May 2, 1961 L. T. MITCHELL, JR 2,982,912

TESTING APPARATUS

Filed Feb. 17, 1958

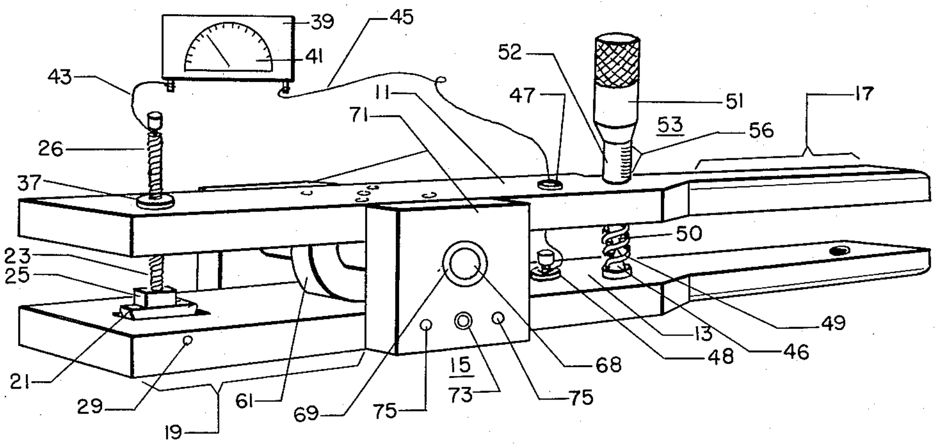

FIG. 1

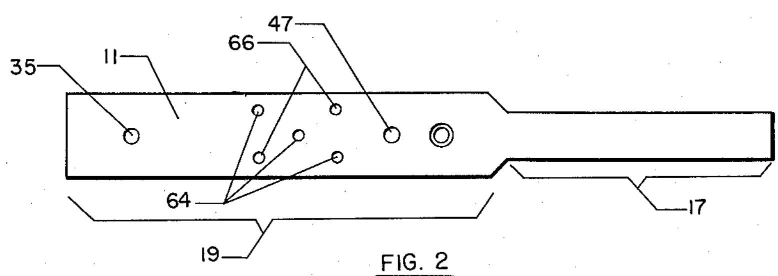

FIG. 2

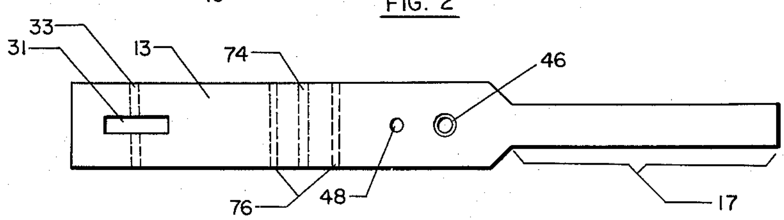

FIG. 3

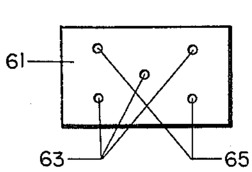

FIG. 4

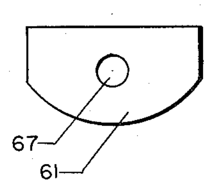

FIG. 5

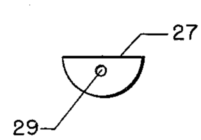

FIG. 6

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TESTING APPARATUS

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Filed Feb. 17, 1958, Ser. No. 715,833

2 Claims. (Cl. 324—65)

This invention relates to an instrument for measuring the electrical resistance of insulating materials and relates in particular to a portable instrument for measuring the insulating qualities of coated laminations, strip or sheet of flat rolled electric grades of steel.

In the manufacture of electrical grades of steel, such as silicon steel strip for winding magnetic cores, it is necessary to provide an adequate insulating film to the surface of the strip. Such electrical grades of silicon steel strip are conventionally alternately cold rolled and heat treated to obtain directional magnetic properties. Final cold rolling generally provides strip material of thin gauge, usually about 13 mils in thickness. The final product is coated with a thin coating of an electrical resistant material which may be of an organic nature such as resins, varnishes or lacquers or more commonly of an inorganic nature such as sodium silicate, talc, magnesium oxide, borax and more recently phosphates. The coated strip is conventionally employed for winding in the direction of rolling, which is also the direction of the improved magnetic properties, into oval or circular shaped cores for various electrical induction applications. The insulating coating serves to separate the alternate steel layers from one another and thus effectively reduce core loss when electric flux is induced into the magnetic core, by cutting down on eddy currents. The thickness of the insulating film is relatively critical for a given application in that if the film is too thick it reduces the quantity of steel present and available in a given size core to provide the desired electrical induction intended. However, if on the other hand the film is too thin, eddy currents will create high core loss.

In order to meet design and manufacturing requirements, the thickness of the film on the surface of a conventional core should be such to permit the space factor of 90%, preferably 94% or 95%. Of the known methods of applying a coating, such as is described in Patent No. 2,753,282, none is capable of providing a constantly satisfactory coating to a continuously moving silicon steel strip that is uniform for the entire length of the strip.

It is therefore necessary to frequently and periodically check the quality of the coated material for its electrical resistance in a given area. For example, orders are conventionally placed with manufacturers to supply a material with a given ohm resistance per square inch of coated strip. Prior known methods of acquiring such information generally involve shearing samples from sections of the strip for testing and examination as to the thickness and ohmic resistance of the material. This practice results in considerable loss of labor and, not being a nondestructive test, is wasteful of the coated silicon steel strip.

It has now been found, that by employing the instrument of the present invention, continuously moving coated silicon steel strip or laminate may be easily and effectively inspected periodically to determine the ohmic resistance of a given surface area of such material without adversely affecting the material being tested.

It is therefore the object of the present invention to provide an instrument for testing coated silicon steel laminate without adversely affecting the material being tested.

It is also an object of the present invention to provide a portable instrument that will give accurate ohm resistance readings for given surface areas of coated steel.

A broader aspect of the present invention is to provide an instrument that will effectively measure the ohm resistance of any flat rolled material.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

Figure 1 is a perspective view of a testing apparatus constructed in accordance with the present invention;

Fig. 2 is a plan view of the under surface of the upper elongated member of the assembly of Fig. 1;

Fig. 3 is a plan view of the upper surface of the lower elongated member of the assembly of Fig. 1;

Fig. 4 is a top plan view of the rocker pivot of the assembly of Fig. 1;

Fig. 5 is a side plan view of the rocker pivot of Fig. 4; and

Fig. 6 is a side plan view of the rocker electrode utilized in the assembly of Fig. 1.

Prior art instruments designed to effect such a measurement as is accomplished by the instrument of the present invention are ineffective in providing a constant and given pressure to electrodes impressed upon the coated metal to a specific area in order to give accurate and reliable readings.

In general, the present invention relates to an instrument wherein two elongated members are rigidly but pivotally attached to one another, one side of said pivot constituting the handles of the instrument and the other side the head of the instrument. The head of the instrument contains opposing electrodes of a predetermined contacting area and disposed to oppose one another. One of the electrodes is pivotally mounted so as to effectively provide a means of projecting the entire flat surface of both electrodes onto flat rolled material being tested.

Referring to the drawings and particularly to Figs. 1 to 3, substantially parallel elongated members **11** and **13** are pivotally joined by a pivot mechanism shown generally at **15** and referred to more fully hereinafter. Members **11** and **13** are formed in such a manner as to provide narrowed areas **17** which constitute the handles of the apparatus. On the other side of pivot mechanism **15** is the area **19** to be referred to as the head of the apparatus. Positioned in the head of the apparatus is a pair of opposed electrodes **21** and **23**. Electrode **21** has a flat metal contacting area designed as **27** (see in particular Fig. 6) and electrode **23** has a rectangular material contact head or area such as is shown at **25**. These contact areas are preferably of a known surface area; however, as will be explained further on, the instrument may be calibrated so as to be effectively employed although the exact contacting area may not be known. As shown in Figs. 1 and 6, electrode **21** is of a half cylinder shape and is provided with a pivot pin **29** which is disposed to pivotally seat in a suitable opening **33** provided in elongated member **13** when the curved back portion of the electrode **21** is partially recessed in slot **31** (note in particular Fig. 3). Thus electrode **21** will rock free in a direction parallel to elongated members **11** and **13** while maintaining electrical contact with member **13**.

In the present embodiment, electrode **23** (note in particular Fig. 1) is rod shaped and possesses a head or contact area **25** and a threaded shaft area **26**. This electrode projects through a cylindrical perforation or opening **35** provided with a threaded bushing **37** of insulating material and disposed in the head area of elongated member 11. The electrodes 21 and 23 are connected as by conductors 45 and 43, respectively, to an ohmmeter 39 which is an instrument that is well knonw in the electrical industry as a simple galvanometer arranged to measure electrical resistance of materials interposed between a constant current electric circuit. It is most convenient to employ a conventional instrument that possesses a battery or other constant supply of current to effect measurement of resistance. As illustrated, lead 45 passes through a suitable opening 47 in the handle of elongated member 11 and is connected to a lead terminal 48 provided on the handle of elongated member 13 so that current will flow through member 13 and the pivot pin 29 to electrode 21. Lead 43 is connected to the upwardly projecting portion of electrode 23. If desired an insulating bushing (not shown) may be provided in the opening 47 to effectively insulate conductor or lead 45 from elongated member 11; however, such an insulation is not required because the insulating bushing 37 prevents electrical contact between the two electrodes 21 and 23 except at their contacting areas. The polarity supplied to the respective electrodes is not important in that the instrument may be adjusted to work equally well with the current flowing in either direction.

As shown in Fig. 1, a coil spring 49 is disposed between the handle portions of elongated members 11 and 13 to provide a predetermined pressure for forcing or biasing the handle portions 17 of elongated members 11 and 13 away from one another and to apply a predetermined pressure on the aligned electrodes 21 and 23. In the present embodiment means for maintaining the spring 49 in operative position and providing for adjusting the predetermined pressure applied to the electrodes 21 and 23 by spring 49 are provided. Such an adjustment may be particularly desirable where it is necessary to measure the insulation qualities of laminations of various thickness. Thus the lower end of the spring 49 is seated about an upwardly projecting fixed spring seat 46 and the upper end of the spring 49 is seated about an adjustable spring contacting member 50 disposed at the lower end of a micrometer assembly 53 mounted to extend through the elongated member 11. The micrometer assembly 53 is, in general, of usual construction being provided with an outer cylinder 52 calibrated as at 56 and which in this instance is secured to the elongated member 11 and a micrometer head 51 disposed in threaded engagement with the upper end of cylinder 52. The micrometer head 51 is connected by a shaft (not shown) which extends through the cylinder 52 and elongated member 11 to the spring contacting member 50 whereby movement of the head 51 effects a calibrated movement of the member 50 and consequently a measured adjustment of the spring 49. Thus it can be seen that the tension spring 49 may be easily adjusted to predetermined and calibrated tensions by mere rotation of mircometer head 51.

The pivot mechanism shown generally at 15 is of such a construction as to avoid loose and inaccurate control of the pressures brought to bear on electrodes 21 and 23. Pivot rocker member 61 is securely fastened to member 11 by means of bolts projected through the threaded perforations 65 shown in Fig. 4 into corresponding threaded perforations 66 of elongated member 11 shown in Fig. 2. Perforations 63 shown in Fig 4 are employed to receive dowel pins which are projected through these perforations into corresponding perforations shown as 64 in Fig. 2. Pivot rocker member 61 also possesses a large perforation shown as 67 (Fig. 5). Through this perforation there is projected a brass and steel bushing shown in Fig. 1 as 68 which also projects through perforations in end plates 71. End plates 71 are bolted on either side of elongated member 13 by means of a bolt shown at 73 and dowel pins shown at 75 which project through drill holes in member 13 as shown at 74 and 76 in Fig. 3. Thus it can be seen that rocker member 61

is pivotally but rigidly attached to elongated member 13 and that the elongated members 11 and 13 are solidly pivotally connected by means of bushing 68 and plates 71. Bushing 68 is constructed of a steel core and a brass case shown at 69.

In operation, ohmmeter 39 is connected to the testing apparatus as shown in Fig. 1. A predetermined constant pressure is applied to electrodes 23 and 21 by means of spring 49 as adjusted by rotation of micrometer head 51. Pressure is then applied to the handles of elongated members 11 and 13 in area 17 which acts to pivot the elongated members at mechanism 15 to separate electrodes 21 and 23. Insulated lamination, sheet or strip is then projected between the electrodes and the pressure applied to handles 17 is released permitting the electrodes to clamp down on the interposing material. The electrodes effect a uniform contact throughout their contacting surface area on the sides of flat rolled products in that electrode 21 will pivot on pivot rod 29 in drill holes 33 to adjust and conform to the surface of the insulated and/or laminated parts as contacted by upper electrode 23. A reading is then taken on ohmmeter 39. The resistance offered by the interposing materials and registered on the dial 41 of ohmmeter 39 may be regarded as a measure of the quality of the insulation of the materials tested or may be translated into the thickness of the insulation present. Conventional practice is to employ known standards of insulated samples ranging from those possessing excessive thickness of insulation to those possessing inadequate insulating or laminating qualities. Production line testing may then be effected by periodical inspection with the apparatus and by reference of the ohmmeter readings to the standard values previously established.

As can be seen by the above detailed description, the instrument of the present embodiment may be employed to measure ohm resistance over a given area and under a given pressure. For example, a customer of a producer employing this instrument may require a material that possesses a resistance of about 10 ohms per square inch at a pressure of 10 pounds. The handles 17 of the apparatus of Fig. 1 may then be drawn together thus propelling electrodes 21 and 23 away from one another. The coated steel that has been coated in such a manner as to effectively meet the requirements set forth is then projected between electrodes 23 and 21 whereupon the handles 17 are released and the electrodes firmly grip the material being tested. Micrometer head 51 either has been or can be adjusted to acquire the 10 pounds per square inch. An ohmmeter reading is then taken and knowing the contacting areas, such as area 27 of electrode 21 and the area of the contacting surface of head 25 of electrode 23, the question of whether or not the laminate meets the requirements set forth may be quickly determined without adverse effects on the coated steel products. Thus numerous readings may be taken periodically quickly and efficiently.

Specifications for coated electric grades of steel commonly require an ohm resistance ranging from about 1 to 50 ohms at pressures of from about 10 to 50 pounds.

I claim:

1. Apparatus for testing the electrical resistivity of metal coatings comprising two substantially parallel elongated members pivotally joined between the extremities of said members, the ends of the elongated members on one side of the pivot, constituting the handles of said apparatus, so that reverse movement is effected on the other ends of said elongated members, said other ends of the elongated members constituting the head of said apparatus, a pair of opposed electrodes mounted in the head of said apparatus, one on each of said elongated members and disposed to contact one another when the extremities of said elongated members in the head of said apparatus are propelled towards one another, said electrodes each being formed with a known contacting

area disposed to contact strips of metal interposed between said electrodes, at least one of said electrodes being substantially half cylinder shaped and pivotally mounted with the axis of the pivot being substantially parallel with the axis of the cylinder and positioned as recessed in a groove formed in the elongated member and disposed to permit the flat side of said half cylinder shaped member to face said other electrode and to rock freely in a direction substantially parallel with said elongated members, means for electrically insulating said electrodes from one another, means for supplying said electrodes with an electric current flowing from one of said electrodes to the other when in electrical contact with one another, means for measuring the electrical resistance of any current carrying object interposed between said electrodes, a spring positioned between the handles of said apparatus disposed to provide a predetermined force on said handles to effect a predetermined force on the extremities of said elongated members in the head of said apparatus to propel said electrodes toward one another, and means to adjust the predetermined pressure applied by said spring.

2. Apparatus for testing the electrical resistivity of metal coatings comprising two substantially parallel elongated members pivotally joined between the extremities of said members so that movement of the ends of said elongated members at one extremity towards or away from one another causes reverse movement at the opposite extremities, the area on one side of the pivot constituting the head of said apparatus and the area on the other side constituting the handles of said apparatus, a pair of electrodes mounted in the head of said apparatus, one in each of said elongated members and positioned as opposing one another, said electrodes each being formed with a known contacting area, at least one of said electrodes being substantially half cylinder shaped and pivotally mounted with the axis of the pivot being substantially parallel with the axis of the cylinder and said half cylinder shaped electrode being positioned as recessed in a groove formed in said elongated member so that said electrode may rock freely in a direction substantially parallel with said elongated member to which it is mounted and being disposed to permit the flat side of said half cylinder shaped member to face said other electrode, means for electrically insulating said electrodes from one another, means for supplying said electrodes with an electric current flowing from one of said electrodes to the other when in electrical contact with one another, means for measuring the electrical resistance offered by any current carrying object interposed between said electrodes, a spring positioned between the handles of said apparatus that provides a predetermined positive pressure in causing said handles to oppose one another so that said elongated members of the head of said apparatus provide a positive pressure to said electrodes towards one another, and means to adjust the predetermined pressure applied by said spring.

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