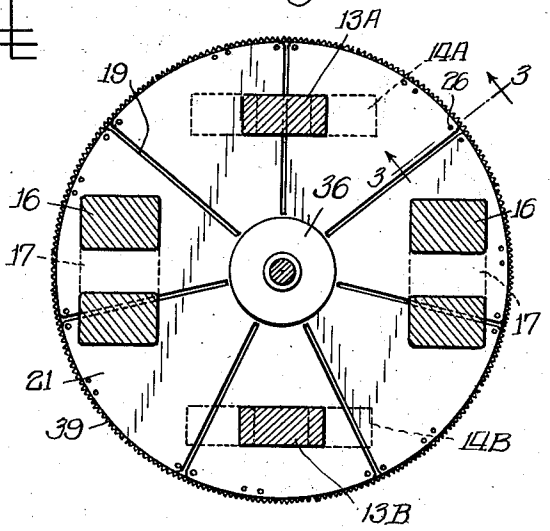


Fig. 5

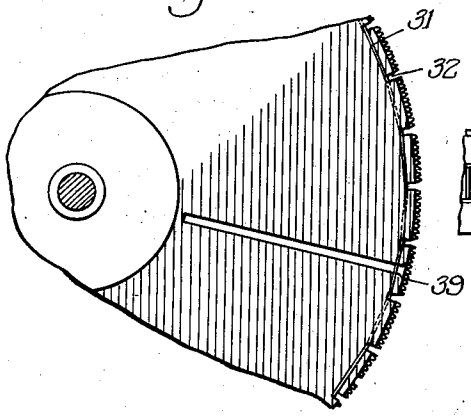
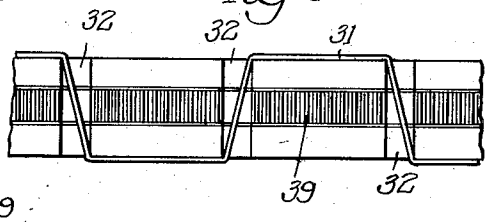


Fig. 6



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UNITED STATES PATENT OFFICE

2,199,991

MULTIELEMENT WATT-HOUR METER

Stanley S. Green, La Fayette, Ind., assignor to Duncan Electric Manufacturing Company, La Fayette, Ind., a corporation of Illinois

Application January 13, 1938, Serial No. 184,751

8 Claims. (Cl. 171—264)

This invention relates to polyphase meters and more particularly to an interference-proof disc for such meters. Polyphase meters differ from single phase meters by employing two or more complete electromagnetic driving elements, while the usual single phase meter has only one. Polyphase circuits have at least three wires, and at least two meter driving elements are required for their measurement.

For many years the use of two driving elements has necessitated the use of two separate discs one for each element in order to prevent interference between the eddy currents induced in the disc by one element and the magnetic field of the other. This was fully explained in my copending applications Serial No. 33,116, filed July 25, 1935, and Serial No. 124,632, filed February 8, 1937 (Patent No. 2,110,417). These applications also describe numerous prior attempts to avoid the expense of a disc for each driving element, explain wherein they had failed to satisfactorily solve the problem, and disclose a satisfactory solution. The present invention utilizes the principles of the solution previously described though the structure is of a somewhat different form.

The general principle of the solution of the problem is to provide a rigid unitary disc made up of laminations thoroughly insulated from one another except at their center portions and each lamination including radially extending slots staggered with respect to the slots of other laminations and dividing the disc as a whole into a plurality of overlapping conductive sections substantially isolated from one another to the extent that eddy currents induced in one section will not flow through the other sections. The driving elements are so positioned, and the sections so proportioned, that no section is materially influenced by more than one driving element at a time.

In the prior applications these principles were satisfactorily embodied in a disc in which the conductive laminations were rigidly secured together throughout their area by an insulating binding material. According to the present invention the insulating material need not be adhesive, as the laminations are held together by mechanical means such as rivets or a binding thread positioned at the periphery of the disc, preferably slightly beyond the various magnet poles so as to make countersinking of the securing means unnecessary. Countersinking can be resorted to, however, if the space and the torque requirements do not permit positioning the securing means as stated. The laminations are filmly secured together at their centers by the hub.

Additional objects will be apparent from the following description and from the drawing, in which:

Fig. 1 is a diagrammatic illustration of a meter embodying this invention.

Fig. 2 is a diagrammatic illustration indicating the structure and assembly of one form of slotted and laminated disc constructed in accordance with this invention.

Fig. 3 is an enlarged fragmentary sectional view of the disc shown in Figs. 2 and 4, being taken approximately on the line 3—3 of Fig. 4.

Fig. 4 is a plan view of the disc showing also the arrangement of magnet poles on the disc and their positioning within the line of rivets.

Fig. 5 is a fragmentary plan view of a modified form of disc in which the laminations are held together by a binding cord instead of by rivets, and

Fig. 6 is an enlarged fragmentary edge view of the disc shown in Fig. 5.

Although this invention may take a variety of forms, only two have been chosen for illustration. In both forms the invention is concerned with a slotted and laminated disc 11 suitable for use in multielement meters such as polyphase meters and mounted on a rotatable shaft 12 which drives a meter register, not shown. As described in my copending application Serial No. 124,632, (Patent No. 2,110,417) such a disc prevents interference within the disc between driving elements A and B, each of which sets up eddy currents in the disc. The eddy currents from one driving element would be affected by those from another if they were not restricted by the slots to the zone in which they originate. The laminations in the disc permit the formation of a disc which will rotate smoothly in spite of the slots. But for the laminations and the attendant staggering of the slots the movement of the disc would be very jerky, and the meter would be completely inoperative at light loads since such a disc would have a strong tendency to stop with a slot under a driving element.

Each of the driving elements A and B includes a potential magnet having a pole 13 adjacent one face of the disc and a current magnet having spaced poles 14 adjacent the other face of the disc. The illustration of these magnets is entirely diagrammatic. A preferred form of driving unit including a potential magnet and a current magnet in one structure is illustrated in my copending application Serial No. 48,713 (Patent No.

2,167,649, issued August 1, 1939). In order to obtain adequate damping torque for such a disc when it is driven by two driving elements A and B, two permanent damping magnets 16 are provided, each having its two poles adjacent one face of the disc, and an armature 17 adjacent the other face of the disc so as to produce two opposed concentrated magnetic fields in close proximity to one another. The opposed adjacent fields have much stronger damping effect than would be the sum of the fields alone especially with the illustrated slotted disc. The two magnets producing two such pairs of opposed adjacent field can be placed as indicated in Fig. 4 midway between the driving elements. With an even number of driving elements it is rather desirable to have an uneven number of slots 19 in each lamination so that slots will not be centered under pole 13A and under pole 13B at the same time.

It is desirable to have the magnetic gaps such as the gap between the pole 13 and the pole 14 of one driving element as small as is commercially practicable, since this will produce the maximum torque, other factors being the same. In order for the disc to operate in such a small gap it is vital not only that it be quite thin, but also that its laminations be dependably secured together. In my copending application Serial No. 124,632 (Patent No. 2,110,417), this vital feature was accomplished by securing the laminations together with an insulating binding layer. A disc produced in that manner is very satisfactory but the present invention contemplates other forms of disc which will be satisfactory without adhesive layers between the laminations. When adhesive layers are used it has so far been considered advisable to use a non-flowing spacer member such as a thin sheet of paper to make certain that the laminations are not pressed into contact with one another by the pressure which is used in securing them to adhere together. When no adhesive is used such pressure is not necessary, and some simplification of manufacture may therefore be possible by simply spraying a coat of insulating paint on the laminations or possibly forming a coat of insulating oxide on them. In other words, the present invention for mechanically securing the laminations together may be advantageous in some instances in simplification of manufacture, but in any event it comprises a useful alternative for the adhered type of laminated disc already found satisfactory.

In both forms of the present invention the disc may include outer laminations 21 and a center lamination 23. Of course, as few as two or as many as five laminations could be used, but three is preferred in the present form of the invention. Since the laminations are not adhered together it is desirable that they be relatively thick so as to have sufficient strength, individually, to make them satisfactory when secured at the center and edge only. With fewer than three laminations the sections of each lamination must be excessively small in order to have enough staggered sections in the disc as a whole to make the torque on the disc sufficiently uniform. As explained in my application Serial No. 124,632 (Patent No. 2,110,417), previously mentioned, the torque is reduced as the number of slots per lamination is increased. Furthermore, it is reduced, as to a disc of a given total thickness, as the amount of non-conductive separation between the laminations is increased.

By using three laminations, having seven slots each, a disc is provided in which the reduction of torque by the slots is not particularly high and in which the individual laminations are sufficiently strong to be dependably secured together by the mechanical means to be described and in which the thickness of non-conductive spacing material may be kept at a minimum.

The three laminations must be insulated from one another except at their center portions (the portions inside the ends of the slots). The insulation preferably comprises a thin coating between each pair of laminations. Such a coating may be applied to or formed on any of the inner faces of the laminations, that is, the inner face of either or both of the outer laminations 21 and either face of the central lamination 23. Such a coating may be an extremely thin layer of insulating paint sprayed on the lamination or a thin layer of oxide formed on the lamination. Before the coating is applied or formed, any burrs on the laminations which might result from stamping them out, for example, should be flattened as with a flattening die in a press. Under such circumstances the insulation may be extremely thin, its thickness in Fig. 2 being somewhat exaggerated for the sake of clarity. With such thin separating coatings and with only three laminations so that there are only two separating coatings it is evident that the disc is substantially all formed of conductive material. This is desirable from the standpoint of obtaining maximum torque and makes it possible to obtain satisfactory torque even though seven slots are used in each lamination. It may be preferred to use this many slots per lamination when only three laminations are used since from twenty-one to twenty-five slots has been believed to be the most satisfactory number in balancing the somewhat conflicting requirements of torque and smoothness. Fifteen slots or five slots per lamination can be used, however, with at least fairly satisfactory results; and in some instances even fewer could be used. Fifteen slots have recently been found to be entirely satisfactory in somewhat similar discs when the discs are made under conditions which result in extreme uniformity.

The laminations may be secured together by rivets 26, one of which should be positioned at each peripheral corner of the sections as seen in Fig. 4. Of course, there may be others along the periphery, and some could be positioned along each exposed slot radially inward from the magnet poles. It is believed that those shown are enough, however. More than necessary are undesirable because they reduce the torque, being insulated as described below.

It is highly desirable that these rivets should not electrically connect the laminations since even a small degree of electrical connection at the outer part of the disc may be very detrimental as to the interference eliminating qualities of the disc. The rivets should therefore be made of insulating material or adequately coated with an insulating enamel, preferably a flexible enamel such as that commonly used for enameled wire. Although even such flexible enamel would ordinarily be split at the inserted end 27 of the rivet when it is upset, the remainder of the enamel will remain intact, thus insulating the rivet from the other two laminations, and in fact, the insulation may be omitted from the end to be upset. The result is that no electrical connection will be formed between the laminations.

When the thickness of the laminations will permit, it is desirable to countersink the rivets 26 in the outer laminations as seen in Fig. 3. In case the countersinking may not be perfect or if countersinking is not resorted to, the rivets should be positioned radially beyond all of the magnetic pole pieces as seen in Fig. 4 so that there will be no danger of any projecting rivet portion striking one of these pole pieces and stopping the disc. With the rivets thus located it is not necessary to make the magnet gaps any wider in order to allow more tolerance for the rivets. Of course, if space requirements will not permit the slightly oversize disc it is merely necessary to make certain that the countersinking of the rivets is complete, and they may then run through the magnet gaps.

To avoid the necessity of insulating rivets the laminations may be held together by an insulating thread 31, as seen in Figs. 5 and 6, this thread being wrapped through small notches 32 formed in all three laminations and alined during assembly. The ends of the thread may be tied or glued together in one of the notches and the entire thread may be varnished after application to help hold it in place and to give it durability and moisture resistance.

Although it is believed that either of the peripheral securing means described will be sufficient to hold the laminations together, especially with the aid of the conventional hub, it may be preferred to use a hub having an enlarged flange 36 extending approximately to the inner ends of the slots 19 and a washer 37 on the opposite side of the disc. The stem of the hub will of course be inserted through the central hole in the finished disc and through the washer 37, after which it will be upset or swedged to secure it in place. The hubbed disc may then be secured to the shaft in the conventional manner.

The center lamination 23 may be provided with projecting teeth 39 extending beyond the other laminations. Such teeth have been commonly provided on meter discs in the past for the purpose of testing and adjusting the meter by stroboscopic methods. Of course, such teeth could be provided on all three laminations, but their provision on the center lamination only is preferred so as to avoid the necessity for extremely accurate alinement of the teeth. If desired, the center lamination could be made thicker than the others so as to give these stroboscopic teeth greater strength.

From the foregoing it is evident that two forms of the invention have been illustrated, each of which provides a laminated interference-proof disc capable of providing high torque smoothly and having the laminations adequately insulated and dependably secured together.

The disclosures of this application are illustrative and the invention is not to be limited by them. In fact, if modifications or improvements are not at once obvious, they may be devised in the course of time to make additional use of the broad ideas taught and covered by this application. The claims are intended to point out novel features and not to limit the invention except as may be required by prior art.

I claim:

1. A watt-hour meter mechanism comprising a disc rotatably mounted about a given axis, a plurality of electromagnetic driving elements having poles adjacent the disc, and damping magnet means having poles adjacent the disc; the disc having a plurality of conducting sections electrically separated from each other sufficiently to confine the currents induced therein by the driving elements to substantially the individual segments, having an area and shape with reference to the disc such that when under the magnetic influence of one driving element they are removed from any substantial magnetic influence of another driving element, spaced out in staggered and overlapping relation in their assembly in the disc, separated from one another by a layer of insulating material and being firmly secured together in the vicinity of the axis by the hub structure and adjacent the periphery by mechanical securing means positioned radially beyond the poles to eliminate danger of the securing means striking the poles.

2. A watt-hour meter mechanism including a plurality of electromagnetic driving elements and a rotatably mounted disc driven thereby and having a plurality of angularly staggered slotted conducting laminations substantially insulated from one another as to currents induced by the driving elements by thin, substantially non-flowable, insulating coatings and secured together by mechanical securing means near the periphery of the disc engaging the outer laminations and extending through the other laminations without electrically connecting the laminations.

3. A watt-hour meter mechanism including a plurality of electromagnetic driving elements and a rotatably mounted disc driven thereby and having a plurality of angularly staggered slotted conducting laminations substantially insulated from one another as to currents induced by the driving elements by thin, substantially non-flowable, insulating coatings and secured together by rivets near the periphery of the disc and extending substantially through the disc without electrically connecting the laminations and having heads countersunk in the outer laminations.

4. A watt-hour meter mechanism including a plurality of electromagnetic driving elements with a rotatably mounted disc driven thereby and having a plurality of angularly staggered slotted conducting laminations substantially insulated from one another as to currents induced by the driving elements by thin, substantially non-flowable, insulating coatings and secured together by rivets extending substantially through the disc without electrically connecting the laminations and positioned radially beyond the portions of the driving elements close to the faces of the disc.

5. A watt-hour meter mechanism including a plurality of electromagnetic driving elements and a rotatably mounted disc driven thereby and having a plurality of angularly staggered slotted conducting laminations substantially insulated from one another as to currents induced by the driving elements by thin, substantially non-flowable, insulating coatings and secured together by metallic rivets separated from all but one of the laminations by an insulating enamel.

6. A watt-hour meter mechanism including a plurality of electromagnetic driving elements and a rotatably mounted disc driven thereby and having a plurality of slotted conducting laminations substantially insulated from one another as to currents induced by the driving elements by thin, substantially non-flowable, insulating coatings and secured together by a fibrous binding member entwined around projecting members on the laminations at the periphery of the disc.

7. A watt-hour meter mechanism including a plurality of electromagnetic driving elements and a rotatably mounted disc driven thereby and hav-

ing a plurality of slotted conducting laminations substantially insulated from one another as to currents induced by the driving elements by thin, substantially non-flowable, insulating coatings and secured together by mechanical securing means near the periphery of the disc engaging and extending between the outer laminations without electrically connecting the laminations, one of the laminations having stroboscopic teeth formed thereon projecting beyond the other laminations.

8. A watt-hour meter mechanism including a plurality of electromagnetic driving elements and a rotatably mounted disc driven thereby, said disc consisting of a plurality of but not over three conducting laminations, each having at least five slots dividing up said laminations into substantially equal segments substantially electrically isolated from each other except at the center, said laminations being substantially insulated from one another as to the currents induced by the driving elements by thin, substantially non-flowable, insulating coatings and secured together by the hub and by mechanical means near the periphery of the disc whereby reasonably good rigidity is obtained.

STANLEY S. GREEN.