Nov. 14, 1950 W. D. WENGER 2,529,717

HEAT SEALING APPLICATOR WITH REMOVABLE ELECTRODE

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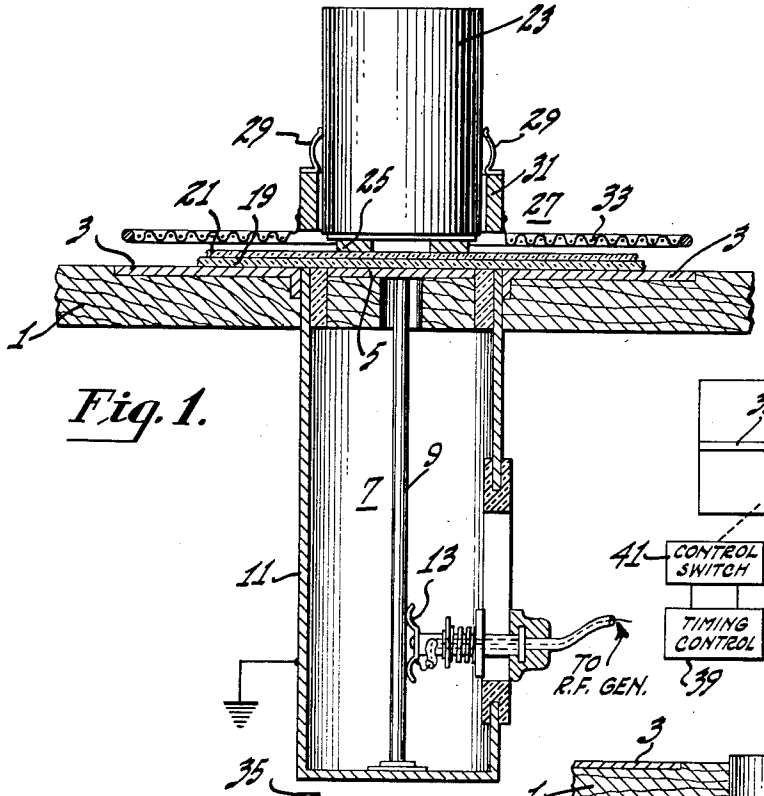


Fig. 1.

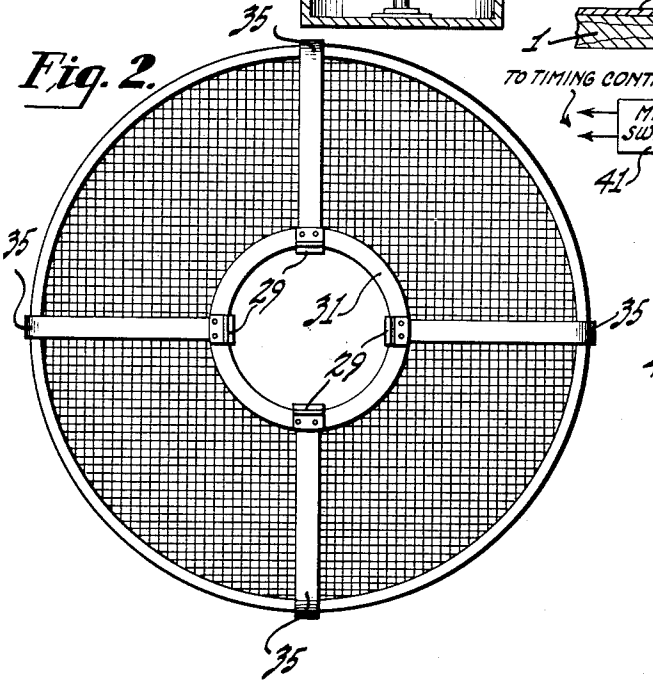


Fig. 2.

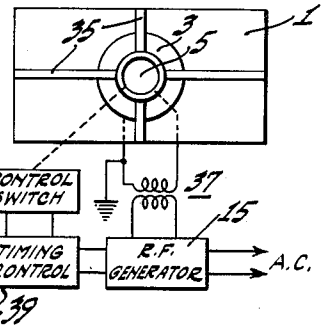


Fig. 7.

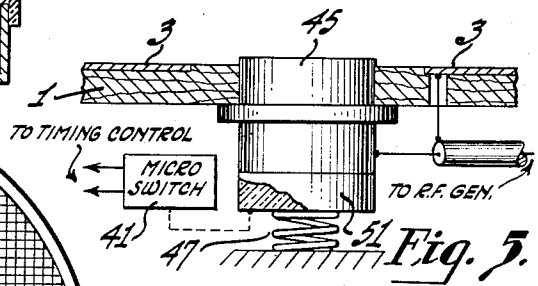


Fig. 5.

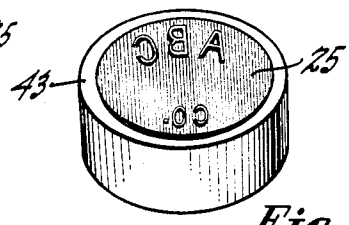


Fig. 4.

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HEAT SEALING APPLICATOR WITH REMOVABLE ELECTRODE

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10 Claims. (Cl. 219—47)

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This invention relates to high frequency devices for sealing thermoplastic materials, and more particularly, to a compact sealing device in which one of the applicator electrodes is freely removable, there being no conductive or physical connection between the electrode and the device so that various shapes and sizes of seals may be made quickly by employing interchangeable electrodes.

The application of radio frequency energy to a thermoplastic dielectric material to effect a seal or bond is well known. The material is placed under pressure between two electrodes which are connected to a suitable source of high frequency energy. Due to the dielectric loss of the material, heat is developed within it to cause the inner adjacent surfaces to flow together while the cold electrodes cool the outer surfaces and prevent distortion of the material.

Long seams may be made by a "sewing machine" type of sealer in which the material is fed through the machine between rollers or reciprocating bar electrodes. Small seals of special shapes cannot conveniently be made on such machines, however. A one shot process is preferable in making buttonhole or other reinforcements. This requires a specially shaped applicator or "bar sealer" for each such job, and where an article requires several different seals of this type it is necessary to move it from machine to machine for each step of the process. This is costly, due to the loss of time in handling. It has not been practical heretofore to change the shape of the electrodes of a given machine in processing an article of this type because the electrodes are rigidly connected to the machine, physically and electrically, and it would take longer to change the electrodes than it would to move the material to another machine.

It is the primary object of this invention to overcome these disadvantages of the prior art devices by providing a heat sealer which utilizes the one shot principle and in which the electrode which determines the shape and size of the seal is freely removable from the machine. The operator can select one out of any number of electrodes which will produce a seal of the desired shape or size, place it over the material at the proper place, and make the seal instantly, without it being necessary to make any physical or electrical connections to the electrode. Merely placing it on the material in the proper position is all that is necessary. Another electrode may immediately be selected to produce a seal of another shape.

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It is therefore a further object of this invention to provide a heat sealing device in which one of the two electrodes between which the seal is made has no conductive electrical or physical connection to the device, and thus is instantly replaceable. In this connection a conductive electrical connection is to be distinguished from a capacitive or inductive coupling, the former inferring an actual physical contact.

A still further object of this invention is to provide means whereby the removable electrode automatically causes the power to be applied to the device to effect the seal when it is placed on the material, thus obviating any separate step of throwing a switch to apply the heating energy, and saving the time previously required for this operation.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings, in which

Figure 1 is a view partly in section of the dielectric heating sealer in accordance with this invention;

Figure 2 is a plan view of a conductive flange used in connection with the device illustrated in Figure 1;

Figure 3 is a diagram illustrating the electrical connections to the applicator;

Figure 4 is a magnetic applicator electrode, and

Figure 5 illustrates the application of an automatic switching device for controlling the application of radio frequency energy to the electrodes.

Referring to Fig. 1, reference numeral 1 indicates a section of a wooden table top such as may be employed in the manufacture of an article of thermoplastic material. Recessed in the top surface of the table is a conductive base plate 3 which is normally connected to ground. An opening within the base plate 3 is provided for the high potential electrode 5 which is mounted with its upper surface substantially in the plane of the table top, and which is suitably spaced and insulated from the base plate. Although the base plate has been illustrated as an annular ring it may take any shape desired and may or may not enclose the high potential electrode 5. It must, however, be adjacent thereto, for reasons which will appear subsequently.

Extending downwardly through the table top

and connected at its upper end to the inner edge of the base plate 3 is a resonant concentric line 7. The line is preferably a quarter wavelength long at the operating frequency, and the inner conductor 9 may therefore be connected to the outer conductor 11 at its closed end. The open end of the inner conductor 9 is connected to the lower surface of the high potential electrode 5. The outer conductor 11 is grounded while the inner conductor 9 is connected through a slidable contact 13 to a flexible lead which is connected to the high potential terminal of the radio frequency generator 15, shown in Fig. 3.

Assuming that a one-shot seal is to be made between two layers of dilectric thermoplastic material 19 and 21, the material is placed on the table top by the operator so that the point to be sealed lies directly over the high potential electrode 5. Since most thermoplastic materials are semi-transparent, there should be no difficulty in observing the location of the high potential electrode through the material. For convenience and speed of operation the electrode may be painted a distinguishing color or if the material is insufficiently transparent a small ridge may be made around the outer circumference of the high potential electrode so that the operator may locate its position by feeling the ridge through the material.

As indicated briefly above, the principal utility of this invention lies in the rapid interchangeability of one of the applicator electrodes to permit selection by the operator of the one which will produce a spot seal of the desired size and shape. From a number of different and freely removable applicator electrodes, the operator then selects the one, 23 for example, which is to be used to produce the seal of the desired size. This electrode is of relatively heavy cylindrical metallic construction having attached to one end a die 25, the raised surface of which is of the shape and size of the desired seal. It has been found that a weight of approximately five pounds will be sufficient to provide the necessary pressure on the thermoplastic material to affect a completely sealed joint. In order to maintain the electrode 23 substantially at or only slightly above ground potential, and thus apply the radio frequency energy to the article to be treated when placed between electrodes 23 and 5, effective capacity coupling means is provided in the form of a conductive flange 27 of relatively large area. The flange 27 may be rigidly connected to the ground or low potential electrode 23, or it may engage the electrode by means of a series of spring contactors 29 mounted on an inner ring 31 which supports a metallic screen 33. This permits the electrode 23 to be replaced when desired and permits the maximum capacitive coupling between the flange and the base plate 3, since the flange may be pressed tightly against the surface of the thermoplastic material. Although a metallic screen construction has been illustrated it is to be understood that a solid sheet metal flange may be employed, the diameter being sufficient to provide an increased area and to bring the electrode substantially to ground potential due to increased capacitive coupling to the base plate considering the frequency employed. For a frequency of the order of 200 meg. which is conventially used in devices of this type, the diameter of the flange 27 may be of the order of 6 to 8 inches. A plan view of the flange 27 is shown in Fig. 2.

In order to assist the operator in orienting ground potential electrode 23 over the center of the high potential electrodes 5, and thus over the portion of the material which is to be bonded, the flange may be painted with four radial stripes 35 which may readily be aligned with the corresponding stripes painted on the table top 1 and extending radially from the center of the high potential electrode as shown in Figs. 2 and 3.

The concentric line 7 is a resonant circuit and develops the maximum voltage across the open terminals when the concentric line is tuned to the frequency of operation. It is evident that electrode 23 will add additional capacity to the high potential electrode, and the length of the line must therefore be adjusted or designed with this fact in mind. Since it is well known that detuning a resonant circuit reduces the voltage developed across the open ends, the removal of the ground potential electrode will detune the resonant line. This has the advantage that the field produced between the adjacent edges of the high potential electrode 5 and the base plate 3 will be insufficient to produce undesirable heating in the thermoplastic material should power be applied before the ground plate electrode is in position.

When ready for operation, the maximum voltage is developed between the adjacent surfaces of the two electrodes and the heating effect is thereby limited to the area immediately beneath the extended surface of the upper electrode. It has also been observed that heat sealing of thermoplastic material in this manner produces an area of decreased light reflection due to the fact that the inner surfaces of the material have flowed together. The seal is therefore readily observable and this effect may be used by the manufacturer of an article to imprint his trademark or other identification in the material at the same time as a seal is made between adjacent layers. The selection of patterns is unlimited and printed material may be readily reproduced on the material by means of a standard printing electrotype plate. Of course the trademark may be impressed on a single layer of the material without affecting bonding, if desired, although the change in transparency of the material will proably be less, due to the fact that the adjacent surfaces of the cold electrodes prevent the outer surfaces of the material from becoming heated, unless the energy is applied over a longer period of time.

Fig. 3 illustrates the electrical connections to the applicator described above. The radio frequency generator 15 is coupled by any suitable means, such as a transformer 37, to the high potential electrode 5, one terminal being connected to the base plate 3 and the ground. Since the period of application of energy to the thermoplastic material is extremely short, an adequate seal being produced in approximately one second, it is desirable to employ a time control device 39 which may be any of the well known devices which apply the energizing current to the R. F. generator for the required time. The timing control 39 may be set into operation at the desired instant by a control switch 41, either manually operated or responsive to the pressure of the ground potential electrode in a manner which will be illustrated subsequently.

In order to reduce the weight of the various ground potential electrodes and yet provide adequate pressure on the thermoplastic material placed between the adjacent surfaces of the two electrodes, the magnetic force of attraction produced by a permanent magnet may be employed.

This is illustrated in Fig. 4, in which a ground or low potential electrode **43** consists of permanently magnetized material such as Alnico, or the like, having attached to its lower face a die **25** suitably designed with raised portions in the form of letters, numbers or any other configuration which will imprint in the material a seal of similar shape. The high potential electrode **5**, in this case, may also be of magnetizable material or itself a permanent magnet of opposite polarity so that the necessary attractive force is produced which will bring the desired pressure on the material. Alternatively, the magnetic electrode may be employed with a non-magnetic high potential electrode. In this case the magnetic attraction would be used to hold a die against the electrode. Special shapes could thus quickly be made up by bending iron wire and placing it in position against the magnetized electrode.

Referring to Fig. 5, a modification is illustrated in which the weight of the ground potential electrode, not illustrated, causes the high potential electrode **45** to move downwardly against the force of a spring **47**. In this case the surface of the high potential electrode may be slightly above the level of the table, although this is not necessary. A microswitch **41** is mechanically coupled to the high potential electrode **45**, preferably through insulating material **51**. The microswitch then operates the timing control **39** to apply a pulse of high frequency energy of the desired duration as illustrated in Fig. 3. There has thus been described an applicator for applying a high frequency electric field to an article to be treated in accordance with known methods comprising two electrodes, one being normally connected to a source of high frequency energy and the other being freely removable and adapted to be brought into cooperative relationship with the other electrode. The removable electrode is maintained substantially at or only slightly above ground potential by a capacitive coupling arrangement which is effective only when the electrode is in its operating position, and no other physical or electrical connections are required. The electrode may thus be readily interchanged, and the above arrangement permits the rapid selection of one of a number of electrodes to effect different sealing processes.

What I claim is:

1. An applicator for applying to a dielectric material simultaneous pressure and a high frequency electric field from the oscillations generated by a high frequency oscillation generator having high potential and ground potential terminals, said applicator comprising a grounded base plate coupled to said ground potential terminal, a high potential electrode coupled to said high potential terminal and having its working surface substantially in the plane of said base plate, a low potential electrode adapted to be capacitively coupled with said high potential electrode with said material between said electrodes, and a conductive flange, said low potential electrode and said conductive flange being removably coupled mechanically and electrically whereby said low potential electrode is removable from said flange, said conductive flange being positionable on said low potential electrode to capacitively couple with said base plate when said high and low potential electrodes are brought into capacitive relationship.

2. A device of the character described in claim 1 in which a magnetic force of attraction is employed to attract said electrodes to each other.

3. An applicator for applying to a dielectric material a high frequency electric field from a high frequency oscillation generator having high potential and ground potential terminals, said applicator comprising a grounded conductive base plate coupled to said ground potential terminal, said plate having an opening therein, a high potential electrode coupled to said high potential terminal, said high potential electrode being positioned in said opening and having a top surface lying substantially in the plane of said plate; a freely removable low potential electrode adapted to be placed into operative relation with said high potential electrode so as to engage said material therebetween, and a conductive flange, said low potential electrode and said conductive flange being removably coupled mechanically and electrically whereby said low potential electrode is removable from said conductive flange, said conductive flange being positionable on said low potential electrode to be capacitively coupled with said base plate when said high and low potential electrodes are brought into operative relation.

4. A device for heating a thermoplastic dielectric material by a high frequency electric field comprising a first electrode, a conductive base plate extending radially outwardly in the plane of said electrode but insulated therefrom, said electrode and said base plate being adapted for connection to a source of high frequency electric energy, a second electrode adapted to be positioned in cooperative, spaced, opposed relation to said first electrode and said base plate to establish an electric field therebetween, said second electrode including a central weighted portion which opposes said first electrode, and a radially extending flange portion electrically and removably connected to said central portion, said radially extending flange portion being positioned near the operating face of said central weighted portion to be opposed to and capacitively coupled with said base plate when said first and second electrodes are in said cooperative, spaced relation.

5. A device of the character described in claim 4 in which said electrodes are held together by a magnetic force of attraction.

6. A device of the character described in claim 4 which includes a switch connected to said first electrode and operable in response to the weight of said second electrode for controlling the application of said high frequency electric energy between said base plate and said first electrode.

7. A device of the character described which includes a first electrode adapted to be connected to the high potential terminal of a high frequency generator, a conductive base plate adjacent said electrode but insulated therefrom, said base plate being adapted for connection to the grounded terminal of said generator, the upper surfaces of said electrode and said base plate lying in approximately the same plane, a freely removable second electrode, said second electrode including a weighted portion to oppose said first electrode, and a coupling flange portion to oppose and capacitively couple with said base plate, said weighted portion being removably connected to said coupling flange portion to be replaceable, said second electrode being adapted to be brought into cooperative relation with said first electrode and said base plate, the capacity between said coupling flange and said base plate bringing said second electrode to substantially the same potential as said base plate when said second electrode

is in said cooperative relation whereby an electric field is established between said electrodes.

8. A device of the character described in claim 4 in which said first electrode is mounted for limited movement in response to pressure applied thereto due solely to the weight of said second electrode, and switch means, actuated by the movement of said first electrode, for controlling the application of said high frequency currents to said electrodes.

9. A heat sealing applicator for thermoplastic dielectric sheet materials and the like, comprising in combination, a conductive base plate element normally grounded and having a high frequency power supply connection therewith, a high potential applicator electrode adjacent to and insulated from said base plate, means providing a high frequency power supply connection for said electrode, a second applicator electrode positioned in spaced opposed relation to said first applicator electrode to receive dielectric material therebetween to be heated, and a conductive flange element surrounding said second applicator electrode, said second applicator electrode being removably electrically connected to said conductive flange element to be replaceable, said conductive flange element being positioned on said second applicator electrode to be in opposed spaced relation to said conductive base plate to establish a high degree of capacity coupling therewith and a relatively low and substantially ground potential on said second electrode with respect to said high potential electrode.

10. An applicator for applying a high frequency electric field to a dielectric material comprising an annular base plate electrode, a plate electrode positioned coaxially and coplanarly with said base plate electrode and insulated therefrom, said base plate and plate electrodes being adapted to

adapted to be respectively connected to the low and high potential terminals of a radio frequency generator, and a movable electrode, said movable electrode including a central portion to opposite said plate electrode and adapted to be brought into bonding relationship therewith and an annular portion to oppose said annular base plate electrode and adapted to be brought into capacitive relation therewith, said central portion being electrically in contact with and slidably removable from the center of said annular portion to permit the replacement thereof.

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