March 10, 1964 J. E. CROWLEY 3,124,773

ELECTRIC CONTROL APPARATUS

Filed July 28, 1961

FIG. 2

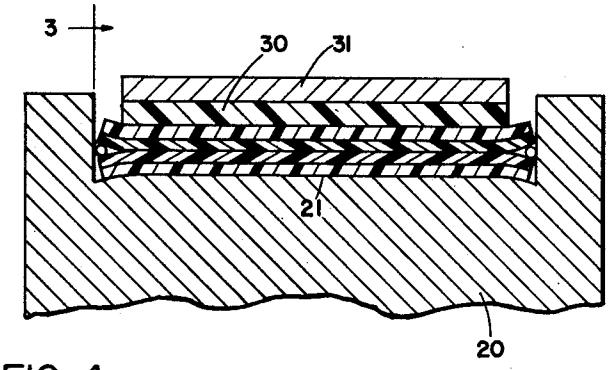


FIG. 4

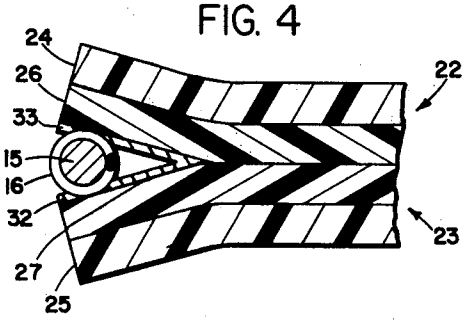


FIG. 1

FIG. 3

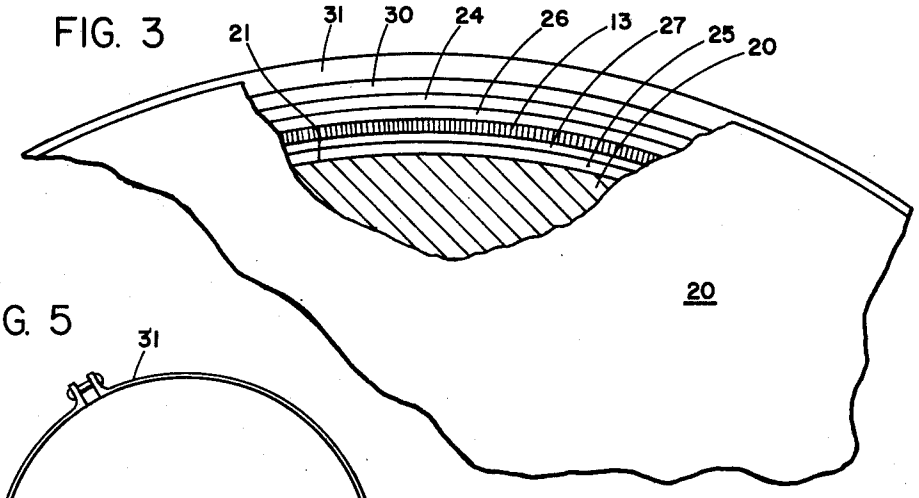
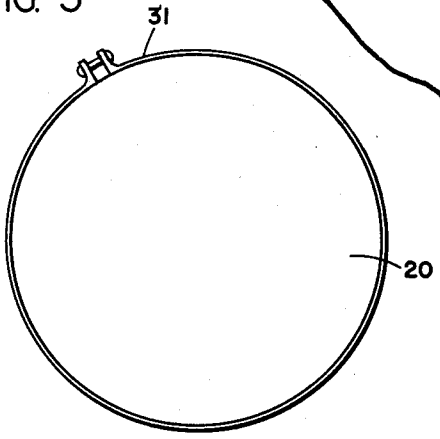


FIG. 5



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3,124,773

ELECTRIC CONTROL APPARATUS

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5 Claims. (Cl. 338—150)

This invention relates to the field of electrical instruments and more particularly to resistance elements for use in such instruments. A filar resistance member is incorporated in the edge of a very thin tape bearing meaningful indicia so that the resistance of the member from some measuring point is always coordinated with the associated indicium. While such a concept is not new, there has been heretofore no teaching of any practical way of accomplishing the desired result, that is, of physically securing a resistance member to the edge of a thin flexible tape so that it remains fastened thereto during the normal flexing of the tape in use, and so that continuous, reliable contact with the resistance member along its entire length can readily be assured.

An object of the invention is to develop a process for constructing an instrument component comprising a flexible graduated indicator tape with a resistance member incorporated into one or both edges thereof for continuous engagement by an external electrical contact. Another object of the invention is to provide a practical instrument component as described above and a further object of the invention is to provide a new and improved laminated fabric for use in such electrical components.

Various other objects, advantages, and features of novelty not individually enumerated above which characterize my invention are pointed out with particularity in the claims annexed hereto and forming a part hereof. However, for a better understanding of the invention, its advantages, and objects attained by its use, reference should be had to the subjoined drawing, which forms a further part hereof, and to the accompanying descriptive matter, in which I have illustrated and described a preferred embodiment of my invention.

In the drawing, FIGURE 1 is a transverse cross sectional view of a completed tape resistor according to the invention, FIGURE 2 is a cross sectional view of a step in the manufacture of the element, FIGURE 3 is a fragmentary side elevation of FIGURE 2, a portion being broken away for clarity of illustration, FIGURE 4 is an enlarged view of a portion of FIGURE 2, and FIGURE 5 is a view on a smaller scale of the apparatus of FIGURES 2 and 3.

FIGURE 1 shows a laminated fabric including outer layers **10** and **11** of Fiberglas and an intermediate layer **12** of nylon, with filar resistance members **13** and **14** partially embedded in the edges of the fabric for edgewise engagement by suitable external electrical contact means not shown. One or both of the outer surfaces of layers **10** and **11** may bear suitable indicia, spaced linearly or nonlinearly, and the resistances of members **13** and **14** are linear or nonlinear accordingly.

Each resistance element is constructed of a flexible core wire **15** on which is formed a helical winding **16** of resistance wire, insulated from the core and between the adjacent turns thereof, as shown in FIGURE 4. In one embodiment of the invention the core was 35 gage Formvar insulated copper wire, and the resistance wire was .001 inch in diameter under enamel insulation, and was of the alloy known as Oro G: obviously other suitable materials and dimensions may be used according to the needs of the user.

The resistance element shown in FIGURE 1 is not easily constructed, and much effort was expended before a satisfactory method of making these units was invented.

In practicing this invention, a metallic disk **20** to act as a holding fixture is first turned to provide a peripheral groove **21** somewhat deeper and wider than the thickness and width of the tape and peripherally longer than the desired length of the tape. There is also provided a pair of laminated fabric members **22** and **23** comprising respectively Fiberglas layers **24** and **25** and nylon layers **26** and **27**. A Teflon cushioning strip **30** and a metal clamping ring **31** are also used.

In making a resistance element, a tape **23** is placed in groove **21** with its Fiberglas surface against disk **20**. An adhesive such as Cycleweld is applied along one or both edges of the tape as at **32**, and the resistance member **13** is positioned next to the edge of groove **21**. This is followed by another application of adhesive **33** and tape **22** is next applied with its nylon surface against the nylon surface of tape **23**. Teflon strip **30** is next applied and the whole assembly is fastened together by clamping ring **31**. Members **30** and **31** are slightly narrower than groove **21** so that upon tightening ring **31**, resistance members **13** and **14** are forced outwardly into engagements with the walls of groove **21**.

The entire assembly is now heated to the point where the two abutting nylon layers fuse into a single homogeneous layer in which the resistance elements are embedded except along the lines where they contact the walls of groove **21**. After a suitable curing interval, the clamping ring and cushioning strip are removed and the finished tape is taken from the disk and sugar-blasted along its edges to remove enamel and foreign matter so that good electrical contact may be made with the winding at any point along its length. The desired indicia may now be printed on the tape surface and the element is ready for use.

In some cases it may be desirable to supply each of members **22** and **23** with nylon strips on both sides of the Fiberglas, to act as an improved base for certain printing inks, and also to facilitate splicing of the completed device, if such is contemplated. Groove **21** may then be lined with Teflon to prevent adhesion of the nylon to the disk.

Numerous objects and advantages of my invention have been set forth in the foregoing description, together with details of the structure and function of the invention, and the novel features thereof are pointed out in the appended claims. The disclosure, however, is illustrative only, and I may make changes in detail, especially in matters of shape, size, and arrangement of parts, within the principle of the invention, to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

I claim as my invention:

1. In combination, a pair of coextensive elongated flexible members, each comprising at least a layer of Fiberglas and a layer of nylon, arranged with their nylon layers in contact, except along an edge thereof, to form a laminated fabric, an elongated filar resistance element partially between said members along said edge, and means adhesively joining said element to said members.

2. The method of making a tape resistor from an elongated flexible resistance element and a pair of laminated flexible tapes each comprising a surface layer of nylon, which comprises the steps of laying one of said tapes, nylon side out, in a groove, of substantially the same width as the tape, in a heat transfer member, applying adhesive along an edge of the tape, applying the resistance element to the edge of the tape in contact with the adhesive so that it projects appreciably beyond said edge, applying the other of said tapes nylon side down to the first tape, applying pressure forcing the two tapes into intimate contact, and heating the assembly to the

point where the two nylon layers amalgamate into a single mass.

3. The method of making a tape resistor, from a coiled, helicoid, flexible resistance element and a pair of laminated flexible tapes each comprising a surface layer of nylon, which comprises the steps of laying one of said tapes, nylon side out, in a groove, of substantially the same width as the tape in a heat transfer member, applying adhesive along an edge of the tape, applying the resistance element to the edge of the tape in contact with the adhesive so that it projects appreciably beyond said edge, applying the other of said tapes nylon side down to the first tape, applying pressure forcing the two tapes into intimate contact and heating the assembly to the point where the two nylon layers amalgamate into a single mass.

4. A resistor comprising a lamina of a thermoplastic material such as nylon, an elongated resistance element substantially embedded in said lamina along an edge thereof so that a relatively small radial portion of said element extends beyond said lamina, and further laminae of Fiberglas overlying the first named lamina.

5. A resistor comprising a lamina of a thermoplastic material such as nylon, a coiled, helicoid resistance element substantially embedded in said lamina along an edge thereof so that a relatively small radial portion of said element extends beyond said lamina, and further laminae of Fiberglas overlying the first named lamina.

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