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2 Sheets-Sheet 2

44 46 48 47 51 50 45 49 13 16 17 19

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ELECTROPERFORATOR

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2 Claims. (Cl. 219—29)

This invention relates to apparatus for perforating materials, sheet materials, more particularly, by means of electric arcs. The apparatus will be referred to hereinafter as an electro-perforating apparatus or electro-perforator.

The invention relates especially, but not exclusively, to an electro-perforator capable of distributing perforations over an irregular object such as a shoe.

One of the objects of the invention is to provide an electro-perforator in which electrical discharges of high voltage are controlled so as to burn clean perforations of the desired diameter through the material treated.

Another object of the invention is to provide the apparatus with a hand controlled device, referred to hereinafter as an applicator, connected with the cabinet containing the impulse generating apparatus and its controls, by flexible insulated electrical connections, whereby the applicator may be freely moved in respect to the material to be perforated; the applicator comprising two spaced electrodes, or electrode carrying members, adapted to contact with opposite sides of the material treated, preferably with spring pressure, and said contacting members being formed so that the applicator may be readily moved with respect to the material and the electrodes kept in proper relation to the material even when the material is not uniform in thickness or has surface inequalities.

A more specific object of the invention is to provide an electro-perforator which may be used for the perforation of leather or like material, particularly leather or other material made up into shoes, for the purpose of ventilating the shoes; and in this connection the object of the invention is to provide a simple and inexpensive device, which is easily handled, even by the unskilled, by means of which the electrical discharges may be controlled so as to burn clean and practically invisible perforations in the shoes, which perforations, however, may be made large enough to be visible if desired. Unless properly controlled the electrical discharges are likely to assume a disruptive character which gives material, such as leather, a pebbled or pimpled appearance usually accompanied by inadequacy in respect to the cleanness and size of the perforations.

To make an electrical perforation in the leather of a shoe requires an inside electrode either connected with the source of current or grounded, as well as an outside electrode. It has been found that to use as an inside electrode a device like a

metal shoe tree would require a very large number of different sizes, shapes and kinds to fit the various shoes to be treated, and this would involve not only selecting the suitable size but connecting it with the electrical apparatus. This would be a troublesome and time consuming operation. Another form of inside electrode might be provided by filling the shoe with shot or loose chain links or copper sponge. A conducting wire would be attached to any one of these three forms of inside electrode for the return of or the grounding of the current. These are troublesome to use for manifest reasons. It is clear that the spark penetrating the leather from the outside and entering any one of these three, or similar inside electrodes, can travel through this electrode to any available point of escape, such as a nail in the heel of the shoe or through the sole. Regardless of where the outside electrode may contact the leather of the shoe, the spark will find its way to this nail and ultimately by repeated arcing through at this point, may burn a hole through the heel or the sole. The applicator illustrated in the drawings is free from these objections. The outside and inside electrodes are companion electrodes, always travelling together and with a minimum gap between them through which the current jumps. In fact, every inducement is offered the current to pass directly from the outside to the inside electrode, a distance of perhaps not more than $\frac{1}{8}$ or $\frac{1}{4}$ of an inch. The applicator therefore controls and directs the location of the spark penetration, and entering the inside electrode, the current is conducted back to its source. This minimizes the jumping of the current from the outside electrode to an adjacent point in the leather which is easier to penetrate and then back inside of the shoe to the inside electrode. This also minimizes the chance of electric shock to the operator since the current more easily goes through the channel provided for it and does not tend to jump to any other route.

Moreover, this simple and inexpensive device, which is easily handled even by the unskilled, will fit any shoe large or small, and is always attached to the electrical cords, ready for instant use. It does not necessitate the selection of a suitable size of inner or outer electrodes or of the disconnecting of the one and the installation of another one more suitable to the shoe being operated upon. The very small spark gap economizes in current consumption. The electrical discharges under the current control may burn clean and perfect invisible perforations in the shoe, but

these perforations may be made large enough to be visible if desired.

A further object is to provide for controlling the electrical discharges whereby the size of the perforations may be varied.

The ordinary alternating current supply lines operate at 60 cycles per second which would tend to produce 120 perforations per second which is too rapid for proper distribution over the irregular surface of a shoe by the manual means contemplated in this invention. Hence, it is preferred to use direct current interrupted at the proper intervals to give the desired effect, that is, current discharges of sufficient intensity and lasting for a long enough time to produce the actual burning of the material in the formation of the perforations. In place of the interrupter a condenser and inductance may be used to obtain approximately, at least, the same effect. The invention contemplates the use of a transformer for giving the electrical discharges a high potential.

The invention is illustrated in certain preferred embodiments in the accompanying drawings, wherein

Fig. 1 is a view in perspective of the electro-perforator showing the applicator as operating on a shoe, the toe portion of which is indicated in cross-section.

Fig. 2 is a schematic drawing showing the electrical apparatus for generating and controlling the perforating discharges.

Fig. 3 is a detailed sectional view of the electrodes of the applicator; and

Fig. 4 is a wiring diagram of an apparatus in which the condenser and inductance take the place of the mechanical interrupter illustrated in Fig. 2.

It will be understood that the drawings show forms of the invention which are typical and preferred. The invention, however, is not to be considered as limited to these particular forms, the intention being to cover all equivalents and all modifications within the scope of the hereto appended claims.

The apparatus shown in Fig. 2 is shown as supplied with direct current. The apparatus, however, may be operated from alternating current by inclusion therein of a suitable full wave rectifier.

Referring first to Fig. 1, A is a cabinet containing the apparatus for generating and controlling the perforating discharges; and B is the applicator, comprising a hand grip 10 to which are attached the electrode supporting members 11 and 12. The upper electrode member 11 is preferably made of insulating material 13 (Fig. 3) encasing the electrode 14 which terminates within a hollow 15 in the end of the member 11, the extremity of which is rounded so as to slide easily over the leather which latter is indicated at C. The lower electrode member consists of a stiff rod 16, the end of which is slotted to receive a flat spring 17 to which is attached by screw 18 a conical electrode element 19, the upper end of which is preferably rounded so that the applicator can be moved with respect to the leather of the shoe with ease even when there are surface inequalities or when the thickness of the material varies. The electrodes are at all times kept in proper relation to the upper and under surfaces of the material by the spring action of the spring member 17. The device is thus adapted, for example, to operate on reinforced and thickened portions of the shoe, such as the heel portion and toe portion as well as upon thinner parts.

Referring to Figs. 1 and 3, it will be observed

that the upper electrode comes close to but not into contact with the leather. It is encased in a member composed of some smooth surface insulating material with a rounded under surface, the purpose of using an insulating casing being, of course, to protect the operator. The lower electrode comes in direct contact with the leather. This is not essential. The lower electrode might be made like the upper one. The term "electrode member" as used in the claims is intended to include both an electrode which comes directly into contact with the material and one which is carried by or encased in an element which contacts with the material to be perforated.

The letters D indicate the flexible cords or cables containing the wires which connect the applicator electrodes with the mechanisms associated with the cabinet A. E is the flexible cord which contains the leads from the service lines and is preferably provided with a plug 20 adapted for insertion in an ordinary light socket. For convenience in operation the applicator is provided with a push button switch 21 for controlling the application of the electrical impulses to the material being perforated. This is also a safety feature. With the release of the hand grip the current is cut off.

The apparatus associated with the cabinet A comprises, in addition to the mechanisms contained within the cabinet and to be described later, a rotatable button 22 for controlling the volume of current flowing through the primary circuit of the transformer; a control button 23 for controlling the speed of the make and break motor; a milliammeter 24; a main switch 25; and a pilot light 26.

Referring now to Fig. 2, the lead 27 contains the main switch 25, the pilot light 26 and the push button switch 21 on the applicator. This lead is connected with the primary coil 28 of the transformer F. The secondary coil of the transformer is indicated at 29 and the iron core at 30. Wire 31 connects the primary coil 28 with one member 32 of the interrupter, designated G as a whole, the other member 33 of the interrupter G being connected with the variable resistance 34, the movable contact 35 of which is operated by the button 22 (Fig. 1). Wire 36 connects the movable member 35 of the variable resistance with the milliammeter 24, which latter is connected by wire 37 with the other main lead 38. The motor 39 of the interrupter G is on a shunt circuit 41 from the main leads 27, 38. The interrupter device 42 is shown as a hexagonal cam rotated by the motor 39 and adapted to bear against member 32 to cause it to break from member 33. The electrodes 14—19 of applicator B are in circuit 43 with the secondary coil 29 of transformer F. Preferably motor 39 is provided with a device for controlling its speed and thereby controlling the number of current interruptions per unit of time, such for example as the variable resistance 40 controlled by the control button 23 (Fig. 1).

Leather and other materials employed in the manufacture of shoes are fairly good dielectrics, that is, non-conductors of electricity. In carrying out the present invention, sufficient electrical potential is applied to the electrodes to break through or puncture the material of the shoe. It has been found that the size of such perforations is determined by the magnitude of the electrical current which is permitted to pass through the holes after the puncture or break down has been accomplished by the initial high potential.

In the perforation of shoe leather it is desirable to employ electrical currents in the range of five to fifty milliamperes flowing for approximately $\frac{1}{10}$ to $\frac{1}{30}$ of a second; and with currents of this character there will ordinarily be no undue distortion of the surface of the leather. Currents of relatively low amperage producing small pores must be used with highly finished fine leathers, whereas the larger currents may be used on materials with coarser or rougher surfaces. It should be understood that in this method of electro-perforation, the current is caused to flow for a sufficient time to actually vaporize or burn away some of the material. This is essential in order to obtain clean and permanent pores or perforations of sufficient size for effecting the desired ventilation of the shoe.

It has also been found that if the electricity is allowed to flow too rapidly through the leather—that is, too high a current for too short a time—the surface of the leather becomes distorted around each perforation giving a pimpled appearance which is undesirable. Thus in the satisfactory electro-perforation of leather shoes, both magnitude and duration of the perforating current must fall within a certain range of values. There are several available means for obtaining electrical impulses of controlled voltage, current and time characteristics. It is deemed preferable to employ the electrical system which is shown in Fig. 2. This system consists, it will be seen, from the above description, of a low voltage source of direct current, at 115 volts for example, and a transformer having a primary circuit through which the direct current is allowed to pass. The magnitude of this primary current is controlled by the variable resistance 34—35 and is measured by the meter 24. This primary current energizes the iron core 30 so that when the circuit is opened suddenly by means of the interrupter G a single high voltage impulse is induced in the secondary winding 29. It has been found that under average conditions from 10 to 30 impulses per second can be properly distributed by means of the manual applicator. The potential of the perforating impulses is determined by the number of turns of wire in the secondary coil and by the degree of magnetization of the iron core at the instant the primary circuit is broken. The magnetization of the core is determined by the number of turns in the primary coil and by the magnitude of current which is permitted to flow therein. In the operation of the apparatus as above described an excess of potential in no way impairs operation. Hence, it is preferred to provide sufficient turns in the secondary coil so that an excess of potential is always present to puncture the material of the shoe, at any place where it is desired to make the perforations, regardless of the adjustment of the variable resistance 34—35. The magnitude and duration of the perforating current also depends upon the degree of magnetization of the iron core. Thus, since sufficient

potential has been provided, the variable resistance device serves as an effective control for the amount of current supplied to the primary coil of the transformer, and, consequently, for the size of the perforations produced by the electrical impulses. As pointed out above, the pore size is determined by the magnitude and duration of the perforating current.

In certain leathers where the surface is sensitive and the proper current setting is consequently too low for a single impulse to produce the desired pore size, the applicator may be passed over the surface repeatedly, thereby enlarging the holes to the desired size.

A modified arrangement is indicated in Fig. 4. It is assumed that the leads 44—45 are connected with the secondary coil of a suitable transformer giving, for example, a potential of 30,000 volts, with the interposition of a rectifier for converting the alternating current into direct current. The lead 44 contains a resistance coil 46 and a spark gap 47 to prevent leakage of current across the gap between the applicator electrodes. A line 48 connects the leads 44—45 and is grounded at 49. It contains an inductance 50 and a condenser 51. This arrangement, which may, of course, be supplied with suitable controls, can be operated to give intermittent discharges of electric current between the electrodes of the applicator of the proper intensity and duration to perforate the material with clean cut perforations; the operation being as follows: The resistance 46 is selected or adjusted so as to give the number of impulses per second that may be desired. When the condenser is charged to a potential sufficient to break down both the spark gap 47 and the material in the gap at the applicator, current will flow through the system at an intensity and for a period of time depending upon the capacity of the condenser 51 and the inductance of the coil 50. The action of the inductance 50 and the condenser 51 makes the current oscillatory and prevents a too rapid discharge.

We claim:

1. In an electro-perforator, a manually operated applicator provided with a pair of electrode members adapted to contact under spring pressure with opposite sides of the material to be perforated, one of said members comprising an electrode and an insulated sheathing having a recess at its extremity to the bottom of which the electrode extends without contact with the material operated upon.
2. In an electro-perforator, a manually operated applicator provided with an upper electrode having a sheathing of insulating material formed with a rounded extremity, and a lower electrode comprising a flat spring and a conical electrode element on said spring in line with the end of the upper electrode.

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