

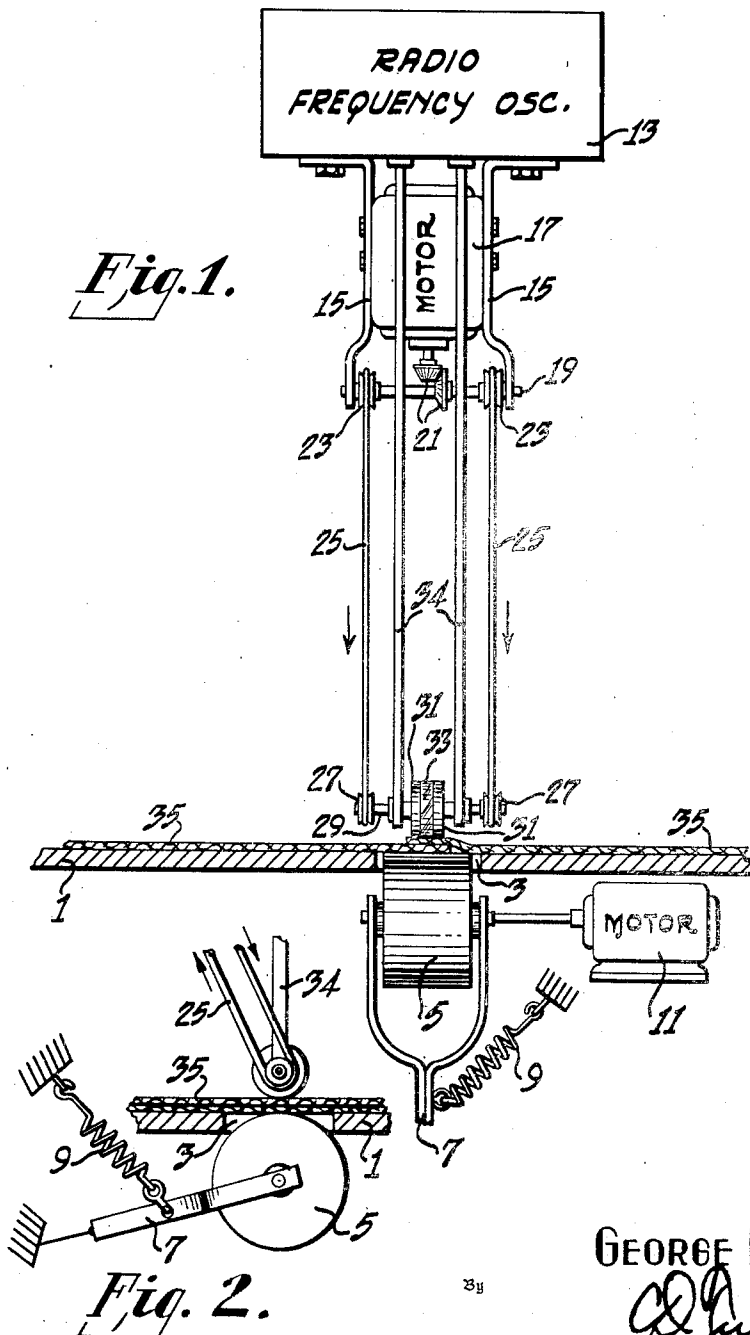
Jan. 18, 1949.

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HIGH-FREQUENCY ELECTRICAL BONDING APPARATUS FOR  
BONDING WIDE LAYERS OF DIELECTRIC MATERIALS

2,459,260

Filed Aug. 23, 1943

2 Sheets-Sheet 1



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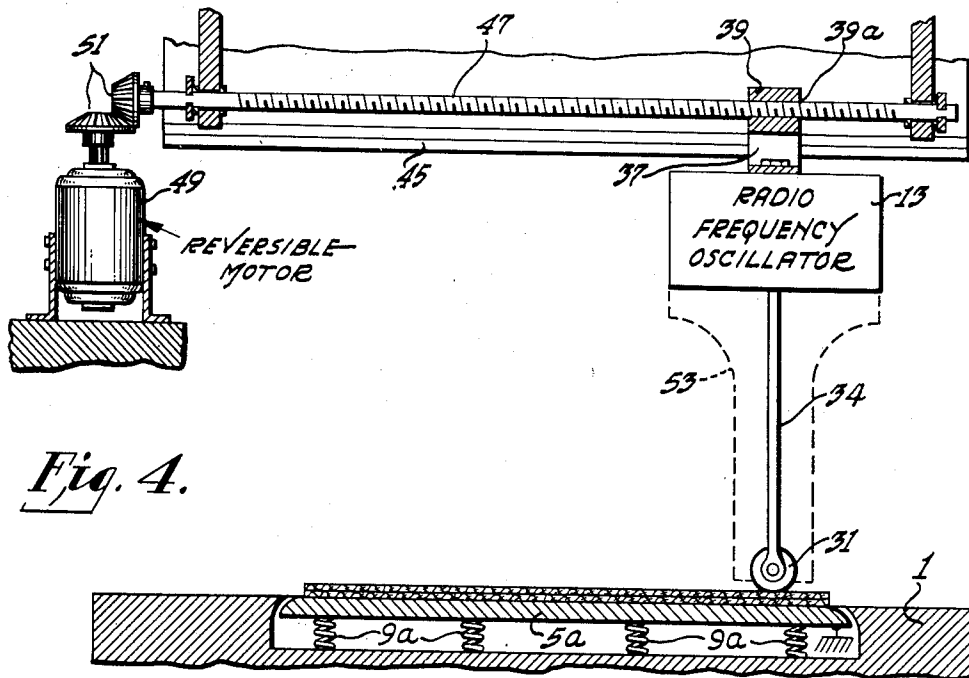


*Fig. 4.*

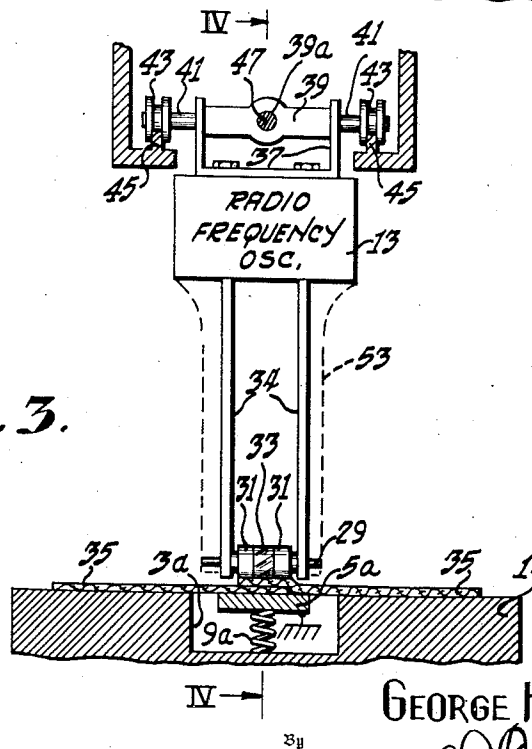


*Fig. 3.*

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## UNITED STATES PATENT OFFICE

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HIGH-FREQUENCY ELECTRICAL BONDING  
APPARATUS FOR BONDING WIDE LAYERS  
OF DIELECTRIC MATERIALSGeorge H. Brown, Princeton, N. J., assignor to  
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Application August 23, 1943, Serial No. 499,599

5 Claims. (Cl. 219-47)

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This invention relates to apparatus for bonding materials electrically, and more particularly to electronic apparatus for sealing together two or more parts or layers of material at least one of which is thermoplastic in nature and is rendered tacky when heated, the present invention being in the nature of an improvement over that disclosed and claimed in the copending application of Cyril N. Hoyler, Serial No. 477,478, filed February 27, 1943, and assigned to Radio Corporation of America.

In the aforesaid copending application, there is disclosed a so-called electronic bonding or "sewing" machine which includes a pair of electrodes coupled to a high frequency oscillation generator and between which the parts to be united are passed. In one form of invention therein disclosed, the electrodes are constituted by a pair of rollers mounted on parallel shafts which are coupled to the generator by a suitable transmission line. Practical considerations dictate that the mounting shafts for the roller electrodes shall be of fairly short lengths. In many instances, however, it is desirable to bond together two or more layers of very wide material. If the shafts on which the electrode rollers are mounted are to be made long enough to provide a head on the machine of sufficient length to accommodate very wide material, the length of the path along which the high frequency current will pass becomes so great that considerable power is lost at the relatively high frequencies at which the machine operates.

The primary object of my present invention is to provide an improved electronic bonding machine of the type set forth above which will be free from the aforementioned difficulty.

More particularly, it is an object of my present invention to provide an improved electronic bonding apparatus of the type set forth in which very wide layers of material or other parts to be bonded together can be readily accommodated.

Another object of my present invention is to provide an improved electronic bonding apparatus as aforesaid which will utilize the available power to maximum advantage.

Still another object of my present invention is to provide an improved electronic bonding apparatus of the type set forth which is simple in construction, relatively inexpensive in cost, and highly efficient in use.

In accordance with my present invention, I provide a work supporting table having an opening into which extends one electrode. Above the work supporting table, I arrange an assembly which in-

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cludes a high frequency oscillation generator and a pair of axially aligned electrodes which are insulated from each other and which cooperate, as a unit, with the first mentioned electrode to receive therebetween the parts to be bonded. Each of the pair of electrodes is connected by a transmission line to the generator, and the transmission line is preferably made of a length equal to substantially one-quarter of the wavelength at the operating frequency, whereby maximum voltage is applied to the work. The two electrodes of the unit cooperate with the first mentioned electrode to provide therebetween a high frequency electric field which produces dielectric losses in the parts to be bonded to thereby heat the same. Preferably, the electrodes all have sufficient mass to conduct away from the outer surfaces of the parts being bonded together the heat developed therein, so that only the inner, contacting regions thereof remain tacky and are caused to adhere to each other in the manner more fully disclosed and claimed in the above identified copending application of Hoyler.

In one form of the present invention, the electrodes are all constituted by conductive rollers which may be power driven to advance or feed the work forward therebetween. In another modification of this invention, the lower electrode is in the form of an elongated bar or plate, and the assembly above the work table is mounted on suitable track structure or the like for movement along the length of the lower electrode. This form may be found more expedient where the work is of large area and where it is comparatively difficult to feed it forward.

The novel features that I consider characteristic of my 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 of several embodiments thereof when read in connection with the accompanying drawings in which

Fig. 1 is a front elevation of an electronic bonding apparatus constructed in accordance with my present invention,

Fig. 2 is a fragmentary side elevation thereof showing the relation of the electrode rollers to each other,

Fig. 3 is a view similar to Fig. 1 but showing a different form of my invention, and

Fig. 4 is a view partly in side elevation and partly in section taken on the line IV-IV of Fig. 3.

Referring more particularly to the drawing wherein similar reference characters designate corresponding parts throughout, there is shown in Figs. 1 and 2 a work supporting plate 1 such as a table top or the like which may be either of insulating material or a grounded conductive material and which has an opening 3 therein. Extending into the opening 3 is a conductive roller 5 which constitutes one electrode and which is rotatably carried by a yoke member 7. The yoke 7 may be constantly urged in an upward direction by a spring 9 and is preferably connected to ground whereby to ground the roller 5. A motor 11 may be coupled to the shaft of the roller 5 to drive the latter if desired.

Suitably mounted above the work supporting member 1 is a high frequency oscillation generator 13, such as a vacuum tube oscillator adapted to operate at radio frequencies. A frame 15 suspended from the casing of the oscillator 13 has fixed thereto a motor 17 and also rotatably carries a shaft 19 which is coupled to the motor 17 by the gears 21. The shaft 19 has fixed thereto a pair of pulleys 23 which are connected by belts 25 to a second pair of pulleys 27 on a lower shaft 29 which is parallel to the shaft or axis of the roller 5 and is disposed in close proximity to the opening 3. The shaft 29 has secured thereto a pair of axially aligned, spaced, conductive rollers 31 which are insulated from each other by an insulating roller 33, the rollers 31 being also insulated from the shaft 29 and acting as a unit in the manner more fully hereinafter described.

The rollers 31 are connected by means of a transmission line 34 to the oscillator 13. Preferably, the line 34 has a length equal substantially to one-quarter of the wave length at the operating frequency of the generator 13 whereby maximum voltage is applied to the electrodes 31 and 5. As will be clearly seen from Fig. 1, the roller 5 has a width sufficient to bridge the two rollers 31, and the rollers 31 cooperate, as a unit, with the roller 5 to receive therebetween two layers of dielectric material 35, the overlapping marginal portions of which are to be bonded together. For this purpose, the overlapped portions of the work 35 are fed between the rollers 5 and 31 and constitute the dielectric therebetween so that the electric fields set up between the rollers 31 on the one hand and the roller 5 on the other, which fields are of opposite phase instantaneously, will develop dielectric losses therein to thereby heat the work. The electrodes 5 and 31 are caused to engage the work in response to the pull of the spring 9 on the yoke 7 in an upward direction. Thus, by reason of the heat developed in the work and the pressure applied thereto by the rollers 5 and 31, the two layers of the work 35 will be bonded together.

The motor 17 is employed to drive the rollers 31 at the same peripheral speed as that at which the motor 11 drives the roller 5. In this way, the work may be fed forward in a continuous operation. At the same time, since the assembly comprising the oscillator 13, the motor 17, the transmission line 34, the electrode rollers 31 and associated parts is mounted above the work table 1 and the work 35, it is apparent that work of any width may be received by the machine between the contacting rollers 5 and 31. Also, since the transmission line is one-quarter wave length long, maximum voltage is applied to the work and a minimum of power is lost.

In some cases, it may be inexpedient or diffi-

cult to feed the work 35 forward by means of the rollers 5 and 31, particularly where the work 35 is extremely wide or where it is relatively heavy. In such cases, auxiliary feed rollers (not shown) may be provided to assist the rollers 5 and 31. Where such an arrangement is impractical or otherwise undesirable, the form of my invention illustrated in Figs. 4 and 5 may be employed. In this form of the invention, the work supporting member or table 1 is provided with an elongated opening 3a in which is disposed an elongated, conductive bar or plate 5a, which is preferably grounded. The frame 15, the motor 17, the pulleys 23 and 27 and the belts 25 of the arrangement shown in Fig. 1 are omitted, instead, the casing of the oscillator 13 may have secured thereto a bracket 37 provided with a crosspiece 39 and outwardly extending shafts 41 on which are mounted track wheels 43. The wheels 43 ride on a pair of parallel tracks 45 which extend in parallel relation to the length of the opening 3a and the electrode 5a. The crosspiece 39 is provided with a threaded opening 39a in which is received a feed screw 47 driven by a reversible motor 49 through the gears 51. The transmission line 34 may be enclosed within a casing 53 from the bottom of which extend the rollers 31 for cooperation with the electrode 5a.

The work 35 may be placed on the supporting member 1 with the overlapping marginal portions thereof between the stationary electrode 5a and the movable electrodes 31. A plurality of springs 9a insure engagement of both electrodes with the work therebetween. When the motor 49 is started, the feed screw 47 is driven to move the assembly comprising the oscillator 13, the transmission line 34 and the rollers 31 along the length of the electrode 5a. As in the case of Fig. 1, the electrode 5a is of a width sufficient to bridge the rollers 31. If found desirable, there may be used instead of rollers 31 a pair of conductive blocks which are insulated from each other by the insulating member 33 and which can slide along the upper surface of the work. In any case, the overlapping margins of the layers 35 will be bonded or "sewn" along two parallel paths or seams.

Although I have shown and described but two embodiments of my present invention, it will undoubtedly be apparent to those skilled in the art that many other modifications thereof, as well as changes in those herein described, are possible. I, therefore, desire that my invention shall not be limited except insofar as is made necessary by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In electrical apparatus for bonding together a plurality of dielectric parts with the aid of heat, the combination of a work supporting member for supporting said parts, said member having an opening therein, an assembly including (1) a source of high frequency electrical energy, (2) a pair of electrodes cooperating as a unit and electrically insulated from each other, and (3) a transmission line coupling each electrode of said pair to said source, said assembly being mounted above said work supporting member and being so arranged relative thereto that said electrodes are disposed in alignment with and in close proximity to said opening, a third electrode mounted below said work supporting member also in alignment with said opening whereby said unit and said third electrode are arranged in opposed relation and are adapted to receive said parts there-

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between, means associated with said electrodes for effecting engagement of said electrodes with said parts, said third electrode bridging said pair of electrodes and cooperating therewith for the establishment therebetween of a high frequency electric field for producing dielectric losses in said parts whereby to heat said parts, and track means above said work supporting member on which said assembly is movably mounted.

2. In electrical apparatus for bonding together a plurality of dielectric parts with the aid of heat, the combination of a work supporting member for supporting said parts, said member having an opening therein, an assembly including (1) a source of high frequency electrical energy, (2) a pair of electrodes cooperating as a unit and electrically insulated from each other, and (3) a transmission line coupling each electrode of said pair to said source, said assembly being mounted above said work supporting member and being so arranged relative thereto that said electrodes are disposed in alignment with and in close proximity to said opening, a third electrode mounted below said work supporting member also in alignment with said opening whereby said unit and said third electrode are arranged in opposed relation and are adapted to receive said parts therebetween, means associated with said electrodes for effecting engagement of said electrodes with said parts, said third electrode bridging said pair of electrodes and cooperating therewith for the establishment therebetween of a high frequency electric field for producing dielectric losses in said parts whereby to heat said parts, supporting means above said work supporting member, said assembly being movably mounted on said supporting means for movement thereon in predetermined relation to said third electrode, and power means for moving said assembly on said supporting means.

3. In electrical heating apparatus for bonding together a plurality of dielectric parts with the aid of heat, the combination of a work supporting member for supporting said parts, said member having an elongated opening therein, an assembly including (1) a source of high frequency electrical energy, (2) a pair of electrodes cooperating as a unit and electrically insulated from each other, and (3) a transmission line coupling each electrode of said pair to said source, supporting means disposed above said work supporting member, said assembly being movably mounted on said supporting means and being so arranged thereon that said electrodes are disposed in close proximity to said opening and are constantly maintained in alignment with said opening upon movement of said assembly on said supporting means, a third electrode mounted below said work supporting member also in alignment with said opening whereby said unit and third electrode are arranged in opposed relation and are adapted to receive said parts therebetween, said third electrode extending along sub-

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stantially the full length of said opening and being of a width sufficient to bridge said pair of electrodes at all times regardless of the position of said assembly in relation to said third electrode, and means associated with said electrodes for effecting engagement of said electrodes with said work regardless of said position, said third electrode and said pair of electrodes cooperating to set up therebetween a high frequency electric field for producing dielectric losses in said parts whereby to heat said parts.

4. The invention set forth in claim 3 characterized in that said supporting means comprises track structure disposed in parallel relation to the length of said opening, and characterized further in that said assembly also includes a plurality of track wheels resting on said track structure whereby said assembly is suspended from said track structure.

5. The invention set forth in claim 3 characterized in that said supporting means comprises track structure disposed in parallel relation to the length of said opening, characterized further in that said assembly also includes a plurality of track wheels resting on said track structure whereby said assembly is suspended from said track structure, and characterized still further by the addition of power means for moving said assembly along said track structure whereby to cause said assembly to move along the length of said opening to thereby cause said unit to traverse the length of said third electrode.

GEORGE H. BROWN.

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