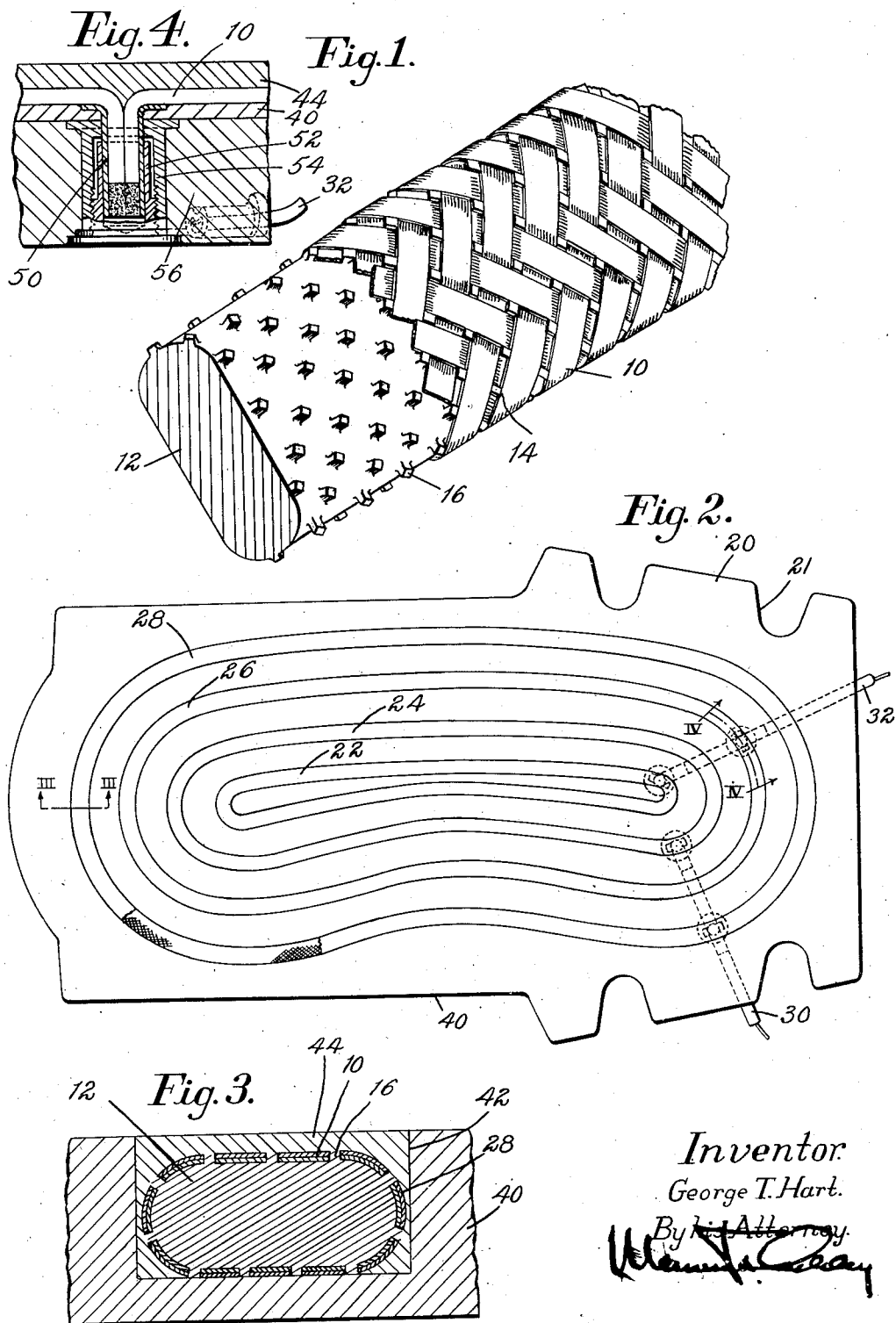


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G. T. HART
FLEXIBLE ELECTRODE MEANS FOR
HIGH-FREQUENCY HEATING.
Filed March 4, 1946

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UNITED STATES PATENT OFFICE

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FLEXIBLE ELECTRODE MEANS FOR HIGH-FREQUENCY HEATING

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6 Claims. (Cl. 219—47)

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This invention relates to flexible electrodes such as are employed in dielectric heating in connection with irregularly shaped articles. It is herein illustrated as embodied in a flexible electrode pad adapted to be pressed into contact with the work to be heated.

Although flexible electrodes may be employed for many purposes where it is desired to set up heat by means of a high-frequency electrostatic field, there are certain special problems which are more evident when such electrodes are employed in shoemaking as, for example, in activating an adhesive used to secure a sole to a shoe. In that particular use, it is desired to hold the work under pressure during the activation of the adhesive so that there shall be uniform contact between the parts to be attached, and it is for this reason that the electrode must be constructed in such a way that it shall be pliable and readily conformable to the shape of the bottom of the shoe. Furthermore, a single electrode must be capable of employment for shoes of different sizes and shapes and must have sufficient mechanical strength under such conditions to wear well and to avoid subjecting the insulating material surrounding the electrode conductors to such stresses that flash-over between adjacent electrode strips may be caused.

Accordingly, one object of the invention is to provide an improved flexible electrode pad embodying conductive strips which have such mechanical strength and pliability as is needed and which will at the same time be of a highly efficient form, electrically, for use for the intended purpose.

In accordance with a feature of the invention and in view of the fact that the "skin effect" makes it desirable in making such a pad to use electrode strips having as large a peripheral surface area as possible, the strips herein illustrated are made up of metal elements braided or clockwise made up in tubular form. Experience shows that such a strip operates at best efficiency when it is approximately twice as wide in directions parallel to the surface of the work as it is high in directions toward and away from the work.

Another feature of the invention lies in the employment in an electrode pad, of hollow strips each filled with a rubber core, without destroying the pliability of the strip, will maintain it, even under pressure, with a physical cross section which is found most desirable.

In flat flexible pads where the strips are surrounded by insulating material, and one pad of

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that sort is illustrated in Letters Patent of the United States No. 2,228,136, granted January 7, 1941, upon my application, it is very desirable that all air shall be excluded from the neighborhood of the conductors for the reason that pocketed air is under a severe electrical strain when surrounded by material of a higher dielectric constant and sets up a condition making flash-overs through the insulating material more likely.

According to another important feature, invention resides in the utilization, in a flexible pad, of strips having a partially vulcanized core material in which, by regulating the tension placed upon the individual conductor elements as they are braided around the core, the latter are embedded, causing the core material to protrude through the spaces between the elements and thus reach a position where it is joined, as by vulcanization, to the surrounding insulating material of the pad. This renders it very unlikely that any air will be trapped between the braided strip and the surrounding insulation.

In electrode pads intended for use in the attachment of soles, it is very desirable that the various portions of the work shall be heated uniformly and in an equal time. The illustrated pad is, therefore, made up with its electrode strips formed in a series of substantially concentric or equally spaced elongated loops. By connecting these loops alternately to opposite sides of the source of power, a series of closely adjacent stray fields will be set up of substantially equal intensity and so distributed that the marginal area of a shoe sole where it has been cemented will receive equal heating effect regardless of the exact size and shape of the sole.

These and other features of the invention will more readily be understood from a consideration of the following specification taken in connection with the accompanying drawings, in which

Fig. 1 is an enlarged angular view of an electrode strip embodying my invention and showing the braided elements removed from a portion of the core;

Fig. 2 is a plan view of an electrode pad embodying my invention; and

Fig. 3 is a vertical section, taken on the line III—III of Fig. 2, through one of the conductive strips embedded in such a pad; and

Fig. 4 is a vertical section on the line IV—IV of Fig. 2 through the pad at a point where connections are made to the oscillator.

In the manufacture of electrode strips to be employed in pads, the desirable flexibility and capability of many bendings without breaking

have been secured by braiding a plurality of strands 10 of copper rather tightly about a flexible core 12 of low-loss elastic material which may be a plastic capable of being bonded to a plastic material employed in the pad. One such plastic material consists of partly vulcanized rubber or rubber substitute. The strands of the braid are shown as flat strips for ease of illustration but may be made up of parallel wires (not shown). Preferably, they are tinned to prevent sulphating. As a result of the fact that the core material is not fully vulcanized, the conductor strands are partially embedded therein, causing the material to protrude, more especially through the spaces 14 between adjacent strands, to form nubs 16.

The cross-sectional shape of the core is substantially oval so that there are no sharp corners in the strip at which excessive dielectric stresses might be set up to cause flash-over. Furthermore, the dimensions of the core are such that it is about twice as wide as it is thick, thus flattening the strip and giving it a dimension found to be particularly efficient in setting up electrostatic fields when embodied in a pad 20 such as is shown in Fig. 2. Notches 21 at sides of the pad facilitate clamping it in position as on a pad box (not shown). This pad is provided with a series of electrode strips in the form of elongated flattened ovals 22, 24, 26 and 28 which are substantially equally spaced along the sides of the pad and at the curved end portions of the ovals. This arrangement of the strips sets up a series of stray fields in which there may be positioned shoe bottoms of a wide variety of shapes and sizes without varying the heating of the adhesives on the work. The outer strip 28 and the alternate strip 24 are joined by a lead 30 which may be connected to the low-voltage side of a source of high-frequency power. This arrangement eliminates any voltage difference between the outer loop 28 and any surrounding metal of the machine. On the other hand, the central loop 22 and the strip 26 are joined to a lead 32 adapted to be connected to the other or high-voltage side of the source.

One arrangement facilitating the connection of the leads 30 and 32 to the strips of the pad is shown in Fig. 4 in which it will be seen that each strip 10 is provided with a downwardly extending bare, metallic terminal 50 adapted to be received in a tubular socket-forming connector 52 held in position in a rigid block 54 of metal carried by a rubber support 56. In this support 56 are positioned the leads 30 and 32 which are given such a position below the pad that they do not improperly affect the electrode strips which they by-pass.

Various methods of making up such a pad may be employed but, conveniently, there is used the structure and method illustrated in the application of James F. Leahy for improvements in pads for high-frequency electrodes filed June 4, 1945, Serial No. 597,470 which application has now become abandoned. In accordance with the practice therein described, the body 40 of the pad is made of a pliable rubber-like material partially vulcanized and provided with grooves 42 in accordance with the desired arrangement of the electrode strips. In those grooves are inserted strips, as shown in Fig. 2, each made up of a partially vulcanized core 12 surrounded by braided strands 10, and then the grooves are filled with a plastic cover material 44 which may be vulcanized to the sides of the grooves and to

the protruding nubs 16 as well as any other portions of the core which extend through the braided sheath. The longer sectional dimension of the strip is arranged horizontally in the groove so that, heightwise, the strip is about half as thick as it is widthwise, thus improving the efficiency of the pad. Preferably and as explained in that application, the efficiency of the pad is increased by using a cover material having a substantially higher dielectric constant than does the material of the body 40 of the pad, thus channelizing the field and obtaining the desired insulating effect without cutting down the efficiency of the pad. After the pad and the strips 15 and the cover material have been assembled, the whole structure is vulcanized to make a substantially unitary structure and to eliminate air pockets. It will be understood, however, that the degree of vulcanization is not such that the pad becomes inflexible or incapable of assuming the contour of the work when the work and the pad are held under pressure.

Electrodes having conductors and covers for the conductors which are made of a material having a substantially higher dielectric constant than the constant of the surrounding medium have been claimed in a copending application Serial No. 580,151, filed February 28, 1945, in my name, which has matured as Letters Patent of the United States No. 2,412,982, granted December 24, 1946.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In an electrode pad for the production of high-frequency electric fields, a support of flexible low-dielectric-loss material, and a series of equispaced, parallel, electrically conductive, hollow strips containing cores on said support, said low-dielectric-loss material closely surrounding the strips and joined to the cores thereby to exclude substantially all air from the pad.

2. In combination, a normally flat, flexible electrode pad, electrically conductive strips therein each comprising an approximately oval flexible core the width of which, parallel to the surface of the pad, is approximately twice the height thereof, and a covering of encircling, flexible wires over said core.

3. In an electrode pad for the production of a high-frequency electric field, a flexible supporting member of dielectric material, a series of flexible electrically conductive strips carried by said supporting member, said strips individually comprising a core of flexible material and a covering of flexible electrically conductive material around said core, and means for connecting alternate strips of the series respectively to the opposite terminals of a source of high-frequency energy.

4. In a conformable flexible electrode pad for the production of a high-frequency electric field in an irregular object, a series of flexible, spaced, electrically conductive strips embodied in a flexible dielectric supporting pad adapted for uniformly engaging a surface of said irregular object, said strips individually comprising a flexible shape-determining core member surrounded by a flexible, braided, electrically conductive covering.

5. Apparatus as defined in claim 4 in which said core members are approximately elliptical in cross-section, the longer cross-sectional dimension of a core member lying substantially in

a plane parallel to the area of the work-opposing face of the pad lying over a core member.

6. In a flexible electrode pad adapted to be engaged with a piece of work under pressure, an electrically conductive strip comprising a core of flexible dielectric material with a flexible metallic covering substantially surrounding said core, and a flexible dielectric pad member for supporting said conductive strip.

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Patent No. 2,474,977

Certificate of Correction

July 5, 1949

GEORGE T. HART

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 1, line 42, for the word "clockwise" read *otherwise*; line 50, before "with-out" insert *which*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 21st day of February, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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